SEWERAGE and WATER BOARD

of

NEW ORLEANS

SPECIFICATIONS

FOR

CONTRACT 1438

COMBUSTION-TURBINE GENERATOR 7 PROCUREMENT (RE-BID OF CONTRACT 1419)

Proposals Due:

[11:00 A.M., Local Time on April 11, 2022]

SEWERAGE & WATER BOARD OF NEW ORLEANS
ADVERTISEMENT FOR BIDS

CONTRACT 1438 Combustion-Turbine Generator 7 Procurement

March 25, 2022

Sealed Bids for **Contract 1438 Combustion-Turbine Generator 7 Procurement**, addressed to **Sewerage and Water Board of New Orleans**, will be received at the office of the Purchasing Agent, Room 133, 625 St. Joseph Street, New Orleans, Louisiana 70165, until 11:00 o'clock a.m., local time, on the 11th day of April, 2022. Any Bids received after the specified time will not be considered.

Bids will then be publicly opened and read in person at 2:30 p.m. in the Personnel Conference Room, Room 112A, at the Sewerage and Water Board of New Orleans administrative building at 625 St. Joseph Street, New Orleans, Louisiana 70165.

The Project contemplated consists of the furnishing, testing, delivery, and commissioning of one combustion turbine-generator, one new fuel gas compressor, and associated auxiliary equipment to provide a minimum of 18MW of net output of 60-Hz generation capacity. This Project is a re-solicitation of bids for Contract 1419.

Bidding Documents and proposal forms are available gratis from Sewerage & Water Board of New Orleans website: www.swbno.org (Click on Doing Business, then Bids, then Advertisements and Specifications).

SWBNO has elected to use LaPAC, the state's online electronic bid posting and notification system, in addition to its standard means of advertising this requirement. LaPAC is resident on State Purchasing's website at https://wwwcfprd.doa.louisiana.gov/OSP/LaPAC/dspBid.cfm?search=department&term=181 and is available for vendor self-enrollment. In that LaPAC provides an immediate e-mail notification to subscribing bidders that a solicitation and any subsequent addenda have been let and posted, notice and receipt thereof is considered formally given as of their respective dates of posting dates. Though not required if receiving solicitation and addenda notices from LaPAC, SWBNO will mail addenda to all vendors contacting our office and requesting to be put on our office Vendor Listing for this solicitation.

Attention of Bidders is called particularly to the requirements for conditions of employment to be observed related to Section 3 (Low Income Resident Participation) of the Housing and Urban Development Act of 1968, Section 109 (Non-Discrimination) of the Housing and Community Development Act of 1974, Section 503 (Non-Discrimination Against Employees with Disabilities) and Section 504 (Non-Discrimination Against Individuals with Disabilities) of the Rehabilitation act of 1973, Segregated Facilities, Executive Order 11246, and all applicable laws and regulations of the Federal government and State of Louisiana.

Minority owned firms, small businesses, and/or Section 3 businesses are encouraged to participate.

Sewerage & Water Board of New Orleans
625 St Joseph St
New Orleans, LA 70165

MATERIAL BID PROPOSAL # C1438

A. MATERIAL BID PROPOSAL GENERAL INFORMATION

1.0 Scope: To furnish services and materials and equipment required to furnish, test, deliver, and commission one new Combustion Turbine Generator, one new Fuel Gas Compressor, associated auxiliary equipment to provide a minimum of 18MW net output of 60-Hz generation capacity. and the requirements contained in this Material Bid Proposal.

1.1 Contract Times: All Work shall be completed within 600 days. Major Component Delivery Dates/Milestones are detailed in Section 01 11 01 of the Technical Specifications.

2.0 Owner:	Sewerage & Water Board New Orleans 625 St Joseph St New Orleans, Louisiana 70165
3.0 Owner Representative:	Jacobs Engineering Group, Inc.
***4.0 Release Date**:*	*March 25, 2022*
***5.0 Bid Due Date and Time**:*	*11:00 am April 11, 2022*
***6.0 Bid Opening Date and Time**:*	*2:30 pm April 11, 2022*
***7.0 Bid Opening location**:*	***Bid due to:*** *Room 133* *Sewerage & Water Board New Orleans* *625 St Joseph St* *New Orleans, LA 70165* ***Bid Opening access information:*** *Room 112A – Personnel Conference Room* *Sewerage & Water Board New Orleans* *625 St Joseph St* *New Orleans, LA 70165*
8.0 Pre-bid Conference:	*There will not be a pre-bid conference for this solicitation.*

9.0 Bid Proposal Documents

9.1 The following documents are made a part of this Bid Proposal and are listed as contained herein:

- Cover Sheet
- Table of Contents
- Advertisement for Bids
- Material Bid Proposal General Information
- Instructions to Bidders
- Material Bid Proposal Form
- Bid Bond Form
- Contract Form
- Technical Specifications

9.2 Section 6-16 *Professional Service Contracts* is not applicable for this contract.

10.0 Bid Security: in the form of a bid bond, certified check or cashier's check as prescribed by LARS 38:2218.A is attached to and made a part of this bid.

11.0 Non-Escalation Clause: The bid prices contained in the Bid Proposal are firm and not subject to escalation.

12.0 Disadvantaged Business Enterprise Program

12.1 Policy to Enhance the Use of DBE Vendors

All vendors/contractors are encouraged to identify and use S&WB'S certified DBE Vendors to the fullest extent possible in major as well as minor purchases of heavy equipment, hardware supplies, etc.

Additionally, the originating Department will include within the specifications the most currently available approved DBE vendor listings.

The Sewerage and Water Board believes that developing such a policy would be a positive step to increase the dollar value of contracts awarded to DBE vendors and subcontractors.

12.2. Access to Approved Vendor Lists

The current listings of Vendors approved by the Sewerage and Water Board are available for use by the bidders on the Sewerage and Water Board external Website, WWW.SWBNO.ORG.

12.3 Form 00 47 17 Disadvantaged Business Enterprise Program provides guidance for DBE requirements determined to be greater than 0%.

Sewerage & Water Board of New Orleans
625 St Joseph St
New Orleans, LA 70165

MATERIAL BID PROPOSAL # C1438

B. INSTRUCTIONS TO BIDDERS

1.0 General

1.1 All definitions set forth in the Draft Contract, or in other Contract Documents are applicable to the Bidding Documents.

1.2 Addenda are written or graphic instruments issued by Owner's Representative (OR) prior to the opening of bids which modify or interpret the Bidding Documents by additions;

1.3 A bid is a complete and properly signed proposal to do the work or designated portion thereof for the sums stipulated therein supported by data called for by the Bidding Documents.

1.4 Base bid is the sum stated in the bid for which the Bidder offers to perform the work described as the base, to which work may be added, or deleted for sums stated in alternate bids.

1.5 An alternate bid (or alternate) is an amount stated in the bid that may be awarded to a Contractor in lieu of the Base Bid.

1.5.1 Bidder may choose not to submit price on alternate or base bid

1.5.2 SWBNO reserves the right to award to either the base bid or alternate bid in the SWBNO's best interest.

1.6 A Bidder is one who submits a bid for a prime Contract with the Owner for the work described in the proposed Contract Documents.

1.7 A Sub-bidder is one who submits a bid to a Bidder for materials and/or labor for a portion of the work.

1.8 Where the word "Engineer" is used in any of the documents, it shall refer to the General Superintendent of SWBNO

2.0 Bidder's Representation

2.1 Each Bidder by making their bid represents that:

2.1.1 They have read and understands the Bidding Documents and his bid is made in accordance therewith.

2.1.2 Their bid is based solely upon the materials, systems, equipment, and services described in the Bidding Documents as advertised and as modified by addenda.

2.1.3 Their bid is not based on any verbal instructions contrary to the Contract Documents and addenda.

3.0 Bidding Documents

3.1Copies

3.1.1 Complete sets of the Bidding Documents are available in electronic form on the Sewerage & Water Board of New Orleans website: www.swbno.org (Click on Bids and Business, then Bid Ads and Spec) and may be downloaded for use by interested bidders. Reproduction costs for any of the downloaded electronic Bidding Documents shall be borne by the Contractor.

3.1.2 Complete sets of Bidding Documents shall be used in preparing Bids. Neither Owner nor Engineer assumes responsibility for errors or misinterpretations resulting from use of incomplete sets of Bidding Documents.

3.1.3 **Drawings** included in the Bidding Documents are electronic .pdf files generated from electronic drawing files. Any reduction from actual size is indicated by a note or scale bar on Drawing.

3.1.4 Owner and Engineer, in making Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not authorize or confer a license or grant for any other use.

3.2 Interpretation or Correction of Bidding Documents

3.2.1 Bidders shall promptly notify the Owner of any ambiguity, inconsistency, or error which they may discover upon examination of the Bidding Documents or of the site and local conditions.

3.2.2 Bidders requiring clarification or interpretation of the Bidding Documents shall make a written request to the Owner, to reach him at least fifteen (15) Working Days prior to the date for receipt of bids.

3.2.3 Any interpretation, correction or change of the Bidding Documents will be made by addendum. Interpretations, corrections, or changes of the Bidding Documents made in any other manner will not be binding, and Bidders shall not rely upon such interpretations, corrections, and changes.

3.3 Substitutes and "Or-Equals"

3.3.1 Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

3.3.1.1. "Or-Equal" Items: If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

A. in the exercise of reasonable judgment, Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and

3) it has a proven record of performance and availability of responsive service.

B. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

3.3.1.2. Substitute Items:

A. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

B. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

C. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.

D. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time,

b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and

c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services; and

4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.

3.3.2. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 3.3.1.2.

3.3.3. Engineer's Evaluation: Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 3.3.1 and 3.3.2. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

3.3.4. Special Guarantee: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

3.3.5. Engineer's Cost Reimbursement: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 3.3.1.2 and 3.3.2. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

3.3.6. Contractor's Expense: Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

3.4 Addenda

3.4.1 All questions about the meaning or intent of the Bidding Documents are to be submitted to the Sewerage & Water Board Purchasing Department. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the office issuing documents as having received the Bidding Documents. Questions received less than 7 business days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

3.4.2 Addenda may also be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

3.4.3 Addenda issued in response to questions will be issued no later than 72 hours prior to bid opening.

4.0 Bidding Procedure

4.1 Form and Style of Bids

4.1.1Bids shall be submitted on the forms provided by the Owner.

4.1.2 All blanks on the Bid Form shall be filled in by typewriter or manually in ink.

4.1.3 Where so indicated by the makeup of the Bid Form, sums shall be expressed in both words and figures, and in case of discrepancy between the two, the written words shall govern. Where unit prices are provided, the unit price shall govern over an extension.

4:1.4 Any interlineation, alteration or erasure must be initialed by the signer of the bid or his authorized representative.

4.1.5 Bidders are cautioned to complete all alternates should such be required in the Bid Form. Failure to submit alternate prices, if applicable, will render the proposal informal and shall cause its rejection.

4.1.6 Bidder shall make no additional stipulations on the Bid Form nor qualify his bid in any other manner.

4.1.7 The bid shall include the legal name of Bidder. The bid shall be signed by the person or persons legally authorized to bind the Bidder to a Contract.

4.2 Bid Security

4.2.1 No bid shall be considered or accepted unless the bid is accompanied by bid security in an amount of not less than five percent (5%) of the base bid and all alternates.

4.2.2 The bid security shall be in the form of a certified check or cashier's check drawn on a bank insured by the Federal Deposit Insurance Corporation, or a Bid Bond written by a surety company licensed to do business in Louisiana, signed by the surety's agent or attorney-in-fact and countersigned by a person who is under Contract with the surety company or bond issuer as a licensed agent in this State and who is residing in this State.

4.2.3 The Bid Bond shall be written on a form provided by surety and surety must meet the qualifications stated therein. The Bid Bond shall be in favor of the Sewerage and Water Board of New Orleans and shall be accompanied by appropriate power of attorney.

4.2.4 Bid security furnished by the Contractor shall guarantee that the Contractor will, if awarded the work according to the terms of his proposal, enter into the Contract and furnish Performance and Payment Bonds as required by these Contract Documents, within ten (10) days after written notice of Proposal award.

4.2.5 Should the Bidder refuse to enter into such Contract or fail to furnish such bonds, the amount of the bid security shall be forfeited to the Owner as liquidated damages, not as penalty.

4.2.6 The Owner will have the right to retain the bid security of Bidders until either (a) the Contract has been executed and bonds have been furnished, or (b) the specified time has elapsed so that bids may be withdrawn, or (c) all bids have been rejected.

4.3 Submission of Bids

4.3.1Bids shall be sealed in an opaque envelope and will be received until the time specified and at the place specified in the Advertisement for Bids. It shall be the specific responsibility of the Bidder to deliver his sealed bid to the Sewerage and Water Board of New Orleans at the appointed place and prior to the announced time for the opening of bids. Late delivery of a bid for any reason, including late delivery by United States Mail, or express delivery, shall disqualify the bid. The bid envelope shall be identified on the outside with the name of the project, and the name and address of the Bidder. If the bid is sent by mail, the sealed envelope shall be"' enclosed in a separate mailing envelope with the notation "Bid Enclosed" on the face thereof. Such bids shall be sent by Registered or Certified Mail, Return Receipt Requested, or by express delivery addressed to:

Address for Postal Delivery
Sewerage & Water Board New Orleans
625 St Joseph St
New Orleans, LA 70165

Address for Courier or Overnight Delivery
Sewerage & Water Board New Orleans
625 St Joseph St
New Orleans, LA 70165

4.3.2 Bids shall be deposited at the designated location prior to the time on the date for receipt of bids indicated in the Advertisement for Bids, or any extension thereof made by addendum. Bids received after the time and date for receipt of bids will be returned unopened.

4.3.3 Bidder shall assume full responsibility for timely delivery at location designated for receipt of bids.

4.3.4 Oral, telephonic, or telegraphic bids are invalid and shall not receive consideration. Owner shall not consider notations written on outside of bid envelope which have the effect of amending the bid. Written modifications made on the Bid Proposal Form will not be accepted.

4.4 Modification or Withdrawal of Bid

4.4.1 A bid may not be modified, withdrawn or cancelled by the Bidder during the time stipulated in the Advertisement for Bids, for the period following the time and bid date designated for the receipt of bids, and Bidder so agrees in submitting his bid, except in accordance with LARS 38:2214 which states, in part, "Bids containing patently obvious mechanical, clerical or mathematical errors may be withdrawn by the Contractor if clear and convincing sworn, written evidence of such errors is furnished to the public entity within forty-eight hours of the Bid Opening I excluding Saturdays, Sundays and legal holidays.

4.4.2 Prior to the time and date designated for receipt of bids, bids submitted early may be modified or withdrawn only by notice to the party receiving bids at the place and prior to the time designated for receipt of bids.

4.4.3 Withdrawn bids may be resubmitted up to the time designated for the receipt of bids provided that they are then fully in conformance with these Instructions to Bidders.

4.4.4 Bid Security shall be in an amount sufficient for the bid as modified or resubmitted.

5.0 Consideration of Bids
5.1Opening of Bids

5.1.1The properly identified Bids received on time will be opened publicly at the place, date and time indicated in these specifications.

5.2 Rejection of Bids

5.2.1The Owner shall have the right to reject any or all bids and in particular to reject a bid not accompanied by any required bid security or data required by the Bidding Documents or a bid in any way incomplete or irregular.

5.3 Acceptance of Bid

5.3.1It is the intent of the Owner either the lowest Base Bid proposal or the lowest Alternate bid proposal, whichever is in the best interest of the Owner.

6.0 Performance and Payment Bond
6.1Bond Required

6.1.1The Contractor shall furnish and pay for a Performance and a Payment Bond written by a company licensed to do business in Louisiana, which shall be signed by the surety's agent or attorney-in-fact and countersign by a person who is under Contract with the surety as a licensed agent in this State and who is residing in this State in an amount equal to one hundred percent (100%) of the Contract amount. Surety must be listed currently on the U.S. Department of Treasury

Financial Management Service List (Treasury List) as approved for an amount equal to or greater than the contract amount. The Bonds shall be signed by the surety's agent or attorney-in-fact and countersigned by a person who is under contract with surety as a licensed agent in this State, and who is residing in this State.

6.2 Time of Delivery and Form of Bonds

6.2.1The Bidder shall deliver the required bonds to the Owner prior to the execution of the Contract.

6.2.2 Bonds shall be in a form acceptable to the Sewerage and Water Board of New Orleans and shall be attached to the CONTRACT BETWEEN OWNER AND CONTRACTOR.

6.2.3 The Bidder shall require the Attorney-in-Fact who executes the required bond on behalf of the surety to affix thereto a certified and current copy of this power of Attorney.

7.0 Form of Agreement between Owner and Contractor

7.1 Award

7.1.11n accordance with Louisiana Law, when the Contract is awarded, the successful Bidder shall execute the Affidavits included in the Bidding Documents

7.1.2 The successful Bidder shall furnish to the Owner a certified copy of the minutes of the corporation or partnership meeting which authorized the party executing the bid to sign on behalf of the Contractor.

7.1.3 Maximum time for holding bids and award of the contract shall be (60) sixty days.

7.1.4 SWBNO shall incur no obligation to the Contractor until the Contract between Owner and Contractor is duly executed.

8.0 Excluded Parties List Verification

8.1 To be awarded a contract the bidder must be eligible to receive a contract under the Community Development Block Grant Program as determined by the Federal Government's Excluded Parties List. Prior to the contract award the successful bidder will be required to provide the names of the company's principals and their titles in addition to its name, address and telephone number. It will be the responsibility of the CONTRACTOR to verify subcontractor eligibility based on factors such as past performance, a yellow page listing, proof of liability insurance, possession of a federal tax ID number, debarment, and state licensing requirements. The prime CONTRACTOR may use the web site: http://sam.gov/ to determine if a subcontractor has been debarred at the federal level.

9.0 DUNS and Bradstreet Number - DUNS

9.1 The selected CONTRACTOR must have an active Data Universal Numbering System (DUNS) number prior to award of the contract. The verification of any active DUNS number is verified at www.sam.gov.

9.2 If the CONTRACTOR does not presently have a DUNS number; go to the following link to initiate the application process for the DUNS number; https://www.dnb.com/duns-number/get-a-duns.html. A DUNS number can be obtained free of charge to the CONTRACTOR applicant.

9.3 All subcontractors must have an active DUNS number prior to execution of any subcontract between the selected CONTRACTOR and subcontractor.

Sewerage & Water Board of New Orleans
625 St Joseph St
New Orleans, LA 70165

MATERIAL BID PROPOSAL # C1438

C. MATERIAL BID PROPOSAL FORM

TO: Sewerage & Water Board New Orleans
625 St Joseph St
New Orleans, LA 70165

BID FOR: Procurement of Combustion Turbine Generator and Associated Equipment for Carrollton Water Plant

The undersigned bidder hereby declares and represents that she/he: a) has carefully examined and understands the Bidding Documents, b) has not received, relied on, or based his bid on any verbal instructions contrary to the Bidding Documents or any addenda, and hereby proposes to furnish services and materials in accordance with the Bidding Documents prepared by Jacobs Engineering Group, Inc.

Bidders must acknowledge all addenda. The Bidder acknowledges receipt of the following ADDENDA:

Enter the number the Owner has assigned to each of the addenda that the Bidder is acknowledging

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1. BASE BID: Lump sum cost to supply NEW CTG Equipment meeting all the requirements of the Scope of Work and Schedule included in the Bidding Documents:

_____Dollars

BASE BID (numbers) = $_____.

2. ALTERNATE BID: Lump sum cost to supply REFURBISHED CTG Equipment meeting all the requirements of the Scope of Work and Schedule included in the Bidding Documents:

_____Dollars

ALTERNATE BID No.1 TOTAL (numbers) = $_____

NAME OF BIDDER: _____

ADDRESS OF BIDDER: _____

NAME OF AUTHORIZED SIGNATORY OF BIDDER: _____

TITLE OF AUTHORIZED SIGNATORY OF BIDDER: _____

SIGNATURE OF AUTHORIZED SIGNATORY OF BIDDER: _____

DATE: _____

D. BID BOND FORM

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned, _____ as Principal, and _____, of _____, A corporation duly organized under the laws of the state of _____ as **SURETY**, are held and firmly bound unto The Sewerage & Water Board of New Orleans, hereinafter called Obligee, in the penal sum of _____ Dollars ($_____), for the payment of which sum, well and truly to be made, the said Principal and the said SURETY, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

Whereas, the Principal has submitted BID for _____

_____.

NOW, THEREFORE,

a. If said BID shall be rejected, or in the alternate,

b. If said BID shall be accepted and the Principal shall execute and deliver a CONTRACT in the form of CONTRACT attachment hereto (properly completed in accordance with said BID} and shall furnish a BOND for his faithful performance of said CONTRACT, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said BID, then this obligation shall be void, otherwise the same shall remain in force and effect; it being expressly understood and agreed that the liability of the SURETY for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The SURETY, for value received, hereby stipulates and agrees that the obligations of said SURETY and its BOND shall be in no way impaired or affected by any extension of the time within which the OWNER may accept such BID, and said SURETY does hereby waive notice of any such extension.

SIGNED AND SEALED THIS _____ Day of _____ 2021 A

(SEAL)

In the presence of:

_____ Witness

_____ Principal

_____ Title

_____ Witness

_____ SURETY

_____ Title

IMPORTANT: SURETY companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state of Louisiana established agent.

ARTICLE IV.
DISADVANTAGED BUSINESS ENTERPRISE ("DBE") PROGRAM

It is the policy of the Board to encourage all vendors/contractors to identify and use S&WB certified DBE vendors to the fullest extent possible, even when a definitive DBE participation goal has not been established by the Board for a specific contract.

Contractor agrees to use its best efforts to carry out this policy by utilizing the current listings of approved DBE vendors available at the Board's website at www.swbno.org, or link to https://www.swbno.org/business_disadvantagedbusinessprogram.asp

BID BOND

Any singular reference to Bidder, Surety, Owner, or other party shall be considered plural where applicable.

BIDDER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

BID

Bid Due Date:
Project (Brief Description Including Location):

BOND

Bond Number:
Date (Not later than Bid due date):

Penal sum _____ _____
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

BIDDER	SURETY
_____(Seal)	_____(Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature and Title	Signature and Title (Attach Power of Attorney)
Attest: _____	Attest: _____
Signature and Title	Signature and Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Surety's liability.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2. All Bids are rejected by Owner, or

3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

END OF SECTION

AFFIDAVIT OF NONCOLLUSION

Each Bidder shall complete the following statement

STATE OF_____}
} ss
COUNTY OF_____}

Affiant is the agent authorized by the Bidder to submit the attached Bid. Affiant further states that the Bidder has not been a party to any collusion among Bidders in restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any State, Parish, or City official or employee as to quantity, quality, or price in the prospective Contract, or any other terms of said prospective contract; or in any discussions between Bidders and any State, Parish, or City official concerning exchange of money or other thing of value for special consideration in the letting of a contract.

Affiant further warrants that no person or selling agency has been employed or retained to solicit or secure such contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, except bona fide employees or bona fide established commercial or selling agencies maintained by Contractor for purpose of securing business.

_____
Name of Contractor

_____
Bidder (Affiant)

Subscribed and sworn to before me this _____ day of _____ , 20 _____

My commission expires: _____

_____ Notary Public

END OF SECTION

STATE OF _____

PARISH OF _____

AFFIDAVIT

BEFORE ME, the undersigned authority, duly commissioned and qualified and sworn in and for the State and Parish aforesaid, personally came and appeared _____ who after being duly sworn, did depose and say as follows:

1) He/she is the _____ (title) of _____ (company);

2) He/she has not been convicted of, or has entered a plea of guilty or nolo contendere to any of the crimes, or equivalent federal crimes, listed in Louisiana Revised Statute 38:2227, specifically: public bribery, corrupt influencing, extortion, money laundering, theft, identity theft, theft of a business record, false accounting, issuing worthless checks, bank fraud, forgery, contractors misapplication of payments, malfeasance in office.

3) The contracting entity, person or corporation whose principal(s), member(s), and /or Officer(s) have, within the preceding 5 years, not been convicted or plead guilty to, a felony under state or federal statutes, for embezzlement, theft of public funds, bribery, falsification or destruction of public records; (City Code Section 2-8)

4) The following is a list of individual partners, incorporators, directors, managers, officers, organizers, or members who have a minimum ten percent interest ownership interest in the bidding entity:

_____(name) _____(name)

_____(name) _____(name)

_____(name) _____(name)

5) No other persons hold an ownership interest in the bidding entity via a counter letter.

6) None of the above named individual partners, incorporators, directors, managers, officers, organizers, or members, who has a minimum ten percent interest ownership in the bidding entity, been convicted of, or has entered a plea of guilty or nolo contendere to any of the crimes, or equivalent federal crimes, listed in Louisiana Revised Statute 38:2227, specifically: public bribery, corrupt influencing, extortion, money laundering, theft, identity theft, theft of a business record, false accounting, issuing worthless checks, bank fraud, forgery, contractors misapplication of payments, malfeasance in office.

7) He/she is not delinquent on any taxes owed the City of New Orleans or fees/charges to the Sewerage and Water Board. (City Code Section 2-8)

The following sections apply only to Public Works Contracts:

8) In accord with LA Revised Statute 38:2212.10 the entity represented herein is registered and participates in the "Status verification system" of the Illegal Immigration Reform and Immigrant Responsibility Act of 1996, 8 U.S.C. 1324(a), known as the "E-Verify" program to verify that all employees in the State of Louisiana are legal citizens of the United States or are legal aliens.

9) The entity represented herein shall continue, during the term of the contract, to utilize a status verification system to verify the legal status of all new employees in the state of Louisiana.

10) The entity represented herein shall require all subcontractors to submit to the contractor a sworn affidavit verifying compliance with the Status verification system.

WITNESSES:

_____ _____

AFFIANT

_____

SWORN TO AND SUBSCRIBED BEFORE ME ON THIS

_____ DAY OF _____, 20_____.

_____ _____

NOTARY PUBLIC **Notary Id. No. or Bar Roll No.**

_____

PLEASE PRINT NAME OF NOTARY

PERFORMANCE BOND FORM

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR
(Name and Address):

SURETY
(Name and Address of Principal Place of Business):

OWNER (Name and Address):

CONTRACT

Date:
Amount:
Description (Name and Location):

BOND

Bond Number:
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest: _____
Signature and Title

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)

SURETY

_____(Seal)

Name and Title

Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

Attest: _____
Signature and Title

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner for the performance of the Contract, which is incorporated herein by reference.

2. If Contractor performs the Contract, Surety and Contractor have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no Owner Default, Surety's obligation under this Bond shall arise after:

3.1. Owner has notified Contractor and Surety, at the addresses described in Paragraph 10 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and

3.2. Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 3.1; and

3.3. Owner has agreed to pay the Balance of the Contract Price to:

1. Surety in accordance with the terms of the Contract;

2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

4. When Owner has satisfied the conditions of Paragraph 3, Surety shall promptly and at Surety's expense take one of the following actions:

4.1. Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or

4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to Owner for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Owner and Contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Contract, and pay to Owner the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by Owner resulting from Contractor Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or

2. Deny liability in whole or in part and notify Owner citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 4.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

6. After Owner has terminated Contractor's right to complete the Contract, and if Surety elects to act under Paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of Surety to Owner shall not be greater than those of Contractor under the Contract, and the responsibilities of Owner to Surety shall not be greater than those of Owner under the Contract. To a limit of the amount of this Bond, but subject to commitment by Owner of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

6.1. The responsibilities of Contractor for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional, and delay costs resulting from Contractor's Default, and resulting from the actions or failure to act of Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Contractor.

7. Surety shall not be liable to Owner or others for obligations of Contractor that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.

8. Surety hereby waives notice of any change, including changes of time, to Contract or to related subcontracts, purchase orders, and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and shall be instituted within two years after Contractor Default or within two years after Contractor ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1. Balance of the Contract Price: The total amount payable by Owner to Contractor under the Contract after all proper adjustments have been made, including allowance to Contractor of any amounts received or to be received by Owner in settlement of insurance or other Claims for damages to which Contractor is entitled, reduced by all valid and proper payments made to or on behalf of Contractor under the Contract.

12.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

12.3. Contractor Default: Failure of Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone
Surety Agency or Broker
Owner's Representative (engineer or other party)

END OF SECTION

PAYMENT BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (*Name and Address*):

SURETY (*Name, and Address of Principal Place of Business*):

OWNER (*Name and Address*):

CONTRACT

Effective Date of Agreement:
Amount:
Description *(Name and Location)*:

BOND

Bond Number:
Date (*Not earlier than Effective Date of Agreement*):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest: _____
Signature and Title

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

Attest: _____
Signature and Title

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to Owner, this obligation shall be null and void if Contractor:

2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2. Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with Contractor:

1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and

2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and

3. Not having been paid within the above 30 days, have sent a written notice to Surety and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.

5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.

6. Reserved.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions:

15.1. Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

15.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone Surety Agency or Broker: Owner's Representative (engineer or other party):

END OF SECTION

CONTRACT

THIS CONTRACT FOR SALE OF EQUIPMENT AND SERVICES ("Contract") is entered into as of the ____ day of _____, ____, Effective Date, by and between _____, having a principal place of business at _____ (the "Supplier"); and the Sewerage & Water Board of New Orleans, with principal offices at 625 St Joseph St, New Orleans, LA 70165 (the "Owner"). Owner and Supplier are referred to herein, individually, as a "Party" and, collectively, as the "Parties."

RECITALS

WHEREAS, Supplier is engaged in the business of manufacturing and delivering various kinds of power plant equipment and of providing services and training in support of the installation, commissioning, maintenance, and use thereof; and

WHEREAS, Owner desires to purchase, and Supplier desires to sell the Equipment, together with certain installation, commissioning, and maintenance support and training services in connection with Owner's Project located in New Orleans, Louisiana where the Equipment will be installed and the Services performed ("Site"), subject to the terms set forth herein;

NOW, THEREFORE, in consideration of the mutual promises stated herein, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

ARTICLE 1 - Definitions.

A. Definitions. As used in this Contract, the following terms have the meanings indicated:

"Affiliate" shall mean any entity that directly or indirectly controls, is controlled by or is under common control with a Party. For the purposes of this definition, "control" means the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of the controlled entity, whether through the ownership of voting securities or partnership or other ownership interests or by Contract or otherwise.

"Ambient Site Conditions" shall have the meaning ascribed in Article 19 of this Contract.

"Bidder" shall mean one who submits a bid for a Contract with the Owner for the work described in the proposed Contract Documents.

"Change in Control" shall mean the occurrence of one or more of the following events: (i) any entity shall become the direct or indirect beneficial owner of a majority of the equity interest in Owner; (ii) any entity shall obtain, by Contract or otherwise, the power to direct the affairs of or elect any of the directors (or other members of the governing body) of Owner; or (iii) any sale, lease, exchange, or other transfer (in one transaction or a series of related transactions) of a majority of the operating assets of Owner to any entity.

"Change in Law" shall mean a new Law or change to an existing Law, or a change in the interpretation or application of a Law by the cognizant executive or judicial authorities occurring after the Effective Date of Supplier's contract to Owner.

"Change Order" shall mean a mutually agreeable written agreement to change the Equipment, Services, or any provision of this Contract, which describes the change, identifies the agreement as a Change Order sets out adjustments, if any, in the Contract Price and any other provision of this Contract which is affected, and is signed by the Parties.

"Codes and Standards" shall have the meaning ascribed in Article 19 of this Contract. "Confidential Information" shall have the meaning ascribed in Article 34 of this Contract. "Contractor" shall mean the person, firm, partnership, or corporation with whom Owner has entered a contract to install the Equipment to be procured via this Contract.

"Contract Currency" shall mean the currency in which the Contract Price is stated in United States Dollars USD.

"Contract Documents" shall have the meaning ascribed in Article 39 of this Contract.

"Contract Price" shall mean the total price as consideration for the Equipment and the Services, as set forth in Article 3 of this Contract, and as may be adjusted from time to time in accordance with this Contract.

"Day" or "Days" shall mean a calendar day, including Saturdays, Sundays, and holidays, except that in the event that an obligation is due for performance on a Saturday, Sunday or US national legal holiday, the obligation shall be deemed due on the next business day thereafter.

"Document Submittals" shall mean the documents to be submitted by Supplier after Notice to Proceed and governed by Contract, which references sections of the Technical Specification Package for direction regarding submittals and submittal procedures. Documents that are indicated to be submitted by Bidder shall not be submitted with bid; they shall be submitted to Owner no later than twenty (20) days after bid opening.

"Delivery Point" shall have the meaning ascribed in Article 11 of this Contract. "Effective Date" shall mean the date described in Article 42 of this Contract.

"Governing Law" shall have the meaning ascribed in Article 41 of this Contract.

"Indemnified Party" shall have the meaning ascribed in Article 28 of this Contract.

"Indemnifying Party" shall have the meaning ascribed in Article 28 of this Contract.

"Key Personnel" shall be Supplier's Project Manager, the Site Manager, and the selected individuals rendering Technical Advisory Services.

"Kickoff Meeting" shall mean a project kick off meeting between Supplier's project execution team and Owner's project team.

"Law" or "Laws" shall mean those laws, regulations, decrees or similar orders with mandatory effect issued by the legislative, judicial or executive branch of any relevant government, in effect as of the date

of Supplier's contract to Owner, to the extent such laws, regulations, decrees or similar orders are applicable to the scope of this Contract.

"Local Laws" shall have the meaning ascribed in Article 19 of this Contract.

"National Laws" shall have the meaning ascribed in Article 19 of this Contract.

"Notice" shall have the meaning of any formal written announcement, notification or other communication required under this Contract. A Notice shall be deemed served if sent by certified mail to the address designated in this Contract.

"Owner" shall mean Sewerage & Water Board of New Orleans ("SWBNO"), the entity that is Contract, and any of its Affiliates or subsidiaries, and which owns the Facility in which the Equipment will be installed.

"Owner Representative" or "OR" shall mean Jacobs Engineering Group. ("JEG") or any of its affiliates or subsidiaries, acting on behalf of the Sewerage & Water Board of New Orleans ("SWBNO").

"Party" and "Parties" shall have the meanings ascribed in the foreword to this Contract.

"Payment Schedule" shall mean the schedule of payments described in Article 6 of this Contract.

"Project" shall mean Owner's project for which Supplier is supplying Equipment and/or Services as described in this Contract.

"Scheduled Major Component Delivery Dates" shall have the meaning ascribed in Article 11 of this Contract.

"Scope of Supply" shall mean the Equipment plus the Services, as set forth in the Technical Specifications.

"Services" shall mean those services described in Article 3(B).

"Site" shall mean the location of the Project and place where the Equipment will be installed:

Sewerage & Water Board of New Orleans
Carrollton Water Plant West Power Complex
8800 S Claiborne Ave
New Orleans, LA 70118

"Subcontractor(s)" shall mean any corporation, partnership, or individual having a contract with Supplier to supply material, equipment, labor, goods, or services to Supplier for inclusion in the Equipment or Services provided by Supplier under this Contract.

"Substantial Completion" shall mean that all the following conditions have been satisfied:

1. Supplier shall have completed the performance of the Work according to all of the provisions of this Contract to the extent necessary;

2. the Work shall have been completed in accordance with the terms of this Contract (except for minor deviations that in no way affect the safe, efficient and full use of the equipment) and shall

have satisfied all the requirements for the commencement of delivery of electricity into the public utility system;

3. Supplier shall have completed all of Supplier's items on the Substantial Completion punch list that in Supplier's reasonable judgment in accordance with prudent industry practices could prevent the safe, normal, and continuous operation of the Work; and

4. Supplier shall provide Owner written notice certifying the date upon which all the preceding conditions (1-3 above) have been satisfied.

Upon the satisfaction of all the above conditions, Substantial Completion will have occurred, and Owner shall accept the Work. If Owner believes any condition to Substantial Completion has not been satisfied, Owner shall notify Supplier thereof in writing within ten (10) business days after delivery of written notice, noted in 4. above. If Owner fails to so notify Supplier within this ten (10) business day period, then Substantial Completion shall be deemed to have occurred on the date stated in Suppliers notice.

"Supplier" shall mean any person, manufacturer, vendor, seller, firm, partnership, or corporation with whom Owner has entered this Contract.

"Supplier Taxes" shall mean corporate and individual taxes that are measured by net income or profit imposed by any governmental authority of any country on Supplier, its employees, subcontractors or contractors due to the execution of any agreement or the performance of or payment for Work hereunder, except for withholding tax for income on payments to Supplier.

"Technical Advisory Services" shall have the meaning ascribed in theTechnical Specifications.

"Unimpeded Access" shall mean Owner providing Supplier with access to the Unit(s) while Owner ensures that the following conditions are met: (i) the necessary fuels, lubricants, operating supplies and third party interconnections are continuously available; (ii) Owner's trained operators are available for operation of the Units); (iii) Owner will operate portions or all of the Facility at the times and at the loads reasonably requested by Supplier; (iv) Supplier will have unimpaired access to all facility work areas, station cranes and similar equipment; and (v) a copy of the control room log is made available to Supplier. Nonetheless, Supplier is responsible for its costs for the repeated Performance Tests, including, but not limited to, the items and services defined in (i) and (ii)

"Unit Price" shall mean the amount bid on a per "day," per "hour," per "trip" basis under Additive Alternate No. 1 as noted on the Material Bid Proposal Form. The "Unit Price" as bid shall not change for the term of the Contract.

"Warranty Period" shall have the meaning ascribed in Article 17 of this Contract.

"Work" shall mean the procurement, fabrication, and supply of the Equipment and the performance of the Services, and any corrective actions undertaken pursuant to Article 17.

B. Rules of Interpretation. The following rules of interpretation shall apply in construction of this Contract. Unless otherwise required by the context in which any term appears: (i) capitalized terms used in this Contract have the meanings specified in this Article, or as otherwise defied in this Contract, (ii) the singular shall include the plural, (iii) the words "herein," "hereof and "hereunder" shall refer to this

Contract as a whole and not to any particular section or subsection of this Contract, (iv) references to this Contract shall include a reference: to all attachments, appendices, annexes, schedules and exhibits hereto, as the same may be amended, modified, supplemented or replaced from time to time, (v) the words "include," "includes" and "'including" are not limiting, (vi) any consent to be given by either Party hereunder shall not be unreasonably withheld, delayed or conditioned, except as explicitly stated to the contrary herein, and (vii) references to any agreement, document or instrument shall mean a reference to such agreement, document or instrument as the same may be amended, modified, supplemented or replaced from time to time.

ARTICLE 2 - Scope of Supply

The Supplier shall manufacture and deliver the Equipment and perform the Services as more fully described in the Technical Specifications, subject to the terms and conditions set forth in this Contract.

ARTICLE 3 - Price

Owner shall pay to Supplier the following "Contract Price" in consideration of the Equipment and Services.

A. Taxes. The Contract Price is stated exclusive of state and local sales taxes. Sewerage & Water Board of New Orleans is exempt by statute from any sales tax, both state and local. The Contract Price is complete compensation for the provision of all Equipment and Services and includes all transportation and shipping costs imposed with respect to the provision of any Equipment or Services. Supplier shall be responsible for all present and future taxes, tariffs, VAT, duties, fees, deductions, withholdings, or other charges and liabilities (all together, "Taxes") imposed by any authorities outside of the State of Louisiana.

B. Services. The Contract Price includes all services, supervision, insurance, consumables, expendables, warranty and other contractual obligations, supplies, equipment, testing, inspection, to design, and fabricate the Equipment included in the Supplier's Scope of Supply attached hereto.

C. Price Adjustments. The Contract Price may be adjusted as necessary to take account of (a) Change Orders, or (b) other adjustments specifically provided for in this Contract.

D. Payment. Payment of Contract Price shall be made in accordance with the Payment Schedule set forth and the payment terms set forth in Article 6. In the case of Change Orders, payment shall be made in accordance with those terms stated in the Change Order.

E. Equipment/Service Description. Supplier will provide one total Contract Price to cover all items included in Scope of Supply.

ARTICLE 4 - Reserved

ARTICLE 5 - Technical Advisory Services

A. Technical Services Installation, Testing, Startup and Training. Supplier is providing Technical Advisory Services in accordance with the Technical Specification and Technical Services. Technical Advisory Services are an on-Site service offered by Supplier to provide technical guidance, advice, and counsel in relation to installation, testing and startup and maintenance of the Equipment based upon Supplier's current engineering, manufacturing, installation, testing, startup and operating practices, and consistent with the Clean Air Act, the Louisiana Environmental Quality Act, any applicable federal and state regulations. The objectives are installation, testing, and startup of the Equipment in a safe, efficient, technically correct, high quality manner, and subsequent reliable operation.

As part of the Technical Advisory Services, Supplier shall assist or train, as applicable, Owner in installation, testing and operation and maintenance as required by Technical Specification Reciprocating Internal Combustion Engine, to ensure that the equipment is installed, operated and maintained correctly so as to not void or limit the manufacturer's warranty.

B. Long Term Services Agreement. A Long-Term Services Agreement ("LTSA") is not included in this Contract; it shall be contracted separately, after award. Nevertheless, Supplier shall offer for purchase a LTSA.

ARTICLE 6 - Payments

A. Payment Milestones. In accordance with the Milestone Payment Schedule, for those payments tied to milestones, invoices shall only be issued upon completion of the milestone and submission by Supplier of the required documentation per this Article, Supplier's Submittal Schedule, and payment shall be due and payable net forty-five (45) Days from the date the Owner receives from the Owner Representative an approved and certified Supplier's invoice.

B. Invoices. The original and two (2) copies of an invoice referencing this Contract Number shall be sent by electronic mail and in PDF format to the Owner Representative, with a courtesy copy to Owner.

C. Retention. Five percent (5%) of each invoice payment will be withheld as retention; Retention money shall be withheld for no more than one hundred and eighty (180) days from delivery of the equipment and complete Contract deliverables, or thirty (30) days from the day Equipment passes the Performance Tests, whichever is later ("Retention Period"). Within twenty-one days (21) Days of the expiration of said Retention Period, Owner shall release all money then withheld to Supplier.

D. Effect of Changes in Contract Price. If any adjustment results in an increase to the Contract Price, Owner shall pay for the increase in accordance with the corresponding invoice submitted by Supplier. If any adjustment results in a decrease in the Contract Price, payments previously made shall be retained by Supplier and will be applied to subsequent payments as they become due.

E. Field Modifications. In the event Owner notes non-conformity in the Equipment as compared to Supplier provided Submittal and specifications, Owner shall send notice of such non-conformity to Supplier as soon as reasonably practicable. Supplier shall review Owner's claim of nonconformity, and if

Supplier agrees with the claim on non-conformity, then within five (5) Days of Supplier's receipt of Owner's notice, Supplier shall commence and continue to cure or remedy the nonconformity.

ARTICLE 7 - Bonds and Statements of Claims

A. Bonds. Supplier shall provide a payment bond and performance bond with a good, solvent, and sufficient surety in a sum no less than the total of the contract price for each bond. All aspects of bonds and statements of claims made applicable to this Contract shall be governed by Louisiana law. Notwithstanding the above, aggregate recovery of the payment bond and the performance bond shall not exceed the total amount of the Contract Price.

B. Requirements. The payment and performance bonds shall be statutory bonds and no modification, omissions, additions, in or to the terms of the contract, in the plans or specifications or in the manner and mode of payment diminish, enlarge, or otherwise modify the obligations of the bonds. The bonds shall be executed by the Supplier with surety or sureties approved by Sewerage & Water Board of New Orleans and shall be recorded with the contract in the office of the recorder of mortgages in the parish where the work is to be done not later than thirty (30) days after the work has begun.

Any surety bond written shall be written by a surety or insurance company currently on the U.S. Department of the Treasury Financial Management Service list of approved bonding companies which is published annually in the Federal Register. In addition, any surety bond written shall be written by a surety or insurance company that is currently licensed to do business in the State of Louisiana.

C. Inspection. Upon request of any person or entity appearing to be a potential claimant requiring payment for work done arising under this Contract, the Supplier shall promptly furnish a copy of the bonds or shall permit a copy to be made.

ARTICLE 8 - Permitting Obligations

Owner has secured a Louisiana Department of Environmental Quality Part 70 Operating Permit (PER20210001) (AI No. 5673). Supplier shall provide reasonable assistance to Owner in its endeavors relating to modifying the permitting of the Site by providing information and support during the application and review process. The Parties agree that, except for the Supplier's obligations specifically set forth in this Article, Supplier will not be liable for delays, denial, revocation, restriction, or non-renewal of above referenced permitting application and review process.

ARTICLE 9 - Correspondence

A. Contract Interpretation. Supplier shall submit all questions and requests for interpretation of the Contract documents prepared by Owner in writing to the Owner Representative (OR).

B. Notices. All notices required in writing under this Agreement will be considered as having been given by one Party to the other upon the latter Party's receipt of same. All notices will be transmitted by registered or certified mail, by overnight courier or facsimile with written confirmation.

C. Project Correspondence. Supplier shall serially number all correspondence issued under this Contract. Except as indicated elsewhere in this Contract or the attachments thereto, or as otherwise directed in writing by Owner, all correspondence to Owner shall reference the Contract number and shall be addressed in accordance with Article 9(B). The Owner Representative and Program Manager shall be copied on all project correspondence. These individuals may be identified in writing to the Supplier.

ARTICLE 10 - Key Personnel

A. Qualifications of Personnel. Supplier agrees to provide the services and work of competent and experienced personnel with backgrounds in providing similar services and work, and who are fluent in written English and verbal English.

B. Identification of Key Personnel. Supplier shall furnish Owner with resumes, including the names, titles, and qualifications, of its Key Personnel. Supplier shall insure that its employees and its subcontractor's employees have valid licenses, permits, certificates, Visas, and any other documentation necessary to perform their duties in accordance with all applicable laws, regulations, and other criteria. Supplier shall maintain records at the job site to show that its employees and its subcontractor's employees have valid licenses, permits, certificates, Visas, and any other documentation necessary to perform their duties.

C. Changes in Key Personnel. Supplier shall minimize changes to its Key Personnel. Owner shall have the right to request Key Personnel changes in the event Supplier’s personnel display substantial failure to complete his/her duties or for other reasonable cause under this Agreement. Supplier recognizes Owner's right to control access to the site, and Supplier agrees to provide Owner ten (10) days written notice prior any changes in Key Personnel.

ARTICLE 11 - Title Transfer, Delivery, Risk of Loss

A. Title. Title to the Equipment shall transfer to SWBNO upon arrival of goods at their destination, in accordance with Louisiana law for Free on Board Destination.

B Delivery. The Delivery Point shall be the Sewerage & Water Board of New Orleans, Carrollton Water Plant. The general terms of Delivery are set forth below:

> Once an item is available for shipment, Supplier will notify Owner of such status in writing in the Notice of Ready to Ship ("RTS"). An item of the Equipment will be "Ready to Ship” (or "RTS”) when it is available for shipment from the manufacturer's facility or warehouse. Supplier shall

provide the Notice of RTS for the Major Components for each Unit in advance of the actual Delivery of the Unit. Partial shipments will be allowed.

Supplier will unload and place all designated Equipment on the engine foundations. If there is a delay in unloading and placing the designated Equipment on foundations that Supplier did not cause, Supplier will be entitled to a Change Order.

C. Delivery Liquidated Damages. If any Major Component associated with any Unit is not delivered on or before their Scheduled Major Component Delivery Date for reasons attributable to Supplier and not excused elsewhere in this Contract, Supplier shall pay as liquidated damages for each such Major Component, and not as a penalty, a sum of $10,000.00 per day for the first thirty (30) days, and $25,000.00 per day thereafter, until actual Delivery of all Major Components in the aggregate. Supplier's aggregate liability hereunder for liquidated damages for delay in Delivery shall not exceed fifteen percent (15%) of the Contract Price, as may be amended. The liquidated damages for delay in Delivery shall be the Owner's exclusive remedy for, and the Supplier's sole obligations arising out of delay.

D. Risk of Loss. With respect to each item of Equipment, Risk of Loss, the parties specifically agree that, regardless of passage of title, the risk of loss to any of the Work and to any goods, materials, Equipment and furnishings, provided or to be provided under the Contract, shall remain with Supplier until Date of Delivery. Should any of the Work and/or goods, materials, Equipment, and furnishings be destroyed, mutilated, defaced, or otherwise damaged before Delivery, the Supplier shall repair or replace them at no additional costs to the Owner. Any performance bond or insurance protection required by this Contract or otherwise provided by the Owner or Supplier shall in no way limit the responsibility of the Supplier under this Section.

ARTICLE 12 - Reserved

ARTICLE 13 - Reserved

ARTICLE 14 - Reserved

ARTICLE 15 - Reserved

ARTICLE 16 - Observation, Inspection and Factory Testing

A. Observation at the Site. Supplier shall be afforded access during normal business hours to observe the work in progress at the Site. Supplier may visit the Site at any time or times or may maintain representatives to observe Owner's or Owner's contractor's work, provided such activity and inspections do not interfere with the Work.

B. Inspections, Tests, and Progress Evaluations at Supplier's Facilities. Owner shall be afforded access to Supplier's facilities provided reasonable written notice is given by Owner. Owner's inspector shall be provided access to Supplier's facilities during normal business hours to obtain information on production progress and make inspections. Owner shall have complete access to those areas concerned with Equipment; however, such access shall not include restricted areas where Work of a proprietary nature is being conducted. It is understood that no additional testing, other than required by the Contract, shall be required of Supplier, unless requested through a Change Order. Supplier shall not be required to delay manufacturing or other activities to accommodate Owner's inspection.

C. Inspections and Tests at Suppliers' Facilities. Subject to the conditions set forth in the foregoing paragraph, Supplier will make reasonable efforts to allow for Owner's access to its Suppliers' facilities for the purposes described in the paragraph above.

D. Inspection Not Acceptance. Owner's inspection of the Equipment or its failure to inspect does not relieve Supplier of its obligation to fulfill the requirements of this Contract, nor is it to be construed as acceptance by Owner.

ARTICLE 17 - Warranty

A. Warranty Period. Notwithstanding the Long Term Services Agreement set forth in accordance with Article 5(B), Supplier shall also warrant the Equipment and the associated Services on the terms set forth in this Article, for whichever period is greater (the "Warranty Period"): i) twenty four (24) months following Substantial Completion; or ii) thirty-six (36) months following Delivery of the Equipment to the Site.

B. Warranty. Supplier warrants to Owner that during the Warranty Period, the Equipment to be delivered hereunder shall be:

(1) designed and fit for the purpose of generating electric power when operated in accordance with Supplier's specific written operation instructions or, in the absence thereof, in accordance with generally accepted operation practices of the electric power producing industry;

(2) free from defects in design, material, workmanship, and title; and

(3) the Services shall be performed in a competent, diligent manner; and

(4) in compliance with 42 U.S.C. § 7541.

C. Remedy. Supplier, at its sole cost, shall promptly repair or, at Owner's discretion, replace any part or component of the Equipment which appears defective during the Warranty Period as a result of faulty design, materials, and/or workmanship; provided, when required by Supplier, that such part or parts replaced be returned to Supplier, at Supplier's cost, to the place instructed by Supplier. Owner shall take appropriate steps to prevent any defect from becoming more serious and to enable Supplier to rectify the aforesaid defect. Any warranty claims or requests with respect to Supplier's warranty must be made in writing as provided for in Notice provision during the Warranty Period.

Replaced parts shall become Supplier's property. Supplier shall bear all costs of repairing or replacing the defective parts originally supplied by Supplier, as well as the shipping costs of the defective parts and of the repaired or replacement parts between the Facility and the place of repair or replacement as instructed by Supplier.

D. Exclusions. Supplier does not warrant the Equipment or any repaired or replacement parts against normal wear and tear, including that due to environment or operation, type of fuel, detrimental air inlet conditions or erosion, corrosion, or material deposits from fluids. Supplier does not warrant defects caused by (a) materials or components or design provided by Owner or on behalf of Owner, (b) negligence of Owner, its employees, agents, or third parties, (c) use of parts, accessories, or attachments which are not sold, supported or expressly approved in writing by Supplier; (d) improper alterations by Owner, its employees, agents, or third parties; or (e) fluctuations in the grid.

The Parties agree that, as between the Parties, the preceding paragraphs of this Article set forth are the sole and exclusive remedies for all claims based on failure of or defect in the Equipment whether failure or defect arises before or during the warranty period and whether such a claim is based in contract, indemnity, warranty, tort (including negligence), strict liability, or otherwise.

ARTICLE 18 - Reserved

ARTICLE 19 - Compliance with Laws, Codes, and Standards

The Contract Price is based on the engineering and manufacture of the Equipment in accordance with Supplier's design criteria, manufacturing processes and procedures and quality assurance programs, to comply as of the Effective Date with:

-those portions of the codes and standards identified in the Technical Specifications which Supplier has deemed applicable to the Equipment ("Codes and Standards"),

-the applicable national Laws of the country where the relevant Equipment is installed ("National Laws"),

-the applicable Laws of the State of Louisiana where the relevant Equipment is installed ("Local Laws"),

-the Site Conditions (including temperature, humidity, elevation and any seismic or windloading requirements) identified by Owner prior to Effective Date and set forth in the Technical Specifications.

Supplier shall perform testing of said equipment and provide training to Owner consistent with the Clean Air Act, the Louisiana Environmental Quality Act, and any applicable federal and state regulations.

Supplier shall fully indemnify, defend, save harmless, and protect Owner, their officials, employees, successors, assigns, subsidiaries and Affiliates, and employees of all of them, against any fines or penalties paid by Owner to government or regulatory authorities arising from Supplier's noncompliance with such laws, regulations, or permit.

ARTICLE 20 - Hazardous Materials

For each chemical substance that Supplier brings onto Owner Site, Supplier shall furnish: all appropriate shipping certification; labeling in compliance with the Workplace Hazardous Materials Information System; and Material Safety Data Sheets in compliance with the Workplace Hazardous Materials Information System.

If, at the Site, Supplier encounters toxic substances, hazardous substances or hazardous wastes, (as such terms may be defined in any statute or ordinance or regulations promulgated by any federal, state or local governmental authority of the United States or the country of the Site) (collectively, the "Hazardous Materials") not brought onto the Site by Supplier, which require special handling and/or disposal, Supplier shall immediately notify Owner and not further exacerbate the existing conditions, and Owner shall immediately take measures required by federal and state laws and regulations to eliminate such hazardous conditions so that the work under the Contract may safely proceed. If any such Hazardous Materials cause an increase in Supplier's cost of or the time required for performance of any part of the work, an equitable adjustment shall be made in the price and schedule. Owner agrees to properly dispose of all Hazardous Materials produced or generated in the course of Supplier's work at the Site. Owner shall indemnify Supplier for any and all claims, damages, losses, causes of action, demands, judgments, and expenses arising out of or relating to (i) the presence of any Hazardous Materials which are present on the Site prior to the commencement of Supplier's work, (ii) improperly handled or disposed of by Owner, or (iii) brought on to the Site or produced thereon by parties other than Supplier.

ARTICLE 21 - Environmental, Safety, and Health Regulations (ES&H)

While on the premises of Owner, Supplier and its employees shall comply with all applicable environmental, safety and health laws, regulations, and ordinances and with the safety, health and plant regulations of Supplier and Owner, and shall ensure that all of its employees and agents have a safe place of work on said premises. Supplier shall keep said premises and the vicinity thereof clean of debris and rubbish caused by its work and, upon completion of its work, shall leave the premises clean and ready for use. Upon request of Owner, and at no cost or expense to Owner, Supplier shall promptly remove from said premises any person under the control of Supplier who violates any of the aforesaid environmental, safety and health laws, regulations, ordinances or plant regulations or who may justifiably cause or threaten to cause a breach of the peace.

ARTICLE 22 - Safety

Supplier shall proceed with the Work in a manner dictated by all applicable federal and state safety regulations, Owner Safety Manual, and safe practice, using materials, tools, and rigging of a safe character. Supplier shall strictly comply with these laws, rules, and regulations including, but not limited to, OSHA requirements, and shall provide documented evidence of that compliance upon the

Designated Representative's request. Supplier shall provide and use all protective devices to permit safe working conditions for Supplier's employees and to prevent hazards to employees of other suppliers, Owner and its employees, or the public. While on Owner's property, Supplier's personnel shall wear appropriate personal protection equipment. If, in Owner's opinion, Supplier is not proceeding with its Work in a safe manner or in accordance with federal, state, or Owner safety regulations, Owner may issue a Safety Violation Notice or otherwise stop the Work and direct Supplier to rectify the unsafe conditions immediately. If Supplier fails to promptly rectify the situation, and it is within his scope of supply to control, Owner may proceed to rectify the unsafe conditions at Supplier's reasonable expense. Compliance with this paragraph shall affect neither the Contract Price nor the schedule. Supplier shall comply with all Owner's and OSHA confined space requirements and procedures, including Owner's permitting requirements.

Owner will take all necessary precautions, at all times, for the safety of Supplier's personnel at Site. This includes, but is not limited to, instruction of Owner's safety practices, proper and safe handling of hazardous substances and protection of Supplier's personnel from exposure thereto, energization and de-energization of all power systems (electrical, mechanical and hydraulic) using a safe and effective lockout tagout procedure, and conducting daily safety meetings during construction and startup.

Supplier may, from time to time, conduct safety audits to ensure safe conditions exist and make recommendations to Owner concerning same. Neither the conduct or non-conduct of safety audits nor the making of any recommendation by Supplier shall relieve Owner of the responsibility to provide a safe place to work. If Supplier's personnel require medical attention, local Owner facilities will be made available to Supplier's personnel for the duration of such needs.

If, in Supplier's opinion, the safe execution of Services at the Site is, or is apt to be, imperiled by local conditions, Supplier may remove some or all of its personnel from the Site, and/or supervise performances of all or any part of its Services, and/or evacuate its personnel with assistance from Owner as necessary for said evacuation, any of which shall be an Excusable Delay.

Supplier will comply with health and safety applicable standards. To the extent a health and safety issue is identified, Supplier will promptly make all reasonable efforts to correct any safety conditions. If Owner or Supplier issues an order stopping all or part of the work due to a Safety issue that is not attributable to Supplier, this shall be treated as Owner delay and Supplier shall be entitled to a Change Order.

ARTICLE 23 - Plant Protection and Security

If the Work requires Supplier's employees to enter a protected or policed area of the Site, including all utility operating areas, Supplier shall arrange, in conjunction with Owner's security, for visible identification badges for all Supplier's personnel employed on such Work. Supplier's trucks or common carriers entering the Site are subject to inspection.

Supplier, its employees, and its subcontractors or material providers, shall observe traffic rules, speed regulations, or other safety rules in the operation of its vehicles and equipment on the Site, as

established by Owner. Supplier's employees shall comply with all other applicable conduct policies of Owner while on the Site.

ARTICLE 24 - Project Management

A. Customer Kickoff Meeting. Supplier shall hold a Customer Kickoff Meeting within Thirty (30) days of the Effective Date.

B. Supplier Project Manager. No later than the execution date of the Contract, Supplier will appoint an individual person as its Project Manager and will authorize that person to act on its behalf in matters connected with this Contract or the Project.

C. Global Sourcing. Supplier reserves the right in its discretion to obtain, source, subcontract, manufacture, fabricate and assemble the Equipment and any of its components and systems from nondomestic concerns; it being understood that the quality standards and warranties of Supplier under this Contract shall be adhered to in all cases irrespective of source. Supplier shall be responsible for those costs associated with its global sourcing and manufacturing activities that occur prior to title transfer to Owner. Owner shall not be required to incur any additional liability under this Contract due to Supplier's global sourcing.

D. Electronic Communication. The Parties agree to use Owner’s Document Management System as the medium for the storage and transmittal of drawings, specifications, and project reports.

ARTICLE 25 - Changes

A. Changes Resulting from Changes in Codes and Changes in Law. If, after the effective date of this Contract, any change to the Codes and Standards, Ambient Site Conditions, Site Requirements or a specific Change in Law that requires a change to the Equipment, Supplier shall be entitled to a Change Order that includes equitable adjustments to the Contract Price and to the Scheduled Major Component Delivery Date(s) and other provisions of this Contract that are impacted. If Supplier is entitled to a Change Order pursuant to the provisions of this paragraph, Supplier shall submit to Owner a draft Change Order which will be subject to Owner's approval.

B. Owner Initiated Changes. Owner shall have the right to request that Supplier consider changes to the Equipment or the Services, including modifications, alterations, or additions. If Owner wishes to request such a change, Owner shall notify Supplier in writing. Within fifteen (15) Days after receipt of such notice (unless otherwise extended by mutual agreement), Supplier shall advise Owner of the feasibility of the requested change, and shall submit to Owner a draft Change Order, unless the matter requires further investigation and research in which case Supplier will provide an estimate of the time frame in which Supplier will be able to submit a detailed response to Owner.

C. Supplier Initiated Changes. If Supplier wishes to propose a change, or if Supplier is entitled to at Change Order pursuant to the provisions of this Contract, Supplier shall submit to Owner a draft Change Order.

D. Contents of Draft Change Order. The draft Change Order shall include:

(1) a technical description of the proposed change in such detail as Owner may reasonably require,

(2) a lump sum firm price adjustment (increase or decrease) in the Contract Price, if any, caused by the proposed change,

(3) all potential effect(s), if any, on the Scheduled Major Component Delivery Date(s), or any other schedule or date for performance by Supplier hereunder caused by the proposed change, and

(4) all potential effect(s), if any, on Supplier's ability to comply with any of its obligations hereunder, including Supplier's warranties and Performance Guarantees caused by the proposed change.

E. Process for Concluding Change Order. Owner shall, within ten (10) Days from the date of receipt of such information, either approve or disapprove the draft Change Order in writing or request additional time to consider the draft Change Order. If Owner approves the Change Order, Owner and Supplier shall then sign the Change Order that shall operate as an amendment to this Contract. If Owner has not approved or disapproved the draft Change Order within ten (10) Days, Supplier shall have the right to reissue the Change Order for Owner review.

F. Agreement Required. Except for Change Orders to which Supplier is expressly entitled pursuant to Article 25 B., all changes under this Contract shall be subject to mutual agreement, and no Change Order will be effective until signed by both Parties.

ARTICLE 26 - Excusable Delays

A. Excusable Delays. Supplier shall not have any liability or be considered to be in breach or default of its obligations under this Contract to the extent that performance of such obligations is delayed or prevented, due to, but not limited to, the following ("Excusable Delay"):

(1) Acts of God, fires, severe weather conditions, earthquakes, strikes or other labor disturbances, floods, war (declared or undeclared), terrorism, epidemics, civil unrest, riots; or

(2) delays in the prerequisite work of Owner, Owner's other contractors or suppliers, or other acts (or omissions) of Owner.

Supplier shall notify Owner of any such delay. Supplier shall be entitled, after consultation with Owner, to an adjustment to the Contract Price, provided, however, that Supplier provides Owner with all reasonable substantiating documentation of any additional costs and expenses derived from an Excusable Delay and Supplier takes all reasonable actions necessary to mitigate or avoid such additional costs and expenses. The Scheduled Major Component Delivery Date(s) or date of performance shall be extended for a reasonable period necessary to overcome the effect of such Excusable Delay. Changes to the Scheduled Major Component Delivery date shall be executed through a mutually agreeable Change

Order. Any dispute as to the quantum of an adjustment to the Contract Price shall be subject to resolution through Article 40 of this Contract.

B. Termination for Extended Delay. If any Excusable Delay extends for more than one hundred eighty (180) Days and the Parties have not agreed upon a revised basis for continuing the Work at the end of the Excusable Delay, including adjustment of the Contract Price, then either Party (except where Excusable Delay is caused by Owner, in which event only Supplier), upon thirty (30) Days written notice, may terminate this Contract with respect to the portion of Equipment to which title has not yet passed, whereupon Owner shall promptly pay Supplier termination charges as set forth in the Termination Schedule.

C. Notice of Labor Disputes. Whenever Supplier has knowledge that any actual or potential labor dispute may delay or threatens to delay the timely performance of this Contract, Supplier shall immediately give Owner written notice thereof and progress made in settlement of such dispute.

ARTICLE 27 - Patents

A. Indemnity. Supplier shall indemnify Owner against any damages, costs and expenses arising out of any suit, claim, or proceeding (a "Claim") alleging that the Work infringes a patent in effect in the U.S., Canada, an EU member state or the country of installation (provided there is a corresponding patent issued by the U.S. or an EU member state or the country of installation) if:

(1) Owner promptly notifies Supplier in writing of the Claim;

(2) Owner makes no admission of liability and gives Supplier sole authority, at Supplier's expense, to direct and control the defense and any settlement and compromise negotiations; and

(3) Owner provides Supplier with full disclosure and assistance that may be reasonably required to defend any such Claim.

B. Exclusions. Supplier shall have no obligation or liability to the extent that any Claim is based upon:

(1) any Work that has been altered by any Party other than Supplier;

(2) the combination or use of the Work with other products not supplied by the Supplier when the combination is part of any alleged infringement;

(3) failure of Owner to implement any update provided by Supplier that would have prevented the Claim;

(4) unauthorized use of the Work, whether or not in breach of the provisions of this Contract; or The Parties shall defend any suit or proceeding based upon, and shall indemnify and hold the other Party harmless against, any claim that any Work made, modified or performed to the extent that such claim is based upon Indemnifying Party's specifications infringes any patent.

C. Remedies. If the Work or any portion thereof becomes the subject of a Claim, Supplier may at its option, either:

(1) settle or defend the claim or any suit or proceeding and pay all damages and costs awarded in it against Owner,

(2) procure for Owner the right to continue using the Equipment, or

(3) modify the Equipment so that it becomes non infringing, or

(4) replace the Equipment with non-infringing Equipment;

(5) remove the infringing Equipment or part thereof and refund the price of the infringing Equipment or part thereof.

If, in any suit arising from such a claim, the continued use of the Equipment for the purpose intended is forbidden by any court of competent jurisdiction, Supplier shall at its option take one or more of the actions under (2), (3), (4), or (5) above.

D. Sole Liability. The above states Supplier's entire liability for indemnification for patent, trademark, copyright, and trade secret infringement for the Work.

E. Exclusion. Notwithstanding this Article, with respect to the Work or any portions thereof that are not manufactured or developed by the Supplier, only the indemnity of the manufacturer or developer, if any, applies.

ARTICLE 28 - General Indemnity

A. General Indemnity. To the fullest extent permitted by law, the Supplier will indemnify, defend, and hold the Board, its officials, employees, and agents (the “Indemnified Parties”) harmless from and against bodily injury to third parties (including employees claims that are specifically not covered by workers compensation) or damage to tangible third party property, and, at its expense, shall defend against and hold the Indemnified Party harmless from any such claims raised by a third party arising in connection with this Contract, to the extent they are caused by the negligence or willful misconduct of the Indemnifying Party or its officers, employees, agents or Suppliers and to the extent the Indemnifying Party is liable to the third party under applicable law. Notwithstanding the foregoing, for third party claims made against Owner, this provision does not waive the defense of governmental immunity otherwise available.

B. "Third Parties" Defined. "Third parties" under this Article do not include the Parties, the owner of the Site, their affiliates, agents, successors or assigns, any operation or maintenance supplier of the Parties or the owner of the Site, or any entity:

(1) with an equity or security interest in any Party or the owner of the Site, or their assets or property,

(2) that seeks to claim any rights, power, or privileges of one of the Parties or the owner of the Site, or

(3) that seeks to claim as a third-party beneficiary of this Contract or one of the Parties or the owner of the Site.

No portion of the Equipment, the Facility, electricity, fuel or hydrocarbons is “Third Party Property" for the purposes of this Article.

ARTICLE 29 - Insurance

Supplier shall provide and maintain during the progress of the work, and until its completion, the following insurance:

A. Workers' Compensation Insurance. Workers' compensation insurance in an amount equal to the limits of liability and in the form prescribed by the laws of Louisiana, for all of suppliers and its subcontractors' employees employed on the Work.

B. Employer's Liability Insurance. Employer's liability insurance with combined single limits of not less than THREE MILLION AND 00/100 DOLLARS ($3,000,000.00) for bodily injury by accident or disease, including death at any time resulting from that injury.

C. Commercial General Liability Insurance. Commercial General Liability, for bodily injury, including death, with combined single limits of not less than THREE MILLION AND 00/100 DOLLARS ($3,000,000.00) for all injuries and/or deaths resulting from any one occurrence The limits of liability for property damage shall not be less than THREE MILLION AND 00/100 DOLLARS ($3,000,000.00) for each occurrence, and not less than SIX MILLION AND 00/100 DOLLARS ($6,000,000.00) in the aggregate. This insurance shall include coverage for special hazards, such as explosion, collapse, damage to underground utilities, supplier's protective and completed operations. The completed operations liability insurance shall be for a period of two (2) years after acceptance of the work and substantial completion certified by SWBNO.

D. Public Liability Insurance--Bodily Injury. Public liability insurance for bodily Injury (including supplier's protective and contractual liability coverage) with combined single limits of not less than THREE MILLION AND 001100 DOLLARS ($3,000,000.00) for injury to, or for death of, any one person.

E. Public Liability Insurance--Property Damage. Public liability insurance covering property damage (including supplier's protective and contractual liability coverage), protecting supplier from claims resulting from damage, including loss of use, to existing property or property being installed by persons other than supplier or its subcontractors, in the amount of THREE MILLION AND 00/100 DOLLARS ($3,000,000.00).

F. Automobile Liability Insurance. Automobile liability insurance shall cover all owned, non-owned, hired and rented automotive or motor vehicle equipment used in the performance of the Work. It shall include bodily injury coverage in an amount not less than ONE MILLION AND 00/100 DOLLARS ($1,000,000.00) for injury to, or for the death of, any one person and, subject to the same limitation for each person, in an amount not less than THREE MILLION AND 00/100 DOLLARS ($3,000,000.00) for each occurrence. Property damage coverage shall be in an amount not less than ONE MILLION AND 00/100 DOLLARS ($1,000,000.00) for each occurrence.

G. Umbrella/Excess Liability Insurance. An Umbrella or Excess Liability Policy with combined single limits of not less than TWENTY-FIVE MILLION AND 00/100 DOLLARS ($25,000,000.00), to apply to all aforementioned liability policies.

H. Terms. Each aforementioned policy of insurance shall:

(1) At Supplier's expense, protect SWBNO, the City of New Orleans, their officers, officials, employees, boards, commissions, and volunteers, and the Supplier itself, from and against any and all claims or damages to public or private property or personal injury, including death, to employees or the public, which may arise from any operations under this contract or any of its subcontracts.

(2) Contain no special limitations on the scope of protection afforded to the Board or the City, naming both SWBNO and the City as "Additional Insured," with the provision that the insurance company waives its right of subrogation against SWBNO;

(3) State the aforementioned policies of insurance are primary to any insurance or self-insurance program of SWBNO; and

(4) Shall not contain any exclusions for the cases of explosion, collapse, or underground hazards (commonly known as X, C, and U Exclusions).

I. Evidence of Insurance. The following applies to all insurance coverage required to be provided to Sewerage & Water Board of New Orleans. The following documents must be provided as evidence of insurance coverage:

• A copy of the policies' declaration pages, showing the insuring company, policy effective dates, limits of liability, and the schedule of forms and endorsements. SWBNO reserves the right to require copies of all policies and requested endorsements.

• A copy of the endorsement naming Sewerage & Water Board of New Orleans as an Additional Insured, showing the policy number, and signed by an authorized representative of the insurance company.

• A copy of an endorsement stating that the coverages provided by this policy to SWBNO or any other named insured shall not be terminated, reduced or otherwise materially changed without providing at least sixty (60) days prior written notice to the Sewerage & Water Board of New Orleans.

J. Policy Rating and Primary Insurance Requirements. All policies shall be subject to approval by the SWBNO's Risk Manager as to insurance company (must be rated A-VII or better in the A.M. Best's Key Rating guide and licensed to do business in the State of Louisiana or issued as a surplus lines by a Louisiana Surplus Lines broker), form and coverage, and primary to all other insurance.

ARTICLE 30 - Suspension

A. Suspension by Owner of Work at Site. Owner shall have the right, at any time, to suspend Work at the Site upon written notice to Supplier. Any direct cost incurred by Supplier in accordance with any such suspension (including storage costs) shall be payable by Owner upon submission of Supplier's invoice(s), provided that actions of Supplier did not directly cause Owner to suspend Work on the Site. Performance of Supplier's obligations shall be extended for a period reasonably necessary to overcome

the effects of such suspension. Suspension right limited to one hundred and eighty (180) days in the aggregate.

B. Suspension by Supplier. Supplier shall have the right to suspend all Work, including the delivery of any Equipment, upon the failure of Owner to make any payment in accordance with Article 6(A). Without limiting the foregoing, Supplier shall have the right to suspend any shipment of the Equipment and may, but shall not be obligated to, ship such Equipment to storage in accordance with Article 11 if all payments due prior to the applicable Scheduled Major Component Delivery Date have not been made. Any cost incurred by Supplier in accordance with any such suspension (including storage costs) shall be payable by Owner upon submission of Supplier's invoice(s). Performance of Supplier's obligations shall be extended for a period of time reasonably necessary to overcome the effects of such suspension, except that Supplier's suspension shall not be deemed to extend the Warranty Period hereunder, provided that actions of Supplier did not directly c:ause Owner to suspend Work on the Site.

ARTICLE 31 - Reserved

ARTICLE 32 - Termination for Cause

The Owner may terminate this Contract upon occurrence of any of the following events:

(A) Supplier shall have defaulted in its performance in any material respect under any material provision of this Contract;

(B) failure of the Supplier to begin the work under the Contract within the time specified unless excused by the Owner or the terms of this Contract;

(C) failure of Supplier to obtain or maintain its payment or performance bond in accordance with Article 7 of this Contract;

(D) if the Supplier shall become insolvent or declared bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against the Supplier unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors;

(E) if the Supplier attempts to assign rights under the Contract without the prior consent of the Owner; or

(F) if Supplier ceases to carry on its business or operations.

Owner shall first have provided Supplier with the written notice of the occurrence which can constitute termination for cause and of Owner's intention to terminate this Contract, as a result of such occurrence, and either:

(A) within fourteen (14) days of Supplier's receipt of Owner's written notice, Supplier has failed to acknowledge receipt of such notice indicating that Supplier has begun to investigate the issue pertaining to the occurrence; or

(B) with respect to an occurrence that can be cured within thirty (30) days, Supplier shall have failed to cure the occurrence within thirty (30) days after receipt of such notice (or such extended period as is considered reasonable by the Parties); or

(C) with respect to an aforementioned occurrence that cannot be cured within thirty (30) days, Supplier, upon its receipt of such notice, either:

(i) failed to commence to cure the abovementioned occurrence or diligently pursue such cure; or

(ii) failed to provide to Owner reasonable evidence that there has been no such aforementioned occurrence.

Supplier may terminate this Contract upon occurrence of any of the following events:

(A)Owner shall have defaulted in its performance in any material respect under any material provision of this Contract;

(B) Owner shall have failed to pay any amount payable to Supplier when due m accordance with this Contract;

(C) If the Owner shall become insolvent or declared bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against the Owner unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors; or

(D) if the Owner attempts to assign rights under the Contract without the prior consent of the Supplier.

Supplier shall first have provided Owner with the written notice of the occurrence which can constitute termination for cause and of Supplier's intention to terminate this Contract, as a result of such occurrence, and either:

(A) within fourteen (14) days of Owner's receipt of Supplier’s written notice, Owner has failed to acknowledge receipt of such notice indicating that Owner has begun to investigate the issue pertaining to the occurrence; or

(B) with respect to an occurrence that can be cured within thirty (30) days, Owner shall have failed to cure the occurrence within thirty (30) days after receipt of such notice (or such extended period as is considered reasonable by the Parties); or

(C) with respect to an aforementioned occurrence that cannot be cured within thirty (30) days, Owner, upon its receipt of such notice, either:

(i) failed to commence to cure the abovementioned occurrence or diligently pursue such cure; or

(ii) failed to provide to Supplier reasonable evidence that there has been no such aforementioned occurrence.

ARTICLE 33 - Reserved

ARTICLE 34 - Termination for Convenience

SWBNO may terminate this Contract at any time during the term of the Contract by giving Supplier written notice of its intention to terminate at least thirty (30) days before the intended date of termination. In the event SWBNO elects to terminate for convenience, SWBNO shall be obligated to pay Supplier only for those services performed up to and through the date of termination.

ARTICLE 35 - Termination for Non-appropriation

This Contract may be terminated immediately and without penalty if, for any reason, funds sufficient to maintain the Contract during and fiscal year are not appropriated.

ARTICLE 36 - Reserved

ARTICLE 37 - Reserved

ARTICLE 38 - Assignment and Change in Control

A. The Parties' Right to Assign. Neither this Contract nor any interest herein nor any claim hereunder (other than accounts receivable or contract rights to payment) shall be assigned or transferred by either Party, nor shall performance hereunder be delegated by either Party to any other party without prior written authorization of the other Party, such consent not to be unreasonably withheld.

B. All Other Assignments and Transfers by Owner. All other assignments or transfers by Owner of any or all of its duties or rights under this Contract (by operation of law or otherwise) are subject to Supplier's prior written consent. Further, Owner agrees that, until Owner receives title to the Equipment as set forth herein, Owner shall not, directly, or indirectly sell, offer to sell, or otherwise broker the Equipment.

Owner, however, retains the unrestricted sole right to assign this Contract to its Contractor for the purpose of the execution and completion of the Project. Upon such assignment, Supplier shall coordinate with the assignee all, or part of, the activities associated with engineering, fabrication, assembly, shop testing, delivery and field testing of the equipment, that otherwise would have been done with the Owner as established in this Contract.

ARTICLE 39 - Reserved

ARTICLE 40 - Reserved

ARTICLE 41 - Governing Law

The laws of the State of Louisiana, including its conflict of laws provisions, shall govern the validity, performance, and enforcement of this Contract. The sole venue for the resolution of all disputes relative to this Contract shall be in the United States District Court in and for the State of Louisiana, Middle District or Eastern District. The Parties further agree that this Contract shall not be construed either for or against the Owner or Supplier but shall be interpreted in accordance with the general tenor of the language in an effort to reach an equitable result.

ARTICLE 42 - Effective Date

This Contract shall become effective when it is signed by both Parties ("Effective Date").

ARTICLE 43 - Acceptance of the Contract

Acceptance of this Contract, whether by written acknowledgment or commencement of performance, is expressly limited to the provisions of the Contract, and no modification, deletion or addition shall be effective unless a duly authorized written amendment to the Contract, signed by Owner and Supplier, is entered into, notwithstanding any contrary or additional provisions (including any preprinted forms) in any communications from Supplier or payment or acceptance of delivery by Owner.

ARTICLE 44 - Right to Audit Records

Supplier shall maintain relevant records pertaining to reports, documents, deliverables, employee time sheets, records of financial transactions, and other evidence, regardless of form, sufficient to properly reflect all costs claimed to have been incurred and services performed pursuant to this Contract relating specifically to the Technically Advisory Services, and Change Orders issued on a unit price basis only. It is specifically understood that no other aspects of this Contract are subject to audit. The scope of any audit shall be limited to the verification of invoices that were issued on a cost-plus margin basis or on a time and materials basis (including Change Orders). All records shall be retained, and shall be subject to examination and audit by Owner's personnel or by Owner's agents (herein after "Authorized Auditors"), for a period of not less than three (3) years following final payment made by Owner hereunder or the expiration date of this Contract, whichever is later.

Supplier, as applicable to the Technical Advisory Services provided under this Contract, shall be subject at any time, with thirty (30) Days, prior written notice to audits or examinations by Authorized Auditors.

ARTICLE 45 - Entire Agreement

This Contract represents the entire agreement between the Parties and supersedes in its entirety all prior agreements concerning the subject matter hereof, and no modification, amendment, revision, waiver, or other change shall be binding on either Party unless consented to in writing by the Party's authorized representative. Any oral or written representation, warranty, course of dealing, or trade usage not contained or referenced herein shall not be binding on either Party. Each Party agrees that it has not relied on, or been induced by, any representations of the other Party not contained in this Contract.

ARTICLE 46 - Miscellaneous Provisions

A. Third Party Beneficiaries. This Contract and its provisions are for the benefit of the Parties hereto and not for any other third party.

B. Non-Waiver. Waiver by either Party of any right under this Contract shall not be deemed a waiver by such Party of any other right hereunder.

C. Invalidity. The invalidity in whole or in part of any part of this Contract shall not affect the validity of the remainder of this Contract.

D. Counterparts. This Contract may be signed in any number of counterparts, each of which shall constitute one and the same instrument.

E. Spare Parts. Supplier shall provide Owner a 3 Year Recommended Spare Parts List for the Equipment, with prices and delivery lead times, not later than the Effective Date. Supplier shall indicate the minimum recommended inventory and identify the specific item or items to which each item applies for routine maintenance at installation, start up and continuous operation for each of the first three years.

Supplier shall also indicate whether the recommended spare is a stock item or special item, location of nearest supply point and approximate lead time required for shipment.

F. Independent Supplier. Supplier is an independent contractor and shall not be regarded as an employee or agent of Owner.

G. Article Headings. The captions used for the Articles in this Contract are inserted only as a matter of convenience and for reference and in no way define, limit, or describe the scope of the intent of this Contract or any Article hereof.

IN WITNESS WHEREOF

The Parties have caused this document to be executed by their authorized representatives as of the date set forth below.

SUPPLIER

_____

By:

_____

(Signature)

_____

(Printed Name)

_____

(Title)

_____

(Date)

OWNER

_____

By:

_____

(Signature)

_____

(Printed Name)

_____

(Title)

_____

(Date)

CDBG COMPLIANCE PROVISIONS

for

CONSTRUCTION CONTRACTS

(These provisions must be included in all construction contracts)

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41. FEDERAL LABOR STANDARDS PROVISIONS

1. EQUAL EMPLOYMENT OPPORTUNITY (Equal Opportunity Clause)
(applicable to contracts and subcontracts above $10,000)

During the performance of this contract, the Contractor agrees as follows:

A. The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity or national origin. Such action shall include, but not be limited to, the following:

Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

B. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

C. The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

D. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the Contractor's commitment under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

E. The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor.

F. The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, as amended, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and others.

G. In the event of the Contractor's noncompliance with the non-discrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in

Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

H. The Contractor will include the provisions of the sentence immediately preceding paragraph A and the provisions of paragraphs A through H in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as administering agency may be direct as a means of enforcing such provisions, including sanctions for noncompliance:

Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, the Contractor may request the United States to enter into such litigation to protect the interest of the United States.

2. STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS
(applicable to contracts and subcontracts above $10,000)

A. As used in these specifications:

(1) "Covered area" means the geographical area described in the solicitation from which this contract resulted;

(2) "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;

(3) "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.

(4) "Minority" includes:

(a) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

(b) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South America or other Spanish Culture or origin, regardless of race);

(c) Asian and Pacific Islander (all persons having origins in any of the original people of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and

(d) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

B. When the Contractor, or any subcontractor, at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract, in excess of $10,000, the provisions of

these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

C. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in compliance with the provisions of any such Hometown Plan. Each Contractor or subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

D. The Contractor shall implement the specific affirmative action standards provided in paragraphs G(1) through G(16) of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing contracts in geographical areas where they do not have a federal or federally-assisted construction contract shall apply the minority and female goals established for the geographic area where the contract is being performed. Goals are published periodically in the Federal Register in notice form and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

E. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

F. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

G. The Contractor shall take specific affirmative action to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

(1) Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

(2) Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organization's responses.

(3) Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions the Contractor may have taken.

(4) Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement have not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

(5) Develop on-the-job training opportunities and/or participate in training programs for the area which expressly includes minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under G(2) above.

(6) Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on a bulletin board accessible to all employees at each location where construction work is performed.

(7) Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination, or other employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foreman, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

(8) Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

(9) Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not

later than one month prior to the date for acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

(10) Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work force.

(11) Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

(12) Conduct, at least annually, an inventory and evaluation of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

(13) Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

(14) Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

(15) Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitation to minority and female contractor associations and other business associations.

(16) Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

H. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (G(1) through G(16)). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under G(1) through G(16) of these specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation shall not be a defense for the Contractor's non-compliance.

I. A single goal for minorities and a separate single goal for women has been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for

women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

J. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any persons because of race, color, religion, sex, or national origin.

K. The Contractor shall not enter into any subcontract with any person or firm debarred from government contracts pursuant to E.O. 11246.

L. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to E.O. 11246, as amended.

M. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph G of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

N. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the government and to keep records. Records shall at least include for each employee, the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number where assigned, social security number, race, sex, status (e.g., mechanic, apprenticeship trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and location at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, Contractors shall not be required to maintain separate records.

O. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application or requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

3. <u>NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION</u>
(applicable to contracts and subcontract over $10,000)

A. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

B. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for minority participation: *(see table below)*

Goals for female participation: 6.9%

These goals are applicable to all the Contractor's construction work (whether or not it is federal or federally assisted) performed in the covered area. If the contractor performs construction work in a geographic area located outside of the covered area, it shall apply the goals established for such geographic area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3 (a) and its efforts to meet the goals established for the geographical area where the contract resulting from this solicitation is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order, and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

MINORITY PARTICIPATION GOALS

PARISH	MIN. GOAL (%)	PARISH	MIN. GOAL (%)	PARISH	MIN. GOAL (%)	PARISH	MIN. GOAL (%)
Acadia	24.1	E. Baton Rouge	26.1	Madison	27.9	St. Landry	24.1
Allen	17.8	East Carroll	27.9	Morehouse	27.9	St. Martin	24.1
Ascension	26.1	East Feliciana	30.4	Natchitoches	29.3	St. Mary	24.1
Assumption	27.7	Evangeline	24.1	Orleans	31.0	St. Tammany	31.0
Avoyelles	29.3	Franklin	27.9	Ouachita	22.8	Tangipahoa	27.7
Beauregard	17.8	Grant	25.7	Plaquemines	27.7	Tensas	27.9
Bienville	29.3	Iberia	24.1	Pointe Coupee	30.4	Terrebonne	27.7
Bossier	29.3	Iberville	30.4	Rapides	25.7	Union	27.9
Caddo	29.3	Jackson	27.9	Red River	29.3	Vermilion	24.1
Calcasieu	19.3	Jefferson	31.0	Richland	27.9	Vernon	17.8
Caldwell	27.9	Jefferson Davis	17.8	Sabine	29.3	Washington	27.7
Cameron	17.8	Lafayette	20.6	St. Bernard	31.0	Webster	29.3
Catahoula	27.9	Lafourche	27.7	St. Charles	27.7	W. Baton Rouge	26.1
Claiborne	29.3	LaSalle	27.9	St. Helena	30.4	West Carroll	27.9
Concordia	30.4	Lincoln	27.9	St. James	27.7	West Feliciana	30.4
De Soto	29.3	Livingston	26.1	St. John the Baptist	27.7	Winn	29.3

C. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the sub-contract; and the geographical area in which the contract is to be performed.

D. As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is *(insert description of the geographical areas where the contract is to be performed, giving the State, parish, and city, if any)*:

4. CERTIFICATION OF NONSEGREGATED FACILITIES
(applicable to contracts and subcontracts over $10,000)

By the submission of this bid, the bidder, offeror, applicant or subcontractor certifies that he/she does not maintain or provide for his/her establishments, and that he/she does not permit employees to perform their services at any location, under his/her control, where segregated facilities are maintained. He/she certifies further that he/she will not maintain or provide for employees any segregated facilities at any of his/her establishments, and he/she will not permit employees to perform their services at any location under his/her control where segregated facilities are maintained. The bidder, offeror, applicant or subcontractor agrees that a breach of this certification is a violation of the equal opportunity clause of this contract.

As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit directive or are, in fact, segregated on the basis of race, color, religion, or national origin because of habit, local custom, or any other reason.

He/she further agrees that (except where he/she has obtained for specific time periods) he/she will obtain identical certification from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause; that he/she will retain such certifications in his/her files; and that he/she will forward the following notice to such proposed subcontractors (except where proposed subcontractors have submitted identical certifications for specific time periods).

5. CIVIL RIGHTS

The Contractor shall comply with the provisions of Title VI of the Civil Rights Act of 1964. No person shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.

6. SECTION 109 OF THE HOUSING AND COMMUNITY DEVELOPMENT ACT OF 1974

The Contractor shall comply with the provisions of Section 109 of the Housing and Community Development Act of 1974. No person in the United States shall on the grounds of race, color, national origin, or sex be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity funded in whole or in part with funds made available under this title. Section 109 further provides that discrimination on the basis of age under the Age Discrimination Act of 1975 or with respect to an otherwise qualified handicapped individual as provided in Section 504 of the Rehabilitation Act of 1973, as amended, is prohibited.

7. SECTION 3 OF THE HOUSING AND URBAN DEVELOPMENT ACT OF 1968 - COMPLIANCE IN THE PROVISION OF TRAINING, EMPLOYMENT AND BUSINESS OPPORTUNITIES

A. The work to be performed under this contract is subject to the requirements of Section 3 of the Housing and Urban Development Act of 1968, as amended, 12 U.S.C. 1701u (section 3). The purpose of section 3 is to ensure that employment and other economic opportunities generated by HUD assistance or HUD-

assisted projects covered by Section 3, shall, to the greatest extent feasible, be directed to low- and very low-income persons, particularly persons who are recipients of HUD assistance for housing.

B. The parties to this contract agree to comply with HUD's regulations in 24 CFR part 135, which implement Section 3. As evidenced by their execution of this contract, the parties to this contract certify that they are under no contractual or other impediment that would prevent them from complying with the part 135 regulations.

C. The contractor agrees to send to each labor organization or representative of workers with which the contractor has a collective bargaining agreement or other understanding, if any, a notice advising the labor organization or workers' representative of the contractor's commitments under this Section 3 clause, and will post copies of the notice in conspicuous places at the work site where both employees and applicants for training and employment positions can see the notice. The notice shall describe the Section 3 preference, shall set forth minimum number and job titles subject to hire, availability of apprenticeship and training positions, the qualifications for each, and the name and location of the person(s) taking applications for each of the positions, and the anticipated date the work shall begin.

D. The contractor agrees to include this Section 3 clause in every subcontract subject to compliance with regulations in 24 CFR part 135, and agrees to take appropriate action, as provided in an applicable provision of the subcontract or in this Section 3 clause, upon a finding that the subcontractor is in violation of the regulations in 24 CFR part 135. The contractor will not subcontract with any subcontractor where the contractor has notice or knowledge that the subcontractor has been found in violation of the regulations in 24 CFR part 135.

E. The contractor will certify that any vacant employment positions, including training positions, that are filled (1) after the contractor is selected but before the contract is executed, and (2) with persons other than those to whom the regulations of 24 CFR part 135 require employment opportunities to be directed, were not filled to circumvent the contractor's obligations under 24 CFR part 135.

F. Noncompliance with HUD's regulations in 24 CFR part 135 may result in sanctions, termination of this contract for default, and debarment or suspension from future HUD assisted contracts.

G. With respect to work performed in connection with Section 3 covered Indian housing assistance, Section 7(b) of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450e) also applies to the work to be performed under this contract. Section 7(b) requires that to the greatest extent feasible (i) preference and opportunities for training and employment shall be given to Indians, and (ii) preference in the award of contracts and subcontracts shall be given to Indian organizations and Indian-owned Economic Enterprises. Parties to this contract that are subject to the provisions of Section 3 and section 7(b) agree to comply with Section 3 to the maximum extent feasible, but not in derogation of compliance with Section 7(b).

8. <u>SECTION 503 OF THE REHABILITATION ACT OF 1973 (29 USC 793)</u>
(applicable to contracts and subcontracts over $10,000)

A. The contractor will not discriminate against any employee or applicant for employment because of physical or mental disability in regard to any position for which the employee or applicant for employment is qualified. The contractor agrees to take affirmative action to employ and advance in employment individuals with disabilities, and to treat qualified individuals without discrimination on the basis of their physical or mental disability in all employment practices, including the following:

(1) Recruitment, advertising, and job application procedures;

(2) Hiring, upgrading, promotion, award of tenure, demotion, transfer, layoff, termination, right of return from layoff and rehiring;

(3) Rates of pay or any other form of compensation and changes in compensation;

(4) Job assignments, job classifications, organizational structures, position descriptions, lines of progression, and seniority lists;

(5) Leaves of absence, sick leave, or any other leave;

(6) Fringe benefits available by virtue of employment, whether or not administered by the contractor;

(7) Selection and financial support for training, including apprenticeship, professional meetings, conferences, and other related activities, and selection for leaves of absence to pursue training;

(8) Activities sponsored by the Contractor including social or recreational programs;

(9) Any other term, condition, or privilege of employment.

B. The Contractor agrees to comply with the rules, regulations, and relevant orders of the Secretary of Labor issued pursuant to the Act.

C. In the event of the Contractor's noncompliance with the requirements of this clause, actions for noncompliance may be taken in accordance with the rules, regulations, and relevant orders of the Secretary of Labor issued pursuant to the Act.

D. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices in a form to be prescribed by the Director, Office of Federal Contract Compliance Programs, provided by or through the contracting officer. Such notices shall state the rights of applicants and employees as well as the Contractor's obligation under the law to take affirmative action to employ and advance in employment qualified employees and applicants with disabilities. The contractor must ensure that applicants or employees with disabilities are provided the notice in a form that is accessible and understandable to the individual applicant or employee (e.g., providing Braille or large print versions of the notice, or posting a copy of the notice at a lower height for easy viewing by a person using a wheelchair). With respect to employees who do not work at a physical location of the contractor, a contractor will satisfy its posting obligations by posting such notices in an electronic format, provided that the contractor provides computers, or access to computers, that can access the electronic posting to such employees, or the contractor has actual knowledge that such employees otherwise are able to access the electronically posted notices. Electronic notices for employees must be posted in a conspicuous location and format on the company's intranet or sent by electronic mail to employees. An electronic posting must be used by the contractor to notify job applicants of their rights if the contractor utilizes an electronic application process. Such electronic applicant notice must be conspicuously stored with, or as part of, the electronic application.

E. The Contractor will notify each labor organization or representative of workers with which it has a collective bargaining agreement or other contract understanding, that the Contractor is bound by the

terms of Section 503 of the Rehabilitation Act of 1973, and is committed to take affirmative action to employ and advance in employment, and shall not discriminate against, individuals with physical or mental disabilities.

F. The Contractor will include the provisions of this clause in every subcontract or purchase order of $10,000 or more unless exempted by rules, regulations, or orders of the Secretary issued pursuant to Section 503 of the Act, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the Director of the Office of Federal Contract Compliance Programs may direct to enforce such provisions, including action for noncompliance.

G. The contractor must, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment and will not be discriminated against on the basis of disability.

9. SECTION 504 OF THE REHABILITATION ACT OF 1973, AS AMENDED

The Contractor agrees that no otherwise qualified individual with disabilities shall, solely by reason of his disability, be denied the benefits, or be subjected to discrimination including discrimination in employment, any program or activity that receives the benefits from the federal financial assistance.

10. AGE DISCRIMINATION ACT OF 1975

The Contractor shall comply with the provisions of the Age Discrimination Act of 1975. No person in the United States shall, on the basis of age, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under, any program or activity receiving federal financial assistance.

11. CERTIFICATION OF COMPLIANCE WITH AIR AND WATER ACTS
(applicable to contracts and subcontracts exceeding $150,000)

The Contractor and all subcontractors shall comply with the requirements of the Clean Air Act, as amended, 42 USC 7401 et seq., the Federal Water Pollution Control Act, as amended, 33 USC 1251 et seq. Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA)

In addition to the foregoing requirements, all nonexempt contractors and subcontractors shall furnish to the owner, the following:

A. A stipulation by the Contractor or subcontractors, that any facility to be utilized in the performance of any nonexempt contract or subcontract, is not listed on the List of Violating Facilities issued by the Environmental Protection Agency (EPA) pursuant to 40 CFR Part 15, as amended.

B. Agreement by the Contractor to comply with all the requirements of Section 114 of the Clean Air Act, as amended, (42 USC 1857 c-8) and Section 308 of the Federal Water Pollution Control Act, as amended, (33 USC 1318) relating to inspection, monitoring, entry, reports and information, as well as all other requirements specified in said Section 114 and Section 308, and all regulations and guidelines issued thereunder

C. A stipulation that as a condition for the award of the contract, prompt notice will be given of any notification received from the Director, Office of Federal Activities, EPA, indicating that a facility utilized, or to be utilized for the contract, is under consideration to be listed on the EPA List of Violating Facilities.

D. Agreement by the Contractor that he will include, or cause to be included, the criteria and requirements in paragraph (1) through (4) of this section in every nonexempt subcontract and requiring that the Contractor will take such action as the government may direct as a means of enforcing such provisions.

12. SPECIAL CONDITIONS PERTAINING TO HAZARDS, SAFETY STANDARDS AND ACCIDENT PREVENTION

A. Lead-Based Paint Hazards
(include in contracts for construction or rehabilitation of residential structures)

The construction or rehabilitation of residential structures is subject to the HUD Lead-Based Paint regulations, 24 CFR Part 35. The Contractor and subcontractors shall comply with the provisions for the elimination of lead-based paint hazards under Subpart B of said regulations. The Owner will be responsible for the inspections and certifications required under Section 35.14 (f) thereof.

B. Use of Explosives (Modify as required)

When the use of explosives is necessary for the prosecution of the work, the Contractor shall observe all local, state and federal laws in purchasing and handling explosives. The Contractor shall take all necessary precaution to protect completed work, neighboring property, water lines, or other underground structures. Where there is danger to structures or property from blasting, the charges shall be reduced and the material shall be covered with suitable timber, steel or rope mats.

The Contractor shall notify all owners of public utility property of intention to use explosives at least 8 hours before blasting is done close to such property. Any supervision or direction of use of explosives by the engineer does not in any way reduce the responsibility of the Contractor or his Surety for damages that may be caused by such use.

C. Danger Signals and Safety Devices (Modify as Required)

The Contractor shall make all necessary precautions to guard against damages to property and injury to persons. He shall put up and maintain in good condition, sufficient red or warning lights at night, suitable barricades and other devices necessary to protect the public. In case the Contractor fails or neglects to take such precautions, the Owner may have such lights and barricades installed and charge the cost of this work to the Contractor. Such action by the Owner does not relieve the Contractor of any liability incurred under these specifications or contract.

13. FLOOD DISASTER PROTECTION

This contract is subject to the requirements of the Flood Disaster Protection Act of 1973 (P.L. 93-234). Nothing included as a part of this contract is approved for acquisition or construction purposes as defined under Section 3(a) of said

Act, for use in an area identified by the Secretary of HUD as having special flood hazards which is located in a community not then in compliance with the requirements for participation in the National Flood Insurance Program pursuant to Section 201(d) of said Act; and the use of any assistance provided under this contract for such acquisition for construction in such identified areas in communities then participating in the National Flood Insurance Program shall be subject to the mandatory purchase of flood insurance requirements or Section 102(a) of said Act.

Any contract or agreement for the sale, lease, or other transfer of land acquired, cleared or improved with assistance provided under this Contract shall contain, if such land is located in an area identified by the Secretary as having special flood hazards and in which the sale of flood insurance has been made available under the National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq., provisions obligating the transferee and its successors or assigns to obtain and maintain, during the ownership of such land, such flood insurance as required with respect to financial assistance for acquisition or construction purposes under Section 102(a) of Flood Disaster Protection Act of 1973.

14. ACCESS TO RECORDS - MAINTENANCE OF RECORDS

The State of Louisiana, the Department of Housing and Urban Development, the Comptroller General of the United States, or any of their duly authorized representatives, shall have access to any books, documents, papers and records of the Contractor which are directly pertinent to this specific contract, for the purpose of audits, examinations, and making excerpts and transcriptions. All records connected with this contract will be maintained in a central location by the unit of local government and will be maintained for a period of five (5) years after the official date of the State's final closeout of its grant with HUD.

15. INSPECTION

The authorized representative and agents of the State of Louisiana and the Department of Housing and Urban Development shall be permitted to inspect all work, materials, payrolls, records of personnel, invoices of materials, and other relevant data and records.

16. REPORTING REQUIREMENTS

The Contractor shall complete and submit all reports, in such form and according to such schedule, as may be required by the Owner.

17. CONFLICT OF INTEREST

A. No officer or employee of the local jurisdiction or its designees or agents, no member of the governing body, and no other public official of the locality who his/her tenure or for one year thereafter, shall have any interest, direct or indirect, in any contract or subcontract, or the proceeds thereof, for work to be performed. Further, the Contractor shall cause to be incorporated in all subcontracts the language set forth in this paragraph prohibiting conflict of interest.

B. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

18. ACTIVITIES AND CONTRACTS NOT SUBJECT TO EXECUTIVE ORDER 11246, AS AMENDED

(applicable to contracts and subcontracts of $10,000 and under)

During the performance of this contract, the Contractor agrees as follows:

A. The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor shall take affirmative action to ensure that applicants for employment are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

B. The Contractor shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by Contracting Officer setting forth the provisions of this non-discrimination clause. The Contractor shall state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

C. Contractors shall incorporate foregoing requirements in all subcontracts.

19. PATENTS

A. The Contractor shall hold and save the Owner and its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the contract including its use by the Owner, unless otherwise specifically stipulated in the Contract Document.

B. License or Royalty Fees: License and/or Royalty Fees for the use of a process which is authorized by the Owner of the project must be reasonable, and paid to the holder of the patent, or his authorized license, direct by the Owner and not by or through the Contractor.

C. If the Contractor uses any design device or materials covered by letters, patent or copyright, he shall provide for such use by suitable agreement with the owner of such patented or copy-righted design device or material. It is mutually agreed and understood, that without exception the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his Sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copy-righted design, device or materials or any trademark or copy-right in connection with work agreed to be performed under this contract, and shall indemnify the Owner for any cost, expense, or damage which it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

20. COPYRIGHT

No materials, to include but not limited to reports, maps, or documents produced as a result of this contract, in whole or in part, shall be available to the Contractor for copyright purposes. Any such materials

produced as a result of this contract that might be subject to copyright shall be the property of the Owner and all such rights shall belong to the Owner.

21. TERMINATION FOR CAUSE

If, through any cause, the Contractor shall fail to fulfill in a timely and proper manner his obligations under this contract, or if the Contractor shall violate any of the covenants, agreements, or stipulations of this contract, the Owner shall thereupon have the right to terminate this contract by giving written notice to the Contractor of such termination and specifying the effective date thereof, at least five (5) days before the effective date of such termination. In such event, all finished or unfinished documents, data, studies, surveys, drawings, maps, models, photographs, and reports prepared by the Contractor under this contract shall, at the option of the Owner, become the Owner's property and the Contractor shall be entitled to receive just and equitable compensation for any work satisfactorily completed hereunder. Notwithstanding the above, the Contractor shall not be relieved of liability to the Owner for damages sustained by the Owner by virtue of any breach of the contract by the Contractor, and the Owner may withhold any payments to the Contractor for the purpose of set-off until such time as the exact amount of damages due the Owner from the Contractor is determined.

22. TERMINATION FOR CONVENIENCE

The Owner may terminate this contract at any time by giving at least ten (10) days notice in writing to the Contractor. If the contract is terminated by the Owner as provided herein, the Contractor will be paid for the time provided and expenses incurred up to the termination date.

23. ENERGY EFFICIENCY

The Contractor shall comply with mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (Public Law 94-163).

24. SUBCONTRACTS

A. The Contractor shall not enter into any subcontract with any subcontractor who has been debarred, suspended, declared ineligible, or voluntarily excluded from participating in contacting programs by any agency of the United States Government or the State of Louisiana.

B. The Contractor shall be as fully responsible to the Owner for the acts and omissions of the Contractor's subcontractors, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by the Contractor.

C. The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractor to the Contractor by the terms of the contract documents insofar as applicable to the work of subcontractors and to give the Contractor the same power as regards terminating any subcontract that the Owner may exercise over the Contractor under any provision of the contract documents.

D. Nothing contained in this contract shall create any contractual relation between any subcontractor and the Owner.

25. DEBARMENT, SUSPENSION, AND INELIGIBILITY

The Contractor represents and warrants that it and its subcontractors are not debarred, suspended, or placed in ineligibility status under the provisions of 2 CFR 180 that implement Executive Order 12549, *Debarment and Suspension* (3 CFR Part 1986 Comp., p. 189) and Executive Order 12689, *Debarment and Suspension* (3 CFR Part 1989 Comp., p. 235).

26. PROTECTION OF LIVES AND HEALTH

The Contractor shall exercise proper precaution at all times for the protection of persons and property and shall be responsible for all damages to persons or property, either on or off the worksite, which occur as a result of his prosecution of the work. The safety provisions of applicable laws and building and construction codes, in addition to specific safety and health regulations described by Chapter XIII, Bureau of Labor Standards, Department of Labor, Part 1518, Safety and Health Regulations for Construction, as outlined in the Federal Register, Volume 36, No. 75, Saturday, April 17, 1971, Title 29 - LABOR, shall be observed and the Contractor shall take or cause to be taken, such additional safety and health measures as the Owner may determine to be reasonably necessary.

27. BREACH OF CONTRACT TERMS

Any violation or breach of terms of this contract on the part of the Contractor or the Contractor's subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this contract. The duties and obligations imposed by the contract documents and the rights and remedies available thereunder shall be in addition to and not a limitation of any duties, obligations, rights and remedies otherwise imposed or available by law.

28. PROVISIONS REQUIRED BY LAW DEEMED INSERTED

Each and every provision of law and clause required by law to be inserted in this contract shall be deemed to be inserted herein and the contract shall be read and enforced as though it were included herein, and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the application of either party the contract shall forthwith be physically amended to make such insertion or correction.

29. CHANGES

The Owner may, from time to time, request changes in the scope of the services of the Contractor to be performed hereunder. Such changes, including any increase or decrease in the amount of the Contractor's compensation which are mutually agreed upon by and between the Owner and the Contractor, shall be incorporated in written and executed amendments to this Contract.

30. PERSONNEL

The Contractor represents that it has, or will secure at its own expense, all personnel required in performing the services under this Contract. Such personnel shall not be employees of or have any contractual relationship with the Owner.

All the services required hereunder will be performed by the Contractor or under its supervision, and all personnel engaged in the work shall be fully qualified and shall be authorized or permitted under State and local law to perform such services.

No person who is serving sentence in a penal or correctional institution shall be employed on work under this Contract.

31. ANTI-KICKBACK RULES

Salaries of personnel performing work under this Contract shall be paid unconditionally and not less often than once a month without payroll deduction or rebate on any account except only such payroll deductions as are mandatory by law or permitted by the applicable regulations issued by the Secretary of Labor pursuant to the "Anti-Kickback Act" of June 13, 1934 (48 Stat. 948; 62 Stat. 740; 63 Stat. 108; Title 18 U.S.C. 874; and Title 40 U.S.C. 276c). The Contractor shall comply with all applicable "Anti-Kickback" regulations and shall insert appropriate provisions in all subcontracts covering work under this contract to insure compliance by the subcontractors with such regulations, and shall be responsible for the submission of affidavits required of subcontractors thereunder except as the Secretary of Labor may specifically provide for variations of or exemptions from the requirements thereof.

32. ASSIGNABILITY

The Contractor shall not assign any interest in this Contract, and shall not transfer any interest in the same (whether by assignment or novation) without prior written approval of the Owner provided that claims for money due or to become due the Contractor from the Owner under this Contract may be assigned to a bank, trust company, or other financial institution, or to a Trustee in Bankruptcy, without such approval. Notice of any such assignment or transfer shall be furnished promptly to the Owner.

33. INTEREST OF CONTRACTOR

The Contractor covenants that he presently has no interest and shall not acquire any interest direct or indirect in the above described project or any parcels therein or any other interest which would conflict in any manner or degree with the performance of his services hereunder. The Contractor further covenants that in the performance of this Contract no person having any such interest shall be employed.

34. POLITICAL ACTIVITY

The Contractor will comply with the provisions of the Hatch Act (5 U.S.C. 1501 et seq.), which limits the political activity of employees.

35. COMPLIANCE WITH THE OFFICE OF MANAGEMENT AND BUDGET

The parties agree to comply with the regulations, policies, guidelines, and requirements of the Office of Management and Budget, *"Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards"*, 2 CFR Part 200, as they relate to the use of Federal funds under this contract.

36. DISCRIMINATION DUE TO BELIEFS

No person with responsibilities in operation of the project to which this grant relates will discriminate with respect to any program participant or any applicant for participation in such program because of political affiliation or beliefs.

37. CONFIDENTIAL FINDINGS

All of the reports, information, data, etc., prepared or assembled by the Contractor under this Contract are confidential, and the Contractor agrees that they shall not be made available to any individual or organization without prior written approval of the Owner.

38. LOBBYING

The Contractor certifies, to the best of his or her knowledge and belief that:

A. No federally appropriated funds have been paid or will be paid, by or on behalf of the contractor, to any person for influencing or attempting to influence an officer or employee of any agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with the awarding of any federal contract, the making of any federal grant, the making of any federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any federal contract, grant, loan, or cooperative agreement.

B. If any funds other than federally appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this federal contract, grant, loan, or cooperative agreement, the contractor shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

39. CONTRACTING WITH SMALL AND MINORITY FIRMS, WOMEN'S BUSINESS ENTERPRISES, AND LABOR SURPLUS AREA FIRMS

The Contractor will take necessary affirmative steps to assure that minority firms, women's business enterprises, and labor surplus area firms are used in subcontracting when possible. Steps include:

A. Placing qualified small and minority businesses and women's business enterprises on solicitation lists:
B. Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources:
C. Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority business, and women's business enterprises;
D. Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority business, and women's business enterprises; and
E. Using the services and assistance of the Small Business Administration, and the Minority Business Development Agency of the Department of Commerce.

40. PROCUREMENT OF RECOVERED MATERIALS

A. In accordance with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, the Contractor shall procure items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR Part 247 that contain the highest percentage of

recovered materials practicable, consistent with maintaining a satisfactory level of competition. The Contractor shall procure items designated in the EPA guidelines that contain the highest percentage of recovered materials practicable unless the Contractor determines that such items: (1) are not reasonably available in a reasonable period of time; (2) fail to meet reasonable performance standards, which shall be determined on the basis of the guidelines of the National Institute of Standards and Technology, if applicable to the item; or (3) are only available at an unreasonable price.

B. Paragraph A of this clause shall apply to items purchased under this contract where: (1) the Contractor purchases in excess of $10,000 of the item under this contract; or(2) during the preceding Federal fiscal year, the Contractor: (i) purchased any amount of the items for use under a contract that was funded with Federal appropriations and was with a Federal agency or a State agency or agency of a political subdivision of a State; and (ii) purchased a total of in excess of $10,000 of the item both under and outside that contract.

41. FEDERAL LABOR STANDARDS PROVISIONS

The Contractor shall abide by the requirements of the Federal Labor Standards Provisions (form HUD-4010) as follows.

construction, prosecution, completion, or repair of a public building or public work, or building or work financed in whole or in part by loans, grants, or guarantees from the United States is *employed* regardless of any contractual relationship alleged to exist between the contractor and such person.

(p) The term *wages* means the basic hourly rate of pay; any contribution irrevocably made by a contractor or subcontractor to a trustee or to a third person pursuant to a bona fide fringe benefit fund, plan, or program; and the rate of costs to the contractor or subcontractor which may be reasonably anticipated in providing bona fide fringe benefits to laborers and mechanics pursuant to an enforceable commitment to carry out a financially responsible plan of program, which was communicated in writing to the laborers and mechanics affected. The fringe benefits enumerated in the Davis-Bacon Act include medical or hospital care, pensions on retirement or death, compensation for injuries or illness resulting from occupational activity, or insurance to provide any of the foregoing; unemployment benefits; life insurance, disability insurance, sickness insurance, or accident insurance; vacation or holiday pay; defraying costs of apprenticeship or other similar programs; or other bona fide fringe benefits. Fringe benefits do not include benefits required by other Federal, State, or local law.

(q) The term *wage determination* includes the original decision and any subsequent decisions modifying, superseding, correcting, or otherwise changing the provisions of the original decision. The application of the wage determination shall be in accordance with the provisions of §1.6 of this title.

[48 FR 19541, Apr. 29, 1983, as amended at 48 FR 50313, Nov. 1, 1983; 55 FR 50149, Dec. 4, 1990; 57 FR 19206, May 4, 1992; 65 FR 69693, Nov. 20, 2000; 65 FR 80278, Dec. 20, 2000; 82 FR 2225, Jan. 9, 2017]

§§ 5.3–5.4 [Reserved]

§ 5.5 Contract provisions and related matters.

(a) The Agency head shall cause or require the contracting officer to insert in full in any contract in excess of $2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in §5.1, the following clauses (or any modifications thereof to meet the particular needs of the agency, *Provided*, That such modifications are first approved by the Department of Labor):

(1) *Minimum wages.* (i) All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred

during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in §5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided*, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(*1*) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(*2*) The classification is utilized in the area by the construction industry; and

(*3*) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii) (B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, *Provided*, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the

meeting of obligations under the plan or program.

(2) *Withholding.* The (write in name of Federal Agency or the loan or grant recipient) shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) *Payrolls and basic records.* (i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency). The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (*e.g.*, the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at *http://www.dol.gov/esa/whd/forms/wh347instr.htm* or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered

worker, and shall provide them upon request to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency), the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, sponsor, or owner).

(B) Each payroll submitted shall be accompanied by a ''Statement of Compliance,'' signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(*1*) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(*2*) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(*3*) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the ''Statement of Compliance'' required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the (write the name of the agency) or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) *Apprentices and trainees*—(i) *Apprentices.* Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any

worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) *Trainees.* Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) *Equal employment opportunity.* The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) *Compliance with Copeland Act requirements.* The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the (write in the name of the Federal agency) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) *Contract termination: debarment.* A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) *Compliance with Davis-Bacon and Related Act requirements.* All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) *Disputes concerning labor standards.* Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

(10) *Certification of eligibility.* (1) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(11) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(111) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(b) *Contract Work Hours and Safety Standards Act.* The Agency Head shall cause or require the contracting officer to insert the following clauses set forth in paragraphs (b)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by §5.5(a) or §4.6 of part 4 of this title. As used in this paragraph, the terms *laborers* and *mechanics* include watchmen and guards.

(1) *Overtime requirements.* No contractor or subcontractor contracting for any part of the conract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) *Violation; liability for unpaid wages; liquidated damages.* In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of $25 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) *Withholding for unpaid wages and liquidated damages.* The (write in the name of the Federal agency or the loan or grant recipient) shall upon its own action or upon written request of an

authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in §5.1, the Agency Head shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency Head shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

(The information collection, recordkeeping, and reporting requirements contained in the following paragraphs of this section were approved by the Office of Management and Budget:

Paragraph	OMB Control No.
(a)(1)(ii)(B)	1235–0023
(a)(1)(ii)(C)	1235–0023
(a)(1)(iv)	1235–0023
(a)(3)(i)	1235–0023
(a)(3)(ii)(A)	1235–0023
	1235–0008
(c)	1235–0023

[48 FR 19540, Apr. 29, 1983, as amended at 51 FR 12265, Apr. 9, 1986; 55 FR 50150, Dec. 4, 1990; 57 FR 28776, June 26, 1992; 58 FR 58955, Nov. 5, 1993; 61 FR 40716, Aug. 5, 1996; 65 FR 69693, Nov. 20, 2000; 73 FR 77511, Dec. 19, 2008; 81 FR 43450, July 1, 2016; 82 FR 2225, 2226, Jan. 9, 2017]

§ 5.6 Enforcement.

(a)(1) It shall be the responsibility of the Federal agency to ascertain whether the clauses required by §5.5 have been inserted in the contracts subject to the labor standards provisions of the Acts contained in §5.1. Agencies which do not directly enter into such contracts shall promulgate the necessary regulations or procedures to require the recipient of the Federal assistance to insert in its contracts the provisions of §5.5. No payment, advance, grant, loan, or guarantee of funds shall be approved by the Federal agency unless the agency insures that the clauses required by §5.5 and the appropriate wage determination of the Secretary of Labor are contained in such contracts. Furthermore, no payment, advance, grant, loan, or guarantee of funds shall be approved by the Federal agency after the beginning of construction unless there is on file with the agency a certification by the contractor that the contractor and its subcontractors have complied with the provisions of §5.5 or unless there is on file with the agency a certification by the contractor that there is a substantial dispute with respect to the required provisions.

Community Development Block Grant Program Disaster Recovery Rider

This Community Development Block Grant Program Rider contains supplementary general conditions for use with procurement contracts and subrecipient agreements that are funded in whole or in part by the U.S. Department of Housing and Urban Development ("HUD") under Title I of the Housing and Community Development Act of 1974 (Pub. L. 93-383) as amended.

For all procurement contracts and subrecipient agreements funded fully or in part by the Community Development Block Grant Disaster Recovery ("CDBG-DR") Program by and between the Sewerage and Water Board of New Orleans, State of Louisiana, acting herein by [*name of grantee representative*], [*title (i.e. president mayor*], hereunto duly authorized, and [*supplier*], a [*type of business (partnership, corporation)*] organized under the laws of the State of Louisiana, acting herein by [*name*], [Chief Executive Officer or appointed representative, hereunto duly authorized; this CDBG Rider will serve as a universal addendum to each of those contracts and/or agreements.

This Rider must be signed separately as a stand-alone document, and the terms and provisions outlined herein will be applicable to all contracts and agreements between Sewerage and Water Board of New Orleans, and [*supplier*] in which CDBG-DR grant funds are a funding source.

FEDERAL REGISTER NOTICES

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Federal Register Notices applicable to the use of CDBG-DR Funds for all associated grants are available on the HUD Web site at:
https://www.hudexchange.info/programs/cdbg-dr/cdbg-dr-laws-regulations-and-federal-register-notices/

COMPLIANCE PROVISIONS FOR CDBG-DR RIDER
FOR
PROFESSIONAL SERVICES CONTRACTS

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35. AUTHORIZATION

1. <u>EQUAL EMPLOYMENT OPPORTUNITY (Equal Opportunity Clause)</u>
(applicable to contracts and subcontracts above $10,000)

During the performance of any contract, the Contractor agrees as follows:

A. The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

B. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration without regard to race, color, religion, sex, or national origin.

C. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided by the Contract Compliance Officer advising the said labor union or workers' representatives of the Contractor's commitment under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

D. The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor.

E. The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, as amended, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the Department and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and others.

F. In the event of the Contractor's noncompliance with the non-discrimination clauses of any contract or with any of the said rules, regulations, or orders, that contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

G. The Contractor will include the provisions of the sentence immediately preceding paragraph A and the provisions of paragraphs A through G in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the Department may direct as a means of enforcing such provisions, including sanctions for noncompliance. Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the Department, the Contractor may request the United States to enter into such litigation to protect the interest of the United States.

2. <u>CERTIFICATION OF NONSEGREGATED FACILITIES</u>
(applicable to contracts and subcontracts over $10,000)

By the submission of this bid, the bidder, offeror, applicant or subcontractor certifies that he/she does not maintain or provide for his/her establishments, and that he/she does not permit employees to perform their services at any location, under his/her control, where segregated facilities are maintained. He/she certifies further that he/she will not maintain or provide for employees any segregated facilities at any of his/her establishments, and he/she will not permit employees to perform their services at any location under his/her control where segregated facilities are maintained. The bidder, offeror, applicant or subcontractor agrees that a breach of this certification is a violation of the equal opportunity clause of this contract.

As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit directive or are, in fact, segregated on the basis of race, color, religion, or national origin because of habit, local custom, or any other reason.

He/she further agrees that (except where he/she has obtained for specific time periods) he/she will obtain identical certification from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause; that he/she will retain such certifications in his/her files; and that he/she will forward the following notice to such proposed subcontractors (except where proposed subcontractors have submitted identical certifications for specific time periods).

3. CIVIL RIGHTS

The Contractor shall comply with the provisions of Title VI of the Civil Rights Act of 1964. No person shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.

4. SECTION 109 OF THE HOUSING AND COMMUNITY DEVELOPMENT ACT OF 1974

The Contractor shall comply with the provisions of Section 109 of the Housing and Community Development Act of 1974. No person in the United States shall on the grounds of race, color, national origin, or sex be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity funded in whole or in part with funds made available under this title. Section 109 further provides that discrimination on the basis of age under the Age Discrimination Act of 1975 or with respect to an otherwise qualified handicapped individual as provided in Section 504 of the Rehabilitation Act of 1973, as amended, is prohibited.

5. SECTION 3 OF THE HOUSING AND URBAN DEVELOPMENT ACT OF 1968 - COMPLIANCE IN THE PROVISION OF TRAINING, EMPLOYMENT AND BUSINESS OPPORTUNITIES

A. The work to be performed under any contract is subject to the requirements of Section 3 of the Housing and Urban Development Act of 1968, as amended, 12 U.S.C. 1701u (section 3). The purpose of section 3 is to ensure that employment and other economic opportunities generated by HUD assistance or HUD-assisted projects covered by Section 3, shall, to the greatest extent feasible, be directed to low- and very low-income persons, particularly persons who are recipients of HUD assistance for housing.

B. The parties to any contract agree to comply with HUD's regulations in 24 CFR part 135, which implement Section 3. As evidenced by their execution of this contract, the parties to

any contract certify that they are under no contractual or other impediment that would prevent them from complying with the part 135 regulations.

C. The contractor agrees to send to each labor organization or representative of workers with which the contractor has a collective bargaining agreement or other understanding, if any, a notice advising the labor organization or workers' representative of the contractor's commitments under this Section 3 clause, and will post copies of the notice in conspicuous places at the work site where both employees and applicants for training and employment positions can see the notice. The notice shall describe the Section 3 preference, shall set forth minimum number and job titles subject to hire, availability of apprenticeship and training positions, the qualifications for each, and the name and location of the person(s) taking applications for each of the positions, and the anticipated date the work shall begin.

D. The contractor agrees to include this Section 3 clause in every subcontract subject to compliance with regulations in 24 CFR part 135, and agrees to take appropriate action, as provided in an applicable provision of the subcontract or in this Section 3 clause, upon a finding that the subcontractor is in violation of the regulations in 24 CFR part 135. The contractor will not subcontract with any subcontractor where the contractor has notice or knowledge that the subcontractor has been found in violation of the regulations in 24 CFR part 135.

E. The contractor will certify that any vacant employment positions, including training positions, that are filled (1) after the contractor is selected but before the contract is executed, and (2) with persons other than those to whom the regulations of 24 CFR part 135 require employment opportunities to be directed, were not filled to circumvent the contractor's obligations under 24 CFR part 135.

F. Noncompliance with HUD's regulations in 24 CFR part 135 may result in sanctions, termination of any contract for default, and debarment or suspension from future HUD assisted contracts.

G. With respect to work performed in connection with Section 3 covered Indian housing assistance, Section 7(b) of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450e) also applies to the work to be performed under this contract. Section 7(b) requires that to the greatest extent feasible (i) preference and opportunities for training and employment shall be given to Indians, and (ii) preference in the award of contracts and subcontracts shall be given to Indian organizations and Indian-owned Economic Enterprises. Parties to any contract that are subject to the provisions of Section 3 and section 7(b) agree to comply with Section 3 to the maximum extent feasible, but not in derogation of compliance with Section 7(b).

6. <u>SECTION 503 OF THE REHABILITATION ACT OF 1973 (29 USC 793)</u>
(applicable to contracts and subcontracts over $10,000)

A. The contractor will not discriminate against any employee or applicant for employment because of physical or mental handicap in regard to any position for which the employee or applicant for employment is otherwise qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified handicapped individuals without discrimination based upon their physical or mental handicap in all

employment practices such as the following: employment upgrading, demotion or transfer, recruitment, advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship.

B. The Contractor agrees to comply with the rules, regulations, and relevant orders of the Secretary of Labor issued pursuant to the Act.

C. In the event of the Contractor's noncompliance with the requirements of this clause, actions for noncompliance may be taken in accordance with the rules, regulations, and relevant orders of the Secretary of Labor issued pursuant to the Act.

D. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices in a form to be prescribed by the Director, provided by or through the contracting officer. Such notices shall state the Contractor's obligation under the law to take affirmative action to employ and advance in employment qualified handicapped employees and applicants for employment, and the rights of applicants and employees.

E. The Contractor will notify each labor union or representative of workers with which it has a collective bargaining agreement or other contract understanding, that the Contractor is bound by the terms of Section 503 of the Rehabilitation Act of 1973, and is committed to take affirmative action to employ and advance in employment physically and mentally handicapped individuals.

F. The Contractor will include the provisions of this clause in every subcontract or purchase order of $10,000 or more unless exempted by rules, regulations, or orders of the Secretary issued pursuant to Section 503 of the Act, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the Director of the Office of Federal Contract Compliance Programs may direct to enforce such provisions, including action for noncompliance.

7. SECTION 504 OF THE REHABILITATION ACT OF 1973, AS AMENDED

The Contractor agrees that no otherwise qualified individual with disabilities shall, solely by reason of his disability, be denied the benefits, or be subjected to discrimination including discrimination in employment, any program or activity that receives the benefits from the federal financial assistance.

8. AGE DISCRIMINATION ACT OF 1975

The Contractor shall comply with the provisions of the Age Discrimination Act of 1975. No person in the United States shall, on the basis of age, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under, any program or activity receiving federal financial assistance.

9. CERTIFICATION OF COMPLIANCE WITH AIR AND WATER ACTS
(applicable to contracts and subcontracts exceeding $100,000)

The Contractor and all subcontractors shall comply with the requirements of the Clean Air Act, as amended, 42 USC 1857 et seq., the Federal Water Pollution Control Act, as amended, 33 USC 1251 et seq., and the regulations of the Environmental Protection Agency with respect thereto, at 40 CFR Part 15, as amended.

In addition to the foregoing requirements, all nonexempt contractors and subcontractors shall furnish to the owner, the following:

A. A stipulation by the Contractor or subcontractors, that any facility to be utilized in the performance of any nonexempt contract or subcontract, is not listed on the List of Violating Facilities issued by the Environmental Protection Agency (EPA) pursuant to 40 CFR Part 15, as amended.

B. Agreement by the Contractor to comply with all the requirements of Section 114 of the Clean Air Act, as amended, (42 USC 1857 c-8) and Section 308 of the Federal Water Pollution Control Act, as amended, (33 USC 1318) relating to inspection, monitoring, entry, reports and information, as well as all other requirements specified in said Section 114 and Section 308, and all regulations and guidelines issued thereunder.

C. A stipulation that as a condition for the award of the contract, prompt notice will be given of any notification received from the Director, Office of Federal Activities, EPA, indicating that a facility utilized, or to be utilized for the contract, is under consideration to be listed on the EPA List of Violating Facilities.

D. Agreement by the Contractor that he will include, or cause to be included, the criteria and requirements in paragraph (1) through (4) of this section in every nonexempt subcontract and requiring that the Contractor will take such action as the government may direct as a means of enforcing such provisions.

10. FLOOD DISASTER PROTECTION

Any contract is subject to the requirements of the Flood Disaster Protection Act of 1973 (P.L. 93-234). Nothing included as a part of the contract is approved for acquisition or construction purposes as defined under Section 3(a) of said Act, for use in an area identified by the Secretary of HUD as having special flood hazards which is located in a community not then in compliance with the requirements for participation in the National Flood Insurance Program pursuant to Section 201(d) of said Act; and the use of any assistance provided under the contract for such acquisition for construction in such identified areas in communities then participating in the National Flood Insurance Program shall be subject to the mandatory purchase of flood insurance requirements or Section 102(a) of said Act.

Any contract or agreement for the sale, lease, or other transfer of land acquired, cleared or improved with assistance provided under any Contract shall contain, if such land is located in an area identified by the Secretary as having special flood hazards and in which the sale of flood insurance has been made available under the National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq., provisions obligating the transferee and its successors or assigns to obtain and maintain, during the ownership of such land, such flood insurance as required with respect to financial assistance for acquisition or construction purposes under Section 102(a) of Flood Disaster Protection Act of 1973.

11. ACCESS TO RECORDS - MAINTENANCE OF RECORDS

The State of Louisiana, the Department of Housing and Urban Development, the Comptroller General of the United States, or any of their duly authorized representatives, shall have access to any books, documents, papers and records of the Contractor which are directly pertinent to this specific contract, for the purpose of audits, examinations, and making excerpts and transcriptions. All records connected with any contract will be maintained in a central location by the unit of local government and will be maintained for a period of five (5) years from the official date of the State's final closeout of the grant.

12. INSPECTION

The authorized representative and agents of the State of Louisiana and the Department of Housing and Urban Development shall be permitted to inspect all work, materials, payrolls, records of personnel, invoices of materials, and other relevant data and records.

13. REPORTING REQUIREMENTS

The Contractor shall complete and submit all reports, in such form and according to such schedule, as may be required by the Owner.

14. CONFLICT OF INTEREST

A. No officer or employee of the local jurisdiction or its designees or agents, no member of the governing body, and no other public official of the locality who his/her tenure or for one year thereafter, shall have any interest, direct or indirect, in any contract or subcontract, or the proceeds thereof, for work to be performed. Further, the Contractor shall cause to be incorporated in all subcontracts the language set forth in this paragraph prohibiting conflict of interest.

B. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of any contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to any contract if made with a corporation for its general benefit.

15. ACTIVITIES AND CONTRACTS NOT SUBJECT TO EXECUTIVE ORDER 11246, AS AMENDED
(applicable to contracts and subcontracts of $10,000 and under)

During the performance of any contract, the Contractor agrees as follows:

A. The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor shall take affirmative action to ensure that applicants for employment are employed, and that employees are treated

during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

B. The Contractor shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by Contracting Officer setting forth the provisions of this non-discrimination clause. The Contractor shall state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

C. Contractors shall incorporate foregoing requirements in all subcontracts.

16. PATENTS

A. The Contractor shall hold and save the Owner and its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the contract including its use by the Owner, unless otherwise specifically stipulated in the Contract Document.

B. License or Royalty Fees: License and/or Royalty Fees for the use of a process which is authorized by the Owner of the project must be reasonable, and paid to the holder of the patent, or his authorized license, direct by the Owner and not by or through the Contractor.

C. If the Contractor uses any design device or materials covered by letters, patent or copyright, he shall provide for such use by suitable agreement with the owner of such patented or copy-righted design device or material. It is mutually agreed and understood, that without exception the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his Sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copy-righted design, device or materials or any trademark or copy-right in connection with work agreed to be performed under this contract, and shall indemnify the Owner for any cost, expense, or damage which it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

17. COPYRIGHT

No materials, to include but not limited to reports, maps, or documents produced as a result of this contract, in whole or in part, shall be available to the Contractor for copyright purposes. Any such materials produced as a result of any contract that might be subject to copyright shall be the property of the Owner and all such rights shall belong to the Owner.

18. TERMINATION FOR CAUSE

If, through any cause, the Contractor shall fail to fulfill in a timely and proper manner his obligations under this contract, or if the Contractor shall violate any of the covenants, agreements, or stipulations of this contract, the Owner shall thereupon have the right to terminate any contract

by giving written notice to the Contractor of such termination and specifying the effective date thereof, at least five (5) days before the effective date of such termination. In such event, all finished or unfinished documents, data, studies, surveys, drawings, maps, models, photographs, and reports prepared by the Contractor under any contract shall, at the option of the Owner, become the Owner's property and the Contractor shall be entitled to receive just and equitable compensation for any work satisfactorily completed hereunder. Notwithstanding the above, the Contractor shall not be relieved of liability to the Owner for damages sustained by the Owner by virtue of any breach of the contract by the Contractor, and the Owner may withhold any payments to the Contractor for the purpose of set-off until such time as the exact amount of damages due the Owner from the Contractor is determined.

19. TERMINATION FOR CONVENIENCE

The Owner may terminate any contract at any time by giving at least ten (10) days' notice in writing to the Contractor. If the contract is terminated by the Owner as provided herein, the Contractor will be paid for the time provided and expenses incurred up to the termination date.

20. ENERGY EFFICIENCY

The Contractor shall comply with mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (Public Law 94-163).

21. SUBCONTRACTS

A. The Contractor shall not enter into any subcontract with any subcontractor who has been debarred, suspended, declared ineligible, or voluntarily excluded from participating in contacting programs by any agency of the United States Government or the State of Louisiana.

B. The Contractor shall be as fully responsible to the Owner for the acts and omissions of the Contractor's subcontractors, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by the Contractor.

C. The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractor to the Contractor by the terms of the contract documents insofar as applicable to the work of subcontractors and to give the Contractor the same power as regards terminating any subcontract that the Owner may exercise over the Contractor under any provision of the contract documents.

D. Nothing contained in any contract shall create any contractual relation between any subcontractor and the Owner.

22. DEBARMENT, SUSPENSION, AND INELIGIBILITY

The Contractor represents and warrants that it and its subcontractors are not debarred, suspended, or placed in ineligibility status under the provisions of 24 CFR 24 (government debarment and suspension regulations).

23. BREACH OF CONTRACT TERMS

Any violation or breach of terms of any contract on the part of the Contractor or the Contractor's subcontractors may result in the suspension or termination of the contract or such other action that may be necessary to enforce the rights of the parties of the contract. The duties and obligations imposed by the contract documents and the rights and remedies available thereunder shall be in addition to and not a limitation of any duties, obligations, rights and remedies otherwise imposed or available by law.

24. PROVISIONS REQUIRED BY LAW DEEMED INSERTED

Each and every provision of law and clause required by law to be inserted in any contract shall be deemed to be inserted herein and the contract shall be read and enforced as though it were included herein, and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the application of either party the contract shall forthwith be physically amended to make such insertion or correction.

25. CHANGES

The Owner may, from time to time, request changes in the scope of the services of the Contractor to be performed hereunder. Such changes, including any increase or decrease in the amount of the Contractor's compensation which are mutually agreed upon by and between the Owner and the Contractor, shall be incorporated in written and executed amendments to this Contract.

26. PERSONNEL

The Contractor represents that it has, or will secure at its own expense, all personnel required in performing the services under this Contract. Such personnel shall not be employees of or have any contractual relationship with the Owner. All the services required hereunder will be performed by the Contractor or under its supervision, and all personnel engaged in the work shall be fully qualified and shall be authorized or permitted under State and local law to perform such services.

No person who is serving sentence in a penal or correctional institution shall be employed on work under any Contract.

27. ANTI-KICKBACK RULES

Salaries of personnel performing work under any Contract shall be paid unconditionally and not less often than once a month without payroll deduction or rebate on any account except only such payroll deductions as are mandatory by law or permitted by the applicable regulations issued by the Secretary of Labor pursuant to the "Anti-Kickback Act" of June 13, 1934 (48 Stat. 948;

62 Stat. 740; 63 Stat. 108; Title 18 U.S.C. 874; and Title 40 U.S.C. 276c). The Contractor shall comply with all applicable "Anti-Kickback" regulations and shall insert appropriate provisions in all subcontracts covering work under the contract to insure compliance by the subcontractors with such regulations, and shall be responsible for the submission of affidavits required of subcontractors thereunder except as the Secretary of Labor may specifically provide for variations of or exemptions from the requirements thereof.

28. ASSIGNABILITY

The Contractor shall not assign any interest in any Contract, and shall not transfer any interest in the same (whether by assignment or novation) without prior written approval of the Owner provided that claims for money due or to become due the Contractor from the Owner under the Contract may be assigned to a bank, trust company, or other financial institution, or to a Trustee in Bankruptcy, without such approval. Notice of any such assignment or transfer shall be furnished promptly to the Owner.

29. INTEREST OF CONTRACTOR

The Contractor covenants that he presently has no interest and shall not acquire any interest direct or indirect in the above described project or any parcels therein or any other interest which would conflict in any manner or degree with the performance of his services hereunder. The Contractor further covenants that in the performance of any Contract no person having any such interest shall be employed.

30. POLITICAL ACTIVITY

The Contractor will comply with the provisions of the Hatch Act (5 U.S.C. 1501 et seq.), which limits the political activity of employees.

31. COMPLIANCE WITH THE OFFICE OF MANAGEMENT AND BUDGET

The parties agree to comply with the regulations, policies, guidelines, and requirements of the Office of Management and Budget, Circulars A-95, A-102, A-133, and A-54, as they relate to the use of Federal funds under any contract.

32. DISCRIMINATION DUE TO BELIEFS

No person with responsibilities in operation of the project to which this grant relates will discriminate with respect to any program participant or any applicant for participation in such program because of political affiliation or beliefs.

33. CONFIDENTIAL FINDINGS

All of the reports, information, data, etc., prepared or assembled by the Contractor under any Contract are confidential, and the Contractor agrees that they shall not be made available to any individual or organization without prior written approval of the Owner.

34. LOBBYING

The Contractor certifies, to the best of his or her knowledge and belief that:

1. No federally appropriated funds have been paid or will be paid, by or on behalf of the contractor, to any person for influencing or attempting to influence an officer or employee of any agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with the awarding of any federal contract, the making of any federal grant, the making of any federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any federal contract, grant, loan, or cooperative agreement.

2. If any funds other than federally appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this federal contract, grant, loan, or cooperative agreement, the contractor shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

35. AUTHORIZATION

ATTEST: Sewerage and Water Board of New Orleans

_____ By:_____
[*name & title of GRANTEE Representative*]

_____ Date:_____

_____[name of SUPPLIER]_____

_____ By: _____
[*name & title of SUPPLIER*

Representative]

_____ Date:_____

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SEWERAGE and WATER BOARD

of

NEW ORLEANS

TECHNICAL SPECIFICATIONS

FOR

CONTRACT 1438

CTG-7 PROCUREMENT

MARCH 2022

Date: March 22, 2022

CONTRACT CP-1438
CTG-7 PROCUREMENT REBID
SEWERAGE AND WATER BOARD OF NEW ORLEANS

To All Prospective Bidders:

The following changes, additions, and/or deletions are hereby made a part of the Contract Documents following this REBID COVERSHEET.

A. TECHNICAL SPECIFICATIONS

1. **DELETE** all notation of 1419 and **REPLACE** it with 1438.

2. **ADD** generator soft start functionality to the Combustion Turbine Generator equipment capability.

3. **CHANGE** the warranty period for all equipment to 12 months from first-fire or 24 months from delivery, whichever comes first.

4. Section 01 33 00.01, Submittal Procedures Supplement, Submittal Register; Paragraph 48 11 23, Combustion Turbine Generator, **DELETE** Paragraph B.1.d.16).

5. Section 01 33 00.01, Submittal Procedures Supplement, Submittal Register; Paragraph 43 12 00, Fuel Gas Compressor, **DELETE** Paragraph D.5.s.

6. Section 01 61 00, Common Product Requirements, Paragraph 1.04.A, Parameter 'Seismic Design Category'; **REPLACE** "C" with "D".

7. Section 25 05 11, Cybersecurity for Facility-Related Control Systems; **ADD** Paragraph 1.01.C. "A Cybersecurity design that is based on the IEC 62443 framework is acceptable, provided the requirements of this Section are met."

8. Section 40 90 10, Instrumentation and Controls Summary of Work, Paragraph 1.02.D; **ADD** the following sentence to the end of the paragraph "This applies only to the main skid compartments such as the electrical and controls enclosure, not field instruments."

9. Section 40 90 13, Concept of Operations Framework; **ADD** Paragraph 1.03.B "The Concept of Operations will be assembled by Owner/Engineer. Supplier is responsible for providing the equipment specific input documents such as P&ID's, System Descriptions and O&M manuals. Format for input documents may be Supplier standard format."

10. Section 40 92 13, Process Control Valves and Regulators; **ADD** Paragraph 2.01.B "Manufacturer Standard "Or-equal" products are acceptable, provided they meet the design requirements of this Section."

11. Section 40 91 00, Instrumentation and Control Components; **ADD** Paragraph 2.01.D "Manufacturer Standard "Or-equal" products are acceptable, provided they meet the design requirements of this Section."

12. Section 48 11 23, Combustion Turbine Generator, **DELETE** Paragraph 1.04.D.2, and **REPLACE** it with the following: "Supplier shall provide Owner a 3 Year Recommended Spare Parts List for the Equipment, with prices and delivery lead times. Supplier shall indicate the minimum recommended inventory and identify the specific item or items to which each item applies for routine maintenance at installation, startup and continuous operation for each of the first three years."

13. Section 43 12 00, Fuel Gas Compressor; **REPLACE** Paragraph 1.04.D.3.o as follows "Certified Material Test Reports (MTR's); only for piping and pressure vessels."

14. Section 43 12 00, Fuel Gas Compressor; **DELETE** Paragraph 1.04.D.5.s.

15. Section 43 12 00, Fuel Gas Compressor, **DELETE** Paragraph 1.04.E.2 and **REPLACE** it with the following: "Supplier shall provide Owner a 3 Year Recommended Spare Parts List for the Equipment, with prices and delivery lead times. Supplier shall indicate the minimum recommended inventory and identify the specific item or items to which each item applies for routine maintenance at installation, startup and continuous operation for each of the first three years."

16. Section 43 12 00, Fuel Gas Compressor; **ADD** Paragraph 2.01.D "The fuel gas compressor should use the applicable API standard as a design guideline. For the manufacturer's listed in Paragraph 2.01 B, the compressor manufacturer's standard exceptions to the applicable API specification (618 or 619) are acceptable. The FGC skid must still meet the other requirements in the specification."

17. Section 48 11 23, Combustion Turbine Generator, Paragraph 2.03.B.1; **ADD** the following sentence to the end of the paragraph "For performance and emissions guarantees, the high-pressure fuel analysis shall be used."

18. Section 48 11 23, Combustion Turbine Generator, Paragraph 2.03.C.3; **DELETE** item 'c' from this paragraph.

19. Section 48 11 23, Combustion Turbine Generator, **REPLACE** Paragraph 2.04.E.4.k.2) as follows "Sight glass for monitoring water level. (Not required if the filter coalescer is provided with an automated drain valve)."

20. Section 43 12 00, Fuel Gas Compressor, Paragraph 2.04.I.2.b; **CHANGE** the paragraph as follows: “A480V ac motor control center will be provided by Supplier for supply and control of fans and pumps ½ Hp and larger. Local disconnect switches rated for Class I Div 2 areas shall be supplied by the Supplier for each motor load.”

21. Section 43 12 00, Fuel Gas Compressor, Paragraph 3.01.H, **REPLACE** the first sentence as follows “Supplier shall maintain factory calibration records for standard Supplier-furnished instruments prior to final acceptance tests as noted below:”.

22. Section 43 12 00, Fuel Gas Compressor; **REPLACE** Paragraph 3.05.A.5 as follows “Performance tests shall use API 618 or 619 standards as a guideline. Supplier shall include Torsional Vibration analysis and Compressor Package Digital Acoustical Pulsation Analysis using API 618 as a guideline. The CTG supplier is responsible for verifying the pulsation requirements at the inlet of the turbine are met if the Pulsation Analysis per API 618 is not included.”

23. Section 43 12 00 Supplement, Fuel Gas Compressor Data Sheets, Load Point CTG 100 Percent (Guarantee); **CHANGE** Gas Outlet Temperature, Deg. F from “<120” to “By MFG”.

All Bidders shall acknowledge receipt and acceptance of this REBID COVERSHEET in the Bid Form. Bid Forms submitted without acknowledgment will be considered in nonconformance.

END OF REBID COVERSHEET

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1419-E-SK01 - CTG-7 OVERALL ONE LINE DIAGRAM

1419-I-SK01 - T7 NETWORK OVERVIEW DIAGRAM

1419-M-SK01 - CTG PROCESS FLOW DIAGRAM

1419-M-SK02 - GENERAL ARRANGEMENT SKETCH

1419-M-SK03A - HIGH PRESSURE FUEL GAS

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1419-M-SK03C - NO 2 FUEL OIL

1419-M-SK04 - T7 INTERCONNECT SKETCH

1419-M-SK05 RAW (POTABLE) WATER ANALYSIS

END OF SECTION

SECTION 01 11 01
PROJECT SUMMARY OF WORK

PART 1 GENERAL

1.01 PROJECT DESCRIPTION

A. The Contract CP-1419 Turbine 7 Procurement Project includes procurement, assembly, testing, delivery and commissioning of one Combustion Turbine Generator (CTG), one Fuel Gas Compressor, and associated auxiliary equipment, which will provide a minimum of 18 MW net output of 60-Hz generation capacity. The new 60-Hz generation will utilize the Static Frequency Converter (SFC) equipment installed under another project to convert the 60-Hz power to 25-Hz for distribution to the existing 25-Hz assets in the Sewerage and Water Board of New Orleans (SWBNO) system.

B. The Contract Documents allow for the provision of a New CTG or a Refurbished CTG, where all proposed equipment must meet all requirements of the Contract Documents. The Base Bid for this contract includes provision of a New CTG, Fuel Gas Compressor, and associated auxiliary equipment. The Alternate Bid for this contract includes provision of a Refurbished CTG, Fuel Gas Compressor and associated auxiliary equipment. The Bidder may elect to submit a bid for the Base Bid scope or the Alternate Bid scope. Additionally, the Bidder may elect to submit a bid for the Base Bid and the Alternate Bid.

C. All site construction activities and installation of the equipment supplied under Contract CP-1419 will be provided by others under a separate contract.

D. Planned future work includes additional Static Frequency Converters, and additional 60-Hz Generators. The ultimate buildout includes interconnection to a new 60-Hz utility substation as a primary feed, and the new 60-Hz generators as backup.

1.02 PROJECT BACKGROUND

A. The Carrollton Water Treatment Plant (CWP) provides purified drinking water for Orleans Parish east of the Mississippi River. Power to the CWP is provided by the co-located CWP power plant, which consists of power generators and local utility feeds located within a group of connected buildings that serve as a building complex. The entrance to this connected building complex is located on Eagle Street, which is accessed from South Claiborne Avenue.

B. The majority of loads connected to the CWP power plant require 25-Hz power. The existing 25-Hz system consists of multiple generation sources, as well as underground feeder installation. This system feeds many of the drainage, sewerage, and potable water stations for New Orleans.

C. Based on the age and condition of the existing 25-Hz generating equipment at the CWP power plant, a phased transition from 25-Hz equipment to 60-Hz equipment is planned. The new CTG will utilize the new SFC and allow for 60-Hz generating equipment to power the 25-Hz system loads. The new CTG will provide increased reliability due to new equipment in sound condition.

D. The CWP 60-Hz system is currently supplied by the local utility (Entergy) as well as the SWBNO Combustion Turbine 6 (T6) generator on site. The utility distribution delivery voltage is nominally 24kV. The on-site generation delivery voltage is 13.8 kV.

E. The 25-Hz system consists of on-site generation at 6.6kV. There is no off-site 25Hz supply.

F. There are several rotary, commutated, frequency converters within the SWBNO managed electrical network that bi-directionally convert 25-Hz to 60Hz or 60-Hz to 25-Hz with a gross aggregate capacity of approximately 25-MW.

1.03 PROJECT CONSIDERATIONS

A. Supply of the CTG, Fuel Gas Compressor, and auxiliary equipment will run concurrent with other onsite construction activities. To maintain the overall construction schedule, the anticipated milestones for supply of the CTG Package are listed in the following table. Supplier shall submit with their bid a milestone schedule indicating the following milestones in their proposed schedule.

Key Milestone	**Schedule – New Equipment**	**Schedule – Refurbished Equipment**
Design Submittal	10 weeks after Notice to Proceed	4 weeks after Notice to Proceed
Design Approval	4 weeks after Design Submittal	4 weeks after Design Submittal
Delivery to Project Site	12 Months after Design Approval	6 Months after Design Approval

B. Special attention should be given to the physical size of the new equipment in coordination with the equipment foundations, adjacent existing structures and underground utilities. Design of the equipment foundation, by others, shall be coordinated with the Supplier. See Reference Documents for the dimensioned area available for the full build-out of the CTG equipment. Supplier shall submit with their bid a proposed equipment layout shown within the dimensioned site layout provided with the Contract Documents.

C. This Work will be performed by multiple entities and it is important to proactively coordinate the Work with the expectation that all Work will affect the Work of other involved entities.

D. Further characterization of the overall project by major project element, project phase, and responsible party is included in the Project Division of Responsibility (DOR). The DOR provides an overview by major project element of the primary, and where applicable a secondary, responsible party(ies) and should be applied in conjunction with the Specification sections to guide scope of work understanding.

1.04 PROJECT SCOPE OF WORK

A. Design, procurement, assembly, testing, delivery and commissioning of all specified equipment, materials, and subcontracts to complete the work.

B. Witnessed factory testing and factory inspection attended by SWBNO (or representative) to include the cost of domestic airfare and hotel accommodations for six people.

C. Installation oversight of new or refurbished Combustion Turbine Generator equipment, Fuel Gas Compressor, and auxiliaries; also known as the CTG Equipment.

D. Commissioning and on-site testing of Combustion Turbine Generator equipment, Fuel Gas Compressor, and auxiliaries.

E. On-Site training for Owner on Combustion Turbine Generator equipment, Fuel Gas Compressor, and auxiliaries.

F. Spare parts as specified.

G. Warranty against defective equipment for a period of 12 months from Substantial Completion.

H. Refer to the following sections for more specific and detailed scopes of work:

1. Section 01 61 00, Common Product Requirements.
2. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

3. Section 40 90 10, Instrumentation and Controls Summary of Work.
4. Section 43 12 00, Fuel Gas Compressor.
5. Section 48 00 10, Mechanical Summary of Work.
6. Section 48 11 23, Combustion Turbine Generator.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. The individual components and equipment shall be commissioned and tested as required by the applicable sections and the detailed scopes of work. All criteria must be met for acceptance by Owner.

3.02 SUPPLEMENTS

A. The supplement listed below, following “End of Section”, is part of this Specification.

1. Division of Responsibility Matrix.

END OF SECTION

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

CONTENTS

1 GENERAL
2 EQUIPMENT PACKAGES
3 ELECTRICAL AND I&C
4 CIVIL STRUCTURAL
5 MECHANICAL
6 SITE/PLANT/CONSTRUCTION SERVICES
7 START-UP/COMMISSIONING/WARRANTY

LEGEND

1419	CTG SUPPLIER
O	OWNER: SEWERAGE AND WATER BOARD OF NEW ORLEANS
ENG	ENGINEER: JACOBS ENGINEERING GROUP
1420	CTG CONSTRUCTION CONTRACTOR/BOP SUPPLY
N/A	Not Applicable
BOP	Balance of Plant abbreviation

DEFINITIONS

Engineering/Design	Design and Co-ordination work including preparation of purchase specifications, evaluation of bids and review and approval of vendor drawings.
Equipment/Material Supply	The supplier of the item or system and accountability for all associated costs. This includes responsibilities such as manufacture and associated studies, soliciting bids and procurement where applicable, scheduling, ordering, quality control, inspecting.
Site Work and Erection	Responsible for the unloading at site/proper erection, installation, cleaning, testing and other work. Includes precommissioning including inspection, lubrication, stroking, adjustment on manual, motor operated and control valves and dampers. Testing and calibration of instrumentation, meters, relays, gauges and transmitters. Performing equiment alignment checks, vibration testing and balancing, removal and reinstallation of orificae plates, flow nozzles and control valve sool pieces. Hydrostatic testing of piping and vessels, ground grid testing, system flushing, continuity checks of electrical cables and cold loop checks, megger testing and high voltage insulation testing and phase and rotation checks on motors.

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

			DESCRIPTION	Engineering / Design	Equipment/Material Supply	Site Work and Erection	Commissioning and Start-Up	REMARKS
1	**GENERAL**							
1.1	**ENGINEERING AND DESIGN**							
	A		**Detailed Engineering**					
		1	Plot Plan and Arrangement Drawings	1419/1423/ENG				A collaboration effort between both entities, based upon 1419 equipment sizing and layout
		2	Design Criteria	ENG				
		3	Construction Specifications	ENG				
		4	Detailed Design	Each Its Own				As defined in Contract Documents
		5	As Built Drawings	1419/1420/1421/1422/1423/ENG				Contractors to keep redlines. 1419 to incorporate into final design documents for equipment supplied. ENG to incorporate changes for BOP drawings.
	B		**Environmental Engineering**					
		1	Design Review	ENG				
		2	Permit Support	ENG				
		3	LDEQ PERMITTING	O				
		4	HAZOP	N/A				
	C		**Purchasing Support**					
		1	Equipment and Materials Specifications	ENG				As issued in Contract Documents
		2	Bills of Material		1419			For equipment supplied.
		3	Review of Vendor Quote Recommendations	ENG				
		4	Review & Approval of Vendor Drawings	ENG				
		5	Procurement Schedule	ENG				Excludes Supplier subsuppliers.
	D		**O & M Manuals**					
		1	O & M Manuals		1419/1420/1421/1422/1423			For equipment supplied
		2	Spare Parts List		1419/1420/1421/1422/1423			For equipment supplied. To be provided minimum 90 days prior to shipment
	E		**Training**					
		1	Classroom		1419		1419/O	OWNER to provide classroom
		2	Training Equipment		1419		1419	
		3	Training Manuals		1419		1419	
1.2	**LOGISTICS**							
	A		Inland Transportation (Country of Origin)		1419/1420/1421/1422/1423			For equipment supplied
	B		Ocean/Air Freight		1419/1420/1421/1422/1423			For equipment supplied
	C		Customs Clearance		1419/1420/1421/1422/1423			For equipment supplied
	D		Duties (plant equipment and material)		1419/1420/1421/1422/1423			For equipment supplied
	E		Construction Permits			O/ENG		ENG supports OWNER
	F		Right of Way/Clearance for All Equipment and Material During Transit to Site		1419/1420/1421/1422/1423			For equipment supplied
	G		Transportation from Port of Import to Site		1419/1420/1421/1422/1423			For equipment supplied
	H		Unloading and Receiving Equipment and Material (at site)			1420		
	I		Receiving, Inspecting, Checking & Inventory Including OS&D			1419/1420		1420 primary inspection. 1419 expected to participate
	J		All Req'd Indoor/Outdoor Storage of Equip & Material			1419/1420		1420 to provide site services to properly store all equipment and materials. 1419 to provide storage requirements
	K		Local Registration Fees, License, Etc.	O				

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

		DESCRIPTION	Engineering / Design	Equipment/Material Supply	Site Work and Erection	Commissioning and Start-Up	REMARKS
	L	Transport of Damaged/Defective Material for Repair		1419/1420/1421/1422/1423			For equipment supplied
	M	Storage Area / Office Space Area			1420/O		1420 expected to supply construction trailer, Owner to supply space on site.
2		**EQUIPMENT PACKAGES**					
2.1		**BOP EQUIPMENT PACKAGE**					
	A	Fuel Oil Storage Tank	ENG/1420	1420	1420	1420	
	B	Fuel Oil Forwarding Pumps	ENG/1420	1420	1420	1420	
	C	Emergency Diesel Generator	ENG/1420	1422	1420	1420	
	D	Air Compressors	ENG/1420	1420	1420	1420	
	E	480V MCC's	ENG/1423	1423	1416	1416	Mounted in Equipment Enclosure
	F	4160V Switchgear 2000A	ENG/1423	1423	1416	1416	Mounted in Equipment Enclosure
	F	4160V Switchgear 1200A	ENG/1423	1423	1416	1416	Mounted in Equipment Enclosure
	G	480V Switchgear 3000A	ENG/1423	1423	1416	1416	Mounted in Equipment Enclosure
	H	6.6kV Switchgear	ENG/1423		1416	1416	
	I	24kV Switchgear	ENG/1423		1416	1416	
	H	Electrical Equipment Enclosure	ENG/1423	1423	1416	1416	
	I	UPS System	ENG/1423	1423	1416	1416	Mounted in Equipment Enclosure
	J	13.8kV/4160V Distr Transformer 7.5MVA	ENG/1423	1423	1416	1416	
	K	CTG-7 13.8kV/24kV GSU Transformer (QTY 1) 25?? MVA	ENG/1421	1421	1420	1420	
	F	CTG-6 13.8kV/24kV GSU Transformer (QTY 1) 25 MVA	ENG/1421	1421	1416	1416	
	F	4160V/480V Distr Transformer (QTY 1) 500kVA	ENG/1423	1423	1420	1420	
	L	4160V/480V Distr Transformer (QTY 1) 3000kVA	ENG/1423	1423	1420	1420	
	M	Continuous Emissions Monitoring Package	ENG/1420	1420	1420	1420	
	N	Oily Water Separator	ENG/1420	1420	1420	1420	
2.2		**COMBUSTION TURBINE GENERATOR EQUIPMENT PACKAGE**					
	A	CTG	1419	1419	1420/1419	1420/1419	Outdoor, 1419 to provide TFA
	B	13.8kV Switchgear 1200A	1419	1419	1420/1419	1420/1419	1419 to provide TFA
	C	480V MCC 600A	1419	1419	1420/1419	1420/1419	
	D	13.8kV/480V Transformer (QTY 1) 500kVA	1419	1419	1420/1419	1420/1419	1419 to provide TFA
	E	Gas Compressor	1419	1419	1420	1420/1419	1419 to provide TFA
	F	Fuel Oil/Gas Conditioning Skids	1419	1419	1420	1420/1419	1419 to provide TFA
	G	CTG Auxiliaries (incl Lube Oil coolers, control systems, starting motor, UPS, etc.)	1419	1419	1420	1420/1419	1419 to provide TFA
	H	Water Treatment Skid (if required)	1419	1419	1420	1420/1419	1419 to provide TFA
	I	Electrical Prefab Enclosure (ex PDC)	1419	1419	1420	1420/1419	
	J	Exterior Lighting	1419	1419	1420	1420/1419	On equipment enclosures/skids
	K	Stairs / platforms / ramps	1419	1419	1420	N/A	
	L	Lifiting Equipment inside modules	1419	1419	1420	1419/1420	If required for maintenance
	M	Air Conditioning / Heating of all enclosures	1419	1419	1420	1419/1420	
	N	Interconnections between 1419 supplied equipment	1419	1419	1420	1420/1419	

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

	DESCRIPTION	Engineering / Design	Equipment/Material Supply	Site Work and Erection	Commissioning and Start-Up	REMARKS
O	Special Tools	1419	1419			
P	FACTORY TEST REPORTS	1419	1419			
Q	CTG Equipment Package Spares	1419	1419			
3	**ELECTRICAL AND I&C**					
3.1	**ELECTRICAL / I & C ENGINEERING & DESIGN**					
1	One-Line Drawings	1419/ENG				ENG for OVERALL PLANT, and 1419 for EQUIPMENT Package
2	System Calculations	1419/ENG				ENG for OVERALL PLANT, and 1419 for EQUIPMENT Package
3	Cable, Conduit, Bus, Tray and Grounding	1419/ENG				1419 within EQUIPMENT Package, ENG/1420 for BOP ties to Equipment Package
4	Interconnections	1419/ENG	1419/1420	1420		1419 within EQUIPMENT Package, ENG/1420 for BOP ties to Equipment Package
5	Ground Resistivity & Corrosivity	ENG		1420		
6	Instrument and Relay Settings	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
7	Power System Studies	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
8	Protective Logic Diagram	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
9	Control Logic Diagrams	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
10	Instrumentation Location Drawings	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
11	Instrumentation Installation Details	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
12	Supervisory Control System / IO List	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
13	Graphics	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
14	Sequence Logic Diagram (including auto sequencing)	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
15	Instrument Data Sheets	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
16	System Operational Description	1419/ENG				ENG for BOP, and 1419 for EQUIPMENT Package
17	Termination Drawings	1419/1420/ENG				ENG/1420 for BOP, and 1419 for EQUIPMENT Package
3.2	**CONTROLS PLANT AUTOMATION**					
A	Control Systems (PLC's, Turbine Controls and Process SCADA System)					
1	Control Systems Equipment	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for Equipment Package/ENG and 1420 for BOP Equipment, 1419 provides TFA for Commissioning and Startup
2	Consoles	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for Equipment Package/ENG and 1420 for BOP Equipment
4	Data Link Interface	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for Equipment Package/ENG and 1420 for BOP Equipment
5	Accessory Equipment	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for Equipment Package/ENG and 1420 for BOP Equipment
6	Software	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for Equipment Package/ENG and 1420 for BOP Equipment
B	Relaying/Metering/Protection (Power Distribution Control System)					
1	Relay/Protection/Control Panels	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for CTG package equipment, 1419 TFA for Commissioning.
2	Relay Coordination and Settings	1419/1420/ENG	1419/1420	1420	1420/1419	1419 for Equipment Package/ENG and 1420 for BOP Equipment, 1419 provides TFA
3.3	**CABLE AND RACEWAY SYSTEM**					
A	RACEWAY SYSTEM					
1	Conduit	1419/1420/ENG	1419/1420	1420		1419 within Equipment Package Boundary, ENG from interface point to Plant
3	Medium Voltage distribution (13.8 kV)	1419/ENG	1419/1420	1420		1419 within Equipment Package Boundary, ENG from interface point to Plant
4	Low voltage Distribution (480 V)	1419/ENG	1419/1420	1420		1419 within Equipment Package Boundary, ENG from interface point to Plant
B	Cables					

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

	DESCRIPTION	Engineering / Design	Equipment/Material Supply	Site Work and Erection	Commissioning and Start-Up	REMARKS
1	High voltage cable interconnects	1419/ENG	1419/1420	1420		
2	Medium voltage interconnects (13.8 Kv/15kV)	1419/ENG	1419/1420	1420		1419 within Equipment Package Boundary, ENG from interface point to Plant
3	MV interconnects (24kV)	ENG	1419/1420	1420		
6	LV Interconnects	1419/ENG	1419/1420	1420		1419 within package
8	Instrumentation Cables	1419/ENG	1419/1420	1420		1419 for cables within their boundary.
3.4	**PLANT AND INSTRUMENT GROUNDING**					
A	Ground Grid	ENG/1420	1420	1420		
B	Equipment and System Grounding	1419/1420/ENG	1419/1420	1420		1419 within Equipment Package Boundary, ENG/1420 for BOP
C	Lightning Protection	1419/1420/ENG	1419/1420	1420		1419 to design and supply Lightning Protection System for all equipment and structures within Equipment Package Boundary/1420 BOP
3.5	**CATHODIC PROTECTION**					For systems that require one.
A	Sacrificial Anodes	ENG/1420		1420		
B	Exothermic Weld Kits/Molds/Charges	ENG/1420		1420		
C	Insulated Flanges	ENG/1420		1420		
3.6	**PLANT LIGHTING SYSTEM**					
A	Outdoor Area Lighting	ENG/1420	1419	1420		1419 to design and supply Lighting for area within Equipment Package Boundary, ENG for areas outside boundary.
B	Roadway Lighting	ENG/1420	1420	1420		
D	Equipment Enclosure Lighting	ENG/1419/1420	1419/1420	1419		1419 to design and supply Lighting for Equipment Package enclosures and skids, ENG for remainder.
4	**CIVIL / STRUCTURAL**					
A	Site Survey, Soil Study & Recommendations	ENG		O/1420		Soil Study by Owner. Site Survey by 1420. Must include soil base & acidity values (i.e., pH values) and soil thermal resistivity values (rho) for design related to cathodic protection and conduit / ductbank heat transfer capability (i.e., heat rejection), respectively.
4.1	**SITE WORK**					
A	Clearing/Grubbing	O		O		
B	Demolition	O		O		
C	Special Shoring	N/A				
D	Earthwork	ENG	1420	1420		
E	Drainage	ENG	1420	1420		
F	Dewatering	ENG	1420	1420		
G	Roads and Surfacing	ENG	1420	1420		
H	Fencing / Gates	ENG	1420	1420		
I	Landscaping	N/A	N/A	N/A		
J	Railroads	N/A	N/A	N/A		
K	Docks	N/A	N/A	N/A		
L	Tunnels	N/A	N/A	N/A		
M	Wells	N/A	N/A	N/A		
N	Containment Systems	ENG	1420	1420		
O	Miscellaneous Concrete Work (i.e sidewalks)	ENG	1420	1420		
P	Masonry	ENG	1420	1420		If required

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

	DESCRIPTION	Engineering / Design	Equipment/Material Supply	Site Work and Erection	Commissioning and Start-Up	REMARKS
4.2	**PILING**					
A	Piling	ENG	1420	1420		
4.3	**FOUNDATIONS**					
A	CTG Equipment Package Foundations (for all equipment provided by 1419)	1419/ENG	1420	1420		ENG designs based upon 1419 loads, dimensions
B	Embedments (including Anchor Bolts, Sole Plates, and Conduits)	1419/ENG	1419	1420		1419 to specify any specialty embedments
C	Shims and grout for all equipment	1419/ENG	1419/1420	1420		
4.4	**PIPE/CABLE TRAY RACK**					
A	Structural support for piping, cable tray, other between Supplier equipment	1419	1419	1420		Structural Contractor to install steel, Electrical to install Cable Tray/Conduit, Mechanical to install Piping
B	Structural support for piping, cable tray, conduit, other from Supplier equipment interface point to Plant	ENG	1420	1420		
4.5	**PAINTING**					
A	Final Painting		1419/1420/1421/1422/1423			1419 CTG Package Equipment Supplier to deliver with final paint. 1420 for BOP Equipment
B	Touchup		1420	1420		
5	**MECHANICAL**					
5.1	**MECHANICAL DESIGN & ENGINEERING**					
1	P&ID's / Flow Diagrams	ENG/1419/1420	1419/1420/1422	1420		1419 for CTG Package, ENG and 1420 for BOP, 1422 for Diesel Generator
2	Piping and Hanger Design	ENG/1419/1420	1419/1420	1420		1419 for CTG Package, ENG and 1420 for BOP
3	Thermal Insulation	ENG/1419/1420	1419/1420/1422	1420		1419 for CTG Package, ENG and 1420 for BOP, 1422 for Diesel Generator
4	Lists of Lubricants, Chemicals, and Gases	ENG/1419/1420	1419/1420/1422	1420		1419 for CTG Package, ENG and 1420 for BOP, 1422 for Diesel Generator
5.1	**FIRE PROTECTION**					
A	Portable Fire Extinguishers	1419/ENG	1419/1420	1420		1419 for area and equipment within Equipment Package Boundary. ENG and 1420 for remainder of plant
B	Fire Detection and Alarm Systems					
1	CTG Packaged Equipment	1419	1419	1420	1420/1419	
2	Transformers	1419/ENG	1419/1420/1421	1420	1420	If required by transformer design
3	Remainder of Project Area	ENG	1420	1420		
6	**SITE / PLANT / CONSTRUCTION SERVICES**					
6.1	**SITE MANAGEMENT AND SERVICES**					
A	Site Manager			1420		
B	Construction Management			1419/1420		
C	Start-up Management			1420		
D	Craft Labor			1420		
E	TA's			1419/1420		Each for their own equipment

SECTION 01 11 01
PROJECT SUMMARY OF WORK
SUPPLEMENT 1 - DIVISION OF RESPONSIBILITY

		DESCRIPTION	Engineering / Design	Equipment/Material Supply	Site Work and Erection	Commissioning and Start-Up	REMARKS
	F	Resident Engineer			1420		As needed.
	G	Clerical Staff			1420		
	H	Materials Coordinator			1420		
	i	Site QA/QC			1420		
	j	Office and office equipment			1420		One office within construction trailer complex for 1419.
	K	Construction water			O		
	L	Construction power			1420		
7		**START-UP / COMMISSIONING / WARRANTY**					
7.1		**FIRST FILLS**					
	A	Transformer Oil		1419/14211423			Depends on transformer supplied
	B	Chemicals and Gases (Initial Fill and start up test)		1420			
	C	Oils and Greases(Initial Fill and start up test)		1420			
	D	Other Consumables (Initial Fill and start up test)		1420			
7.2		**COMMISSIONING & TESTING**					
.	A	Fuel Supply				O	
	B	Operators				1420/O	
	C	Supervision				1420/1419	1419 for TFA
	D	Craft Labor				1420	
	E	Electrical Load & Start-Up Power				O	
	F	Standard and Special Test Instruction, Tools, & Equipment				1419/1420	For equipment provided
	G	Instrument Calibration				1420	
	H	Start-Up and Commissioning Spares				1419/1420	For equipment provided
	I	Documentation, Tests, Data, & Reports				1419/1420	For equipment provided
	J	Equipment & System Walk down and Turnover				1419/ENG/O/1420	
	K	Punch List Creation and Maintenance				1420	
	L	Potable Water				O	
	M	Performance Testing & Reliability Run				1419/1420	For equipment provided
	N	Reporting				1419	
7.3		**WARRANTY SERVICES**					
	A	Equipment Replacement		1419			
	B	Construction / In/Out Services		1419			
	C	Maintenance Labor/Troubleshooting Services		O			
		END OF LIST					

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SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Schedule of Values: Submit on Contractor's standard form.
2. Schedule of Estimated Progress Payments:
   a. Submit baseline forecast within 7 days of Owner acceptance of Schedule of Values.
   b. Submit adjustments thereto with Application for Payment.
3. Application for Payment.
4. Final Application for Payment.

1.02 SCHEDULE OF VALUES

A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement. The Schedule of Values shall be based on the items in the Conformed Bid form utilizing the bid items as primary line items and breaking down the primary items into sub items as appropriate.

B. Upon request of Engineer, provide documentation to support the accuracy of the Schedule of Values.

C. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

D. Lump Sum Work:

1. Reflect specified alternates, as applicable.
2. Break down by Division 2 through 49 with appropriate subdivision of each Specification.

E. An unbalanced or front-end loaded schedule will not be acceptable.

F. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.

G. Submit Schedule of Values electronically in a spreadsheet format compatible with latest version of Excel. Include also three printed versions of the Schedule in the agreed to format(s).

1.03 SCHEDULE OF ESTIMATED PAYMENTS

A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.

B. Base estimated payments on initially acceptable baseline schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

1.04 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.

B. Use detailed Application for Payment Form acceptable to the Engineer.

C. Provide separate form for each schedule as applicable.

D. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.

E. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.

F. Preparation: Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.

1.05 MEASUREMENT—GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, material shall be weighed on scales furnished by Contractor and certified accurate by state agency responsible. Weight or load slip shall be obtained from weigher and delivered to Owner’s representative at point of delivery of material.

C. If material is shipped by rail, car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Engineer. Each vehicle shall bear a plainly legible identification mark.

E. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

F. No payment will be processed if Contractor is not current with monthly Updated Progress Schedule and Narrative Progress Report submission.

1.06 PAYMENT

A. The following sum of the items that are subsidiary to the whole Work. The cost of these items shall be balanced throughout the separate pay items:

1. Insurance, permits, and licenses.
2. Contractor’s supervision, progress schedules and Site meetings.
3. Administrative items.
4. Mobilization, demobilization, insurance, and performance bonding.
5. Indirect support services and support including temporary facility and quality control, inclusive of construction management/coordination/ supervision and administration. Also includes the following:
    a. Administrative items detailed within Section 01 33 00, Submittal Procedures. This includes preparation, printing, processing, delivery of submittals, resubmittal and other work as required and necessary for approval of materials, equipment, means and methods as detailed within the Contract Documents from the Engineer and Owner.

B. Payment for all Lump Sum Work shown or specified in Contract Documents is included in the Contract Price. Payment will be based on milestone completion for each line item of the accepted Schedule of Values.

C. Payment for lump sum and unit price items covers all the labor, materials, and services necessary to furnish and install the items listed in Table 1.

Table 1: Payment Items

Reference Number	Description	QTY	Unit of Measure	Measurement and Payment Item Description	Reference Specification (Including but not limited to)
1	**CTG Equipment** 20% Upon Contract Signing	1	LS	Complete and Final contract execution of the CP-1419 Contract Documents.	Commercial Terms and Conditions of the Contract Documents.
2	**CTG Equipment** 30% Upon Drawing Approval	1	LS	Submittal of CTG Equipment Package design documents to Engineer for Approval. Physical design includes but is not limited to civil / structural / architectural components such as equipment layout, dimensions, weights, anchorage and bracing requirements. Non-physical design includes but is not limited to electrical / controls / process and instrumentation.	01 33 00, Submittal Procedures 48 11 23, Combustion Turbine Generator Other applicable Technical Specifications
3	**CTG Equipment** 20% Upon Shipment	1	LS	Successful Factory Acceptance Testing of the CTG Equipment and control system and subsequent shipping from the manufacturer's facility to the project site. Documentation for this item includes certified FAT reports, Manufacturer's Certificate of Compliance, and shipping paperwork.	01 61 00, Common Product Requirements 48 11 23, Combustion Turbine Generator Other applicable Technical Specifications
4	**CTG Equipment** 25% Upon Delivery to Job Site	1	LS	Delivery and satisfactory inspection of all CTG Equipment Package components to the SWBNO project site.	01 61 00, Common Product Requirements 48 11 23, Combustion Turbine Generator Other applicable Technical Specifications

Table 1: Payment Items

Reference Number	Description	QTY	Unit of Measure	Measurement and Payment Item Description	Reference Specification (Including but not limited to)
5	**CTG Equipment** 5% Upon Successful Completion of the On-Site Performance Test	1	LS	Successful Performance Testing of all CTG Equipment Package components located in their final installed location at the SWBNO project site. Performance test requirements are listed in the relevant Technical Specification section.	43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator
6	**Fuel Gas Compressor Equipment** 20% Upon Contract Signing	1	LS	Complete and Final contract execution of the CP-1419 Contract Documents.	Commercial Terms and Conditions of the Contract Documents.
7	**Fuel Gas Compressor Equipment** 30% Upon Drawing Approval	1	LS	Submittal of Fuel Gas Compressor Equipment Package design documents to Engineer for Approval within 8 weeks of NTP. Physical design includes but is not limited to civil / structural / architectural components such as equipment layout, dimensions, weights, anchorage and bracing requirements. Non-physical design includes but is not limited to electrical / controls / process and instrumentation.	01 33 00, Submittal Procedures 43 12 00, Fuel Gas Compressor Other applicable Technical Specifications
8	**Fuel Gas Compressor Equipment** 20% Upon Shipment	1	LS	Successful Factory Acceptance Testing of the Fuel Gas Compressor Equipment and control system and subsequent shipping from the manufacturer's facility to the project site. Documentation for this item includes certified FAT reports, Manufacturer's Certificate of Compliance, and shipping paperwork	01 61 00, Common Product Requirements 43 12 00, Fuel Gas Compressor Other applicable Technical Specifications

Table 1: Payment Items

Reference Number	Description	QTY	Unit of Measure	Measurement and Payment Item Description	Reference Specification (Including but not limited to)
9	**Fuel Gas Compressor Equipment** 25% Upon Delivery to Job Site	1	LS	Delivery and satisfactory inspection of all Fuel Gas Compressor Equipment Package components to the SWBNO project site.	01 61 00, Common Product Requirements Other applicable Technical Specifications
10	**Fuel Gas Compressor Equipment** 5% Upon Successful Completion of the On-Site Performance Test	1	LS	Successful Performance Testing of all Fuel Gas Compressor Equipment Package components located in their final installed location at the SWBNO project site. Performance test requirements are listed in the relevant Technical Specification section.	43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator
11	Installation Supervision	1	LS	Provide installation supervision in accordance with the requirements of the technical specifications. Documentation for this payment item includes a signed Manufacturer's Certificate of Proper Installation.	01 43 33, Manufacturers' Field Services 43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator
12	Field Testing and Commissioning	1	LS	Satisfactory completion of Equipment field testing including the 5 day reliability field test and the Performance Test of the CTG equipment and controls in accordance with the technical specifications.	01 43 33, Manufacturers' Field Services 01 91 14, Equipment Testing And Facility Startup 43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator
13	Training	21	Calendar Day	Satisfactory completion of on-site training for the Owner's personnel in accordance with the Technical Specifications.	01 43 33, Manufacturers' Field Services 43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator

Table 1: Payment Items

Reference Number	Description	QTY	Unit of Measure	Measurement and Payment Item Description	Reference Specification (Including but not limited to)
14	Spare Parts	1	LS	Provision of spare parts for successful operations of the equipment following substantial completion. Quantity of spare parts shall conform with the requirements of the Technical Specifications.	43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator
15	Special Tools	1	LS	Provision of special tools, required for maintenance of the equipment installed under the project shall be provided in accordance with the Technical Specifications.	43 12 00, Fuel Gas Compressor 48 11 23, Combustion Turbine Generator

Units of Measure

AC	Acre—Field Measure by Engineer
CY	Cubic Yard—Field Measure by Engineer within limits specified or shown
EA	Each—Field Count by Engineer
GAL	Gallon—Field Measure by Engineer
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by Engineer
LS	Lump Sum
MFBM	Thousand Foot Board Measure-Delivery Invoice
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)

1.07 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by Owner.
6. Material remaining on hand after completion of Work.

1.08 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and storage of said materials/equipment is in accordance with manufacturer's instructions and are acceptable to Engineer.

B. Contractor is to provide with the request for payment confirming documentation that the cited material or equipment has been paid for by the Contractor. Failure to provide confirming documentation will result in denial of the request for payment. Payment for any approved stored materials or equipment shall not exceed 90 percent of the purchased value which must be validated by a paid invoice. Retainage will be withheld on the approved amount.

C. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

1.09 PARTIAL PAYMENT FOR UNDELIVERED, PROJECT-SPECIFIC MANUFACTURED OR FABRICATED EQUIPMENT

A. Notwithstanding above provisions, partial payments for undelivered (not yet delivered to Site or not stored in the vicinity of Site) products specifically manufactured for this Project, excluding off the shelf or catalog items, will be made when all following conditions exist:

1. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.
2. Equipment is adequately insured, maintained, stored, and protected by appropriate security measures.
3. Each equipment item is clearly marked and segregated from other items to permit inventory and accountability.

4. Authorization has been provided for access to storage Site for Engineer and Owner.
5. Equipment meets applicable Specifications of these Contract Documents.
6. Engineer concurs that affected equipment was specifically manufactured for this Project.

B. Failure of Contractor to continue compliance with above requirements shall give cause for Owner to withhold payments made for such equipment from future partial payments.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor or Supplier that requires Engineer's approval.

B. Informational Submittal: Information submitted by Contractor or Supplier that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

1.02 PROCEDURES

A. Submittals should follow the Project Specific Records Management Information, attached as a supplement to this Specification.

B. Electronic Submittals: Submittals shall, unless specifically excepted, be made in electronic format.

1. Each submittal shall be an electronic file in Portable Document Format (PDF).
2. Each submittal shall be delivered under the guidelines set out in the Project Specific Records Management Information, attached as a supplement to this Specification.
3. Electronic files that contain more than ten pages in PDF format shall contain internal bookmarking from an index page to major sections of the Document.
4. PDF files shall be set to open "Bookmarks and Page" view.
5. Add general information to each PDF file, including title, subject, author, and keywords.
6. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
7. Submit new electronic files for each resubmittal. Resubmitted file must be a complete file with corrections annotated appropriately.
8. Include a copy of the Contractor's Submittal form with each electronic file.
9. Engineer will reject a submittal that is not electronically submitted, unless specifically excepted.
10. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.

C. Transmittal of Submittal:

1. Complete, sign, and transmit with each submittal package, one Submittal form in format approved by Engineer.
2. Identify each submittal with the following:
   a. Numbering and Tracking System:
      1) Sequentially number each submittal.
      2) Resubmission of submittal shall have original number with sequential alphabetic or numeric suffix.
   b. Specification section and paragraph to which submittal applies.
   c. Project title and Engineer's project number.
   d. Date of transmittal.
   e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
3. Identify and describe each deviation or variation from Contract Documents.

D. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual Specification section. Do not combine different Specification sections together in submittal package, unless otherwise directed in Specification.
3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. All documents, Drawings, and data submitted shall be in the English language, with all dimensions in USCS units.

E. Timeliness: Schedule and submit in accordance with Schedule of Submittals, and requirements of individual Specification sections.

F. Processing Time:

1. Time for review shall commence upon Engineer's receipt of submittal.
2. Engineer will consult with Owner and act on Contractor's submittal and transmit response to Contractor not later than 2 weeks after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.

G. Resubmittals: Clearly identify each correction or change made and include an index of changes/corrections as a submitted item annotated accordingly on the submittal transmittal.

H. Incomplete Submittals:

1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete: Submittal form; completed and signed.

I. Submittals not required by Contract Documents: Will not be reviewed and will be returned stamped "Not Subject to Review / For Information Only."

1.03 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual Specification sections.

B. Shop Drawings:

1. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
   b. Equipment and Component Title: Identical to title shown on the Drawings.
   c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
   d. Project-specific information drawn accurately to scale.
2. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.
3. Product Data: Provide as specified in individual Specifications.
4. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual Specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. Sample source.

3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
4. Full-size Samples:
   a. Size as indicated in individual Specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

D. Action Submittal Dispositions: Engineer will review, comment, stamp, and distribute as noted:

1. Approved:
   a. Contractor may incorporate product(s) or implement Work covered by submittal.
   b. Distribution: Electronic.
2. Approved as Noted:
   a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
   b. Distribution: Electronic.
3. Revise and Resubmit:
   a. Contractor may not incorporate product(s) or implement Work covered by submittal. Make corrections or obtain missing portions, and resubmit.
   b. Contractor shall maintain a log of all comments including Contractor's disposition of each comment. The Comment Log shall be returned with resubmittals and included in Contractor's monthly report.
   c. Distribution: Electronic.
4. Rejected:
   a. Contractor may not incorporate product(s) or implement Work covered by submittal.
   b. Distribution: Electronic.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Refer to individual Specification sections for specific submittal requirements.
2. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will require that submittal be corrected and resubmitted.

B. Certificates:

1. General:
   a. Provide notarized statement that includes signature of entity responsible for preparing certification.
   b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual Specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual Specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual Specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.

C. Manufacturer-design Data:

1. Written and graphic information.
2. List of assumptions.
3. List of performance and design criteria.
4. Summary of loads or load diagram, if applicable.
5. Calculations.
6. List of applicable codes and regulations.
7. Name and version of software.
8. Information requested in individual Specification section.

D. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual Specification section.

E. Operation and Maintenance Data: As required in individual Specification sections.

F. Quality Control Documentation: As required in individual Specification sections.

G. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule.
   a. Show for each, at a minimum, the following:
      1) Specification section number.

2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
3) Estimated date of submission to Engineer, including reviewing and processing time.

b. On a monthly basis, submit updated Schedule of Submittals to Engineer if changes have occurred or resubmittals are required.

H. Submittal review does not change the terms of the Contract. Submittal review does not alleviate the contractor from meeting all terms and conditions as outlined in the Specifications, Drawings, plans, etc.

I. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.

J. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals. Reference paragraph 1.01.A.52 of Supplementary Conditions for definition of Specialist.

K. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Promptly submit notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to Engineer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.

L. Test, Evaluation, and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
   a. Identification of product and Specification section, type of inspection or test with referenced standard or code.
   b. Date of test, Project title and number, and name and signature of authorized person.
   c. Test results.
   d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
   e. Provide interpretation of test results, when requested by Engineer.
   f. Other items as identified in individual Specification sections.

3. Field:
   a. As a minimum, include the following:
      1) Project title and number.
      2) Date and time.
      3) Record of temperature and weather conditions.
      4) Identification of product and Specification section.
      5) Type and location of test, Sample, or inspection, including referenced standard or code.
      6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
      7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
      8) Provide interpretation of test results, when requested by Engineer.
      9) Other items as identified in individual Specification sections.

M. Testing and Startup Data: In accordance with individual Specification sections.

N. Training Data: In accordance with Section 01 43 33, Manufacturers Field Services, and individual Specification sections.

1.05 SUPPLEMENTS

A. The supplements listed below, following “End of Section”, are part of this Specification.

1. Project Specific Submittal Register.
2. Project Specific Records Management Information.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SUBMITTAL REGISTER

Contract Package #: 1419
Project Name: Combustion Turbine Generator 7 Equipment Procurement
Client: Sewerage and Water Board of New Orleans

SECTION 01 11 01
PROJECT SUMMARY OF WORK

A. N/A

SECTION 01 29 00
PAYMENT PROCEDURES

A. Informational Submittals:

1. Schedule of Values: Submit on Contractor's standard form.
2. Schedule of Estimated Progress Payments:
    a. Submit baseline forecast within 7 days of Engineer acceptance of Schedule of Values.
    b. Submit adjustments thereto with Application for Payment.
3. Application for Payment.
4. Final Application for Payment.

SECTION 01 33 00
SUBMITTAL PROCEDURES

A. Prepare and submit Action Submittals required by individual Specification sections.

B. Shop Drawings:

1. Identify and Indicate:
    a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
    b. Equipment and Component Title: Identical to title shown on Drawings.
    c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
    d. Project-specific information drawn accurately to scale.
2. Manufacturer's standard schematic drawings and diagrams as follows:
    a. Modify to delete information that is not applicable to the Work.
    b. Supplement standard information to provide information specifically applicable to the Work.
3. Product Data: Provide as specified in individual Specifications.

4. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual Specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. Sample source.
3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
4. Full-size Samples:
   a. Size as indicated in individual Specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

A. Informational Submittals:

1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 60 days prior to start of equipment testing and startup and revise as necessary for acceptance.
2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
3. Training Session Documentation: Furnish Owner with one complete electronic set of fully indexed and cataloged documentation of the training sessions using the training plan as the basis with each lesson plan expanded to include presentations, notes, questions and answers, reference material, photographs, and the like, that clearly represent the proceedings of the training sessions.

SECTION 01 58 53
PROJECT EQUIPMENT IDENTIFICATION

A. N/A

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

A. N/A

SECTION 01 77 00
CLOSEOUT PROCEDURES

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Approved Shop Drawings and Samples: As required in the General Conditions.
   c. Special bonds, Special Guarantees, and Service Agreements.
   d. Consent of Surety to Final Payment: As required in General Conditions.
   e. Releases or Waivers of Liens and Claims: As required in General Conditions.
   f. Releases from Agreements.
   g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   h. Extra Materials: As required by individual Specification sections.

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

A. Informational:

1. Data Outline: Submit six copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit six copies for Engineer's review.
   b. If data meets conditions of the Contract one copy will be returned to Contractor.
   c. If data does not meet conditions of the Contract:
      1) All copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
      2) Engineer's comments will be retained in Engineer's file.
      3) Resubmit three copies revised in accordance with Engineer's comments.
3. Final Data: Submit one hard copy and one electronic copy in format specified herein.

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

SECTION 09 90 01
PAINTING AND PROTECTIVE COATINGS

A. N/A

SECTION 10 14 00
SIGNAGE

A. N/A

SECTION 26 00 00
ELECTRICAL GENERAL REQUIREMENTS

A. N/A

SECTION 26 00 10
ELECTRICAL SUMMARY OF WORK

A. N/A

SECTION 26 05 04
ELECTRICAL REQUIREMENTS FOR PACKAGED MECHANICAL EQUIPMENT

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, or required elsewhere in this section, the following Drawings and data shall be submitted for approval:

1. Equipment outlines including junction box size and location.
2. Elementary diagrams and schematic diagrams.
3. Connection Wiring diagrams indicating terminal points for external wiring.
4. Control Panel arrangement drawings.
5. Bill of materials listing each device by manufacturer’s part number.
6. Load List information for all equipment supplied.
7. Motor data sheets.

8. Packaged Mechanical Equipment Cable Schedule listing cable tag number, cable type, cable from, cable to, cable scope of design, cable scope of supply, cable scope of installation, and cable function. All cables required for a complete and functional package shall be included in Packaged Mechanical Equipment Cable Schedule.
9. Packaged Mechanical Equipment Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
10. Installation and Operating Manuals.
11. Manufacturer Drawings and Catalog Cut Sheets for all components.
12. Test Reports for all components.

B. Additional Documentation:

1. Submit complete engineering information for electrical items being furnished. The information shall include but not be limited to horsepower ratings, operating voltage, frequency, amperage, power factor, demand factor, and other data which can help the adequate sizing of the power supply.
2. Submit electrical documentation indicating sensors, RTDs, and control devices as well as their operating voltage.
3. List required external power sources indicating voltage, number of phases, frequency, maximum and nominal kW and kVA requirements.
4. Submit design data sheets, descriptive literature, outline dimensions, anchor bolt location drawings, junction box locations, and other conduit interface points.

SECTION 26 05 05
LOW VOLTAGE AC INDUCTION MOTORS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Completed motor data sheet attached to this specification for each motor supplied.
2. Standard motor data submittals including safety stall times.
3. Outline drawings, Preliminary and Certified.
4. Performance curves (speed-torque at 100 percent and 80 percent voltage).
5. Speed-current / acceleration curves at 100 percent and 80 percent voltage.
6. Stator and rotor thermal damage curve.
7. Wiring Diagram.
8. Installation Instructions.

9. Operating and Maintenance Manual.
10. Test Reports.

SECTION 26 05 13
MEDIUM VOLTAGE CABLE

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Manufacturer's data cut sheets.
2. Certified Factory Test Reports.
3. Manufacture's installation instructions.
4. Recommended field tests.

SECTION 26 05 19
LOW VOLTAGE WIRE AND CABLE

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Manufacturer's data cut sheets.
2. Certified Factory Test Reports.
3. Manufacture's installation instructions.
4. Recommended field tests.

SECTION 26 05 33
CONDUIT INSTALLATION

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the Documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Manufacturer's data cut sheets.

B. Conduit Schedule: a conduit schedule shall be maintained for all installed conduits recording the following information:

1. Conduit Number.
2. Conduit Type.
3. Conduit Size.
4. Conduit run Length.
5. Conduit FROM equipment tag.

6. Conduit TO equipment tag.
7. Listing of cable numbers installed in conduit.
8. Conduit fill tabulation.
9. Conduit Hazardous Area boundary flag (Y/N); this 'flag' is true/Yes if conduit required hazardous area seal to be installed in conduit.

SECTION 26 05 36
CABLE TRAY

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition, the Documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Manufacturer data sheets.
2. Installation guidelines.
3. Dimensional Drawings.
4. Load ratings.
5. All related data for cable tray and associated cable tray supporting material.

B. Cable Tray Schedule: a cable tray schedule shall be maintained for all installed cable trays, recording the following information:

1. Cable Tray Number.
2. Cable Tray Type.
3. Cable Tray Size.
4. Cable Tray run length.
5. Cable Tray From equipment tag.
6. Cable Tray To equipment tag
7. Listing of cable numbers installed in Cable Tray.
8. Cable Tray fill tabulation.

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

A. As Applicable to CP-1419.

SECTION 26 05 75
BASIC ELECTRICAL MATERIALS AND METHODS

A. N/A

SECTION 26 11 16
DRY TYPE MEDIUM VOLTAGE TRANSFORMERS

A. As Applicable to CP-1419.

SECTION 26 12 13
LIQUID FILLED MEDIUM VOLTAGE TRANSFORMERS

A. As Applicable to CP-1419.

SECTION 26 13 00
MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Provide Shop Drawings.
2. Test reports.
3. Maintenance and service instructions.

B. The following Drawing type shall be submitted for approval as a minimum:

1. Plan and elevation Drawings including minimum access dimensions.
2. Single-line diagrams.
3. Three-line diagrams.
4. Schematics for each circuit breaker including terminal block numbers and all control circuits.
5. Device list with part number.
6. Nameplate schedules.
7. Connection diagrams.
8. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.

SECTION 26 23 00
LOW VOLTAGE METAL ENCLOSED SWITCHGEAR

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Provide Shop Drawings.
2. Test reports.
3. Maintenance and service instructions.

B. The following Drawing type shall be submitted for approval as a minimum:

1. Plan and elevation Drawings including minimum access dimensions.
2. Single-line diagrams.
3. Three-line diagrams.
4. Schematics for each circuit breaker including terminal block numbers and all control circuits.
5. Device list with part number.
6. Nameplate schedules.
7. Connection diagrams.
8. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.

SECTION 26 24 16
PANELBOARDS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's Shop Drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.
   d. Voltage, frequency, and phase ratings.
   e. Enclosure type.
   f. Bus and terminal bar configurations and current ratings.
   g. Provisions for circuit terminations with wire range.
   h. Short circuit current rating of assembled panelboard at system voltage.
   i. Features, characteristics, ratings, and factory settings of auxiliary components.

B. Informational Submittals: Manufacturer's recommended installation instructions.

SECTION 26 25 02
NON-SEGREGATED PHASE BUS DUCT

A. As Applicable for CP-1419.

SECTION 26 33 55
DC/AC UPS SYSTEM

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Completed Data Sheets.
2. Preliminary and final electrical one-line diagram for the system.
3. Plan and elevation outline drawings.
4. Schematic diagrams.
5. Connection diagrams.
6. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
7. Heat loading data for complete system at 100 percent load, in Btu.
8. Any special handling and/or installation requirements for batteries.
9. Discharge and charging profile for battery.
10. Battery sizing calculation per IEEE 485.

SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

A. Action Submittals:

1. Lightning protection system layout Drawings signed/sealed by a Louisiana PE.
2. Component locations.
3. Detailed plans.
4. Down conductor.
5. Connecting conductor.
6. Bond strap.
7. Air terminals.
8. Fittings.
9. Connectors.
10. Ground rods.

B. Informational Submittals:

1. Field test report.
2. Ground Witness Certification-Form LPI175A.
3. Post-Installation Certification-Form LPI175B.
4. UL 96 Master Label “C” Certification.

SECTION 26 43 00
Transient Voltage Suppression

A. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.

B. Submit manufacturer's UL certified test data and nameplate data for each Transient Voltage Surge Suppression (TVSS) device.

SECTION 26 50 00
LIGHTING

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition, supply engineering data, as listed below:

1. Manufacturer's data including, but not limited to:
   a. Dimensioned and detailed drawings in booklet form with separate sheet or sheets for each fixture, assembled in luminaire "type" alphabetical order and showing:
      1) Materials of construction.
      2) Arrangement of components and wiring.
      3) Gasketing for weather tightness.
      4) Means of mounting luminaire and adjusting aspect.
      5) Finish.
      6) Photometric data with lamp or lamps specified.
      7) Electrical data including volts, amperes, and watts.
      8) For roadway type lighting fixtures, light distribution data according to IESNA roadway classification type.
   b. Lamp data:
      1) ANSI designation.
      2) Initial and mean lumen output.
      3) Average rated hours of lamp life and lamp mortality curve.
      4) Color temperature and color rendering index.
   c. Ballast data:
      1) ANSI designation.
      2) Voltage.
      3) Corresponding lamp.
      4) Line operating and starting amperes.
      5) Watts and watt losses.
      6) Percent allowable line voltage variation range and lamp crest factor.
      7) Total current harmonic distortion.
      8) Minimum lamp starting temperature.
      9) Normal and maximum ballast operating temperature.

d. Pole data:
1) Dimensions and details.
2) Handholes and wire entry details.
3) Mast or bracket arms and connection to poles.
4) Base plate and anchor bolt details.
5) Wind load and deflection.
6) Finishes.

B. Manufacturer's data and connection diagrams for dimmers and dimming systems.

C. Connection diagrams for lighting control systems.

D. Outline drawings, connection diagrams, and instruction books for inverter type power units.

E. Such other similar information as Engineer may request.

SECTION 40 10 00
PIPING SUMMARY OF WORK

A. N/A

SECTION 40 42 16
POWER PLANT PIPING AND EQUIPMENT INSULATION

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Action Submittals:

1. Shop Drawings:
a. Supplier's Literature: Require data to include but not necessarily be limited to the following: Insulation details showing how equipment, vessels, manways, removable covers, control valves, instrumentation, and tanks will be insulated.
1) Type of insulation.
2) Insulation details including thickness, density, etc.
3) External and internal facing.
4) Maximum and minimum temperature ratings.
5) Fire and Smoke ratings.
6) Thermal conductivity.
7) Description of adhesives, cements, and tapes.
8) Description of mechanical fastening systems.
9) Description of finishing and flashing materials and methods.
10) Installation instructions.
11) Method of sealing and securing insulation.

12) Jacket details such as material, thickness, and profile.
13) Jacket coating details such as paint type, coating thickness, emissivity, and color.
14) Method of sealing and securing jacketing.
15) Quality assurance document.

2. Coated aluminum jacket samples (of each color) for Owner approval.

C. Information Submittals: Certification that insulating materials are free of asbestos.

SECTION 40 50 20
ABOVEGROUND POWER PLANT

A. As Applicable for CP-1419.

SECTION 40 55 00
POWER PLANT VALVES

A. As Applicable for CP-1419.

SECTION 40 90 00
INSTRUMENT AND CONTROL GENERAL REQUIREMENTS

A. N/A

SECTION 40 90 10
I&C SUMMARY OF WORK

A. N/A

SECTION 40 90 13
CONCEPT OF OPERATIONS

A. N/A

SECTION 40 90 40
INSTRUMENTATION AND CONTROL FOR PACKAGED MECHANICAL EQUIPMENT

A. The following types of instrument and controls documentation shall be generated:

1. Process and Instrument Diagrams (P&IDs): Using ISA Std. 5.1 symbols and tag numbering to denote instrumentation and controls, including all interfaces with rest of plant equipment.
2. Instrument Location Drawings: Instrument locations shall be shown either on dedicated Instrument Location Drawings or may be shown on Piping Plan Drawings or Electrical Plan Drawings.

3. Instrument Index:
    a. A list of all instruments including tag number, service description, manufacturer, model, type, size, and detailed operating data including ranges and set points.
    b. The instrument index shall also list control valves including tag number, service description, manufacturer, model, type, size, end connections, actuator information, min/normal/max process conditions, C (flow coefficient), and all other pertinent information.
    c. Shall be provided in both hard copy and in Microsoft Excel electronic file format.
4. I/O Lists:
    a. A list of all hardwired inputs and outputs, including: tag number, service description, signal type (AI, AO, DI, DO, TC, RTD, etc.), point characteristics (24V dc, 4-20mA, Type K, 100-Ohm PT, etc.), range (for analog points), signal power source (internal or external), PLC address, alarm setpoints, state descriptors, and other pertinent signal characteristics as required.
    b. For each PLC datalink, a list of soft points (includes calculated values and data comm links) including: tag number, service description, signal type, range, address, alarm setpoints, state descriptors, and other pertinent signal characteristics as required. The list format shall include the array name and point within the array where the datalink point is packed.
    c. Equipment Suppliers shall include in the data exchange arrays any PLC I/O points requested by other parties and shall request of other parties any PLC I/O points required in the data exchange arrays for completion of their programming.
5. Instrument Installation Drawings: For all instruments and valves shipped loose that will require installation in the field.
6. Complete wiring connection drawings.
7. Control system programming documents:
    a. For all control, monitor, alarm, shutdown or interlock loops.
    b. Logic can be in ladder logic or block diagram form.
    c. Control system logic description shall be used for monitoring and alarm functions.
8. Data Sheets:
    a. Data Sheets shall be provided for all instruments and control valves in ISA-style format, similar to those in ISA-S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
9. Provide both the native file and pdf version for each document submitted. Native files are Word, Excel, or AutoCad.

B. PLC Signal Tagging:

1. All hardwired and datalink signals between PLCs shall be assigned a unique tag per the project tagging philosophy.
2. All PLC hardwired and soft datapoint addresses (including array points) shall be documented and submitted for approval prior to the performance of a Factory Acceptance Test (FAT).
   a. Tagging must comply with Section 01 58 53, Project Equipment Identification.

C. For general Instrumentation and control requirements, see Section 40 90 00, Instrumentation and Controls General Requirements.

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

A. N/A

SECTION 40 92 13
PROCESS CONTROL VALVES AND REGULATORS

A. As Applicable for CP-1419

SECTION 40 94 23
PDCS ECS SPECIFICATION

A. N/A for CP-1419

SECTION 40 94 24
PDCS HMI SPECIFICATION

A. N/A for CP-1419

SECTION 40 94 25
PDCS INTERFACE SPECIFICATION

A. N/A for CP-1419

SECTION 43 12 00
GAS COMPRESSOR

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures.

B. Submit Shop Drawings and product data under provisions of Section 01 33 00, Submittal Procedures.

C. Submit Operation and Maintenance data under provisions of Section 01 78 23, Operations Maintenance Data.

D. Submittal Drawings and Catalog Data:

1. Contractor shall provide the following information:
2. General Data Requirements
    a. Overall scope of supply and equipment description.
    b. Drawing list and submittal schedule.
    c. Schedule for engineering, fabrication and delivery.
    d. Experience and reference list.
    e. Commercial and technical clarifications.
    f. Listing of all sub-suppliers and subcontractors.
    g. Description of training program included.
    h. Description of site support included.
    i. Completed performance data sheets and guarantees.
    j. Shipping details and weights.
    k. Equipment lifting and rigging drawings and details.
    l. Description of Noise Mitigation Provisions
    m. Shop testing procedures.
    n. Field testing procedures.
    o. Description of QA/QC program.
    p. Spare parts list with pricing.
    q. Special tools list.
    r. Trim List.
    s. General Arrangement (GA) Plans and Elevations.
    t. Code reports and certifications.
    u. Operation and Maintenance (O&M) Manuals.
    v. Bills of materials (BOM's).
3. Mechanical Data Requirements.
    a. Process Flow Diagrams (PFD's).
    b. Dimensional layout drawings.
    c. Piping drawings with connection/interface tables.
    d. Permissible nozzle loading.
    e. Expected thermal movements – equipment.
    f. Expected thermal movements – connection interface points.
    g. Supplier-furnished pipe support details.
    h. Clearance requirements for maintenance.
    i. Equipment design details and materials of construction.
    j. Equipment data sheets.
    k. Weld procedures and welder qualifications.
    l. Performance correction curves, or performance model.
    m. Accessory descriptions.
    n. Utility requirements (air, water, fuel, lube oil, etc.).
    o. Certified Material Test Reports (MTR's).
    p. Equipment Nameplate photograph.

4. Electrical Data Requirements:
    a. Motor list and power requirements.
    b. DC system load requirements.
    c. Accessory descriptions.
    d. Motor data sheets.
    e. One line diagrams.
    f. Three line diagrams.
    g. Connection/Interconnection diagrams.
    h. Electrical Schematics.
    i. Wiring diagrams.
    j. Mounting details.
    k. Grounding details.
    l. Cable list.
    m. Certified test reports.
    n. Electrical cabinet dimensional drawings.
    o. Conduit entrance locations/plan drawings.
5. Instrumentation and Controls Data Requirements:
    a. Piping and Instrumentation Diagrams (P&ID's).
    b. Control system PLC description.
    c. Control system Architecture diagram.
    d. Control cabinet dimensional drawings.
    e. Control panel location drawings.
    f. SAMA/ISA (Analog) and discrete logic diagrams.
    g. Interconnection diagrams.
    h. Point-to-point wiring diagrams.
    i. Control loop diagrams.
    j. Control system power requirements.
    k. Cable list.
    l. Instrument list with process ranges and set points.
    m. Instrument installation details/drawings.
    n. Control valve list.
    o. Alarm list with setpoints in Excel format file.
    p. Component / Equipment list.
    q. Instrument data sheets (Supplier format acceptable).
    r. Control valve data sheets (Supplier format acceptable).
    s. Calibration records for all Supplier-furnished instruments.
    t. Graphical display screens (Screen shots).
    u. Graphical display screens – paging architecture.
    v. Engineering and configuration instructions.
    w. Communication configuration at 75 percent completion for Owner/Engineer review and comment

x. Input/Output (I/O) list for all I/O in communication link required for a fully functional interface. The I/O list shall contain all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner/Engineer, as well as the final controller program native file.

6. Civil/Structural Data Requirements:
   a. Code calculations.
   b. Structural steel plans and elevations.
   c. Platform, ladder, and stair drawings.
   d. Foundation loading diagram (Static and Dynamic).
   e. Location, size, and projection of anchor bolts, sleeves, and/or imbeds.
   f. Equipment weights (dry and operating).
   g. Field erection drawings and details.
   h. Equipment grouting requirements and/or recommendations.

E. Routine Maintenance Schedule, Parts and Service:

1. Provide a complete schedule of normally required inspection, preventative maintenance, predictive maintenance, and overhaul tasks and the outage hours required for all of the equipment supplied under this purchase order, plus replacement parts associated with each task. Provide inspection and maintenance plan required to support a minimum on-line availability of 97 percent. List requirements by year with a list of recommended spare parts for each through one entire cycle.
2. Submit a line item pricing (bid alternate) for recommended spare parts for 2 years of normal operation, including expendables, beyond first year of operation.
3. Submit an itemized list and pricing (bid alternate) for all required tools including any special lifting fixtures to support on-site maintenance of FGC Package(s).
4. Submit itemized pricing (bid alternate) for Long Term Service Agreement. Service agreement term to be no less than 5 years.
5. For each inspection, preventative maintenance and overhaul task, list the following:
   a. Tools required.
   b. Materials required.
   c. Associated warnings and cautions.
   d. Initial system conditions required.
   e. Procedure.

F. Software:

1. Provide licenses/copies of all proprietary software required for installation, testing, tuning, or operation of the equipment, instrumentation, and/or protective devices.
2. For any instrument or component which must be connected to a computer for testing, tuning, or programming and utilizes a proprietary cable, provide a minimum of two cables to the Owner.

SECTION 48 00 10
MECHANICAL SUMMARY OF WORK

A. N/A

SECTION 48 11 23
COMBUSTION TURBINE GENERATOR SPECIFICATION

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data including, but not limited to, the information listed below.

B. Submittal Drawings and Catalog Data:

1. Supplier shall provide the following information:
   a. General Data Requirements:
      1) Overall scope of supply and equipment description.
      2) Drawing list and submittal schedule.
      3) Schedule for engineering, fabrication and delivery.
      4) Experience and reference list.
      5) Commercial and technical clarifications.
      6) Listing of all sub-suppliers and subcontractors.
      7) Description of training program included.
      8) Description of site support included.
      9) Completed performance data sheets and guarantees.
      10) Shipping details and weights.
      11) Equipment lifting and rigging drawings and details.
      12) Shop testing procedures.
      13) Field testing procedures.
      14) Description of QA/QC program.
      15) Spare parts list with pricing.
      16) Special tools list.
      17) General Arrangement (GA) Plans and Elevations.
      18) Code reports and certifications.
      19) Operation and Maintenance (O&M) Manuals.
      20) Cable List.
      21) Certified test reports.

22) Electrical cabinet dimensional drawings.
23) Conduit entrance locations/plan drawings.

b. Mechanical Data Requirements:
1) Process Flow Diagrams (PFD's).
2) Dimensional layout drawings.
3) Piping drawings with connection/interface tables.
4) Permissible nozzle loading.
5) Expected thermal movements – equipment.
6) Expected thermal movements – connection interface points.
7) Supplier-furnished pipe support details.
8) Clearance requirements for maintenance.
9) Equipment design details and materials of construction.
10) Equipment data sheets.
11) Bills of Material (BOM's).
12) Weld procedures and welder qualifications.
13) Performance correction curves, or performance model.
14) Accessory descriptions.
15) Utility requirements (air, water, fuel, lube oil, etc.).
16) Certified Material Test Reports (MTR's).
17) Equipment Nameplate photograph.

c. Electrical Data Requirements:
1) Motor list and power requirements.
2) DC system load requirements.
3) Accessory descriptions.
4) Motor data sheets.
5) One-line diagrams.
6) Three-line diagrams.
7) Connection/Interconnection diagrams.
8) Electrical Schematics.
9) Wiring diagrams.
10) Grounding details.
11) Generator performance curves.

d. Instrumentation and Controls Data Requirements:
1) Piping and Instrumentation Diagrams (P&ID's).
2) Control system PLC description.
3) Control system Architecture diagram.
4) Control cabinet dimensional drawings.
5) Control panel location drawings.
6) Interconnection diagrams.
7) Point-to-point wiring diagrams.
8) Control loop diagrams.
9) Cable list.
10) Instrument list with process ranges and set points.
11) Control valve list.
12) Alarm list with setpoints.
13) Component / Equipment list.

14) Instrument data sheets (Supplier format acceptable).
15) Control valve data sheets (Supplier format acceptable).
16) Calibration records for all Supplier-furnished instruments.
17) Graphical display screens (Screen shots).
18) Graphical display screens – paging architecture.
19) Engineering and configuration instructions.
20) Communication configuration at 75 percent completion for Owner/Engineer review and comment.
21) Input/Output (I/O) list for all I/O in communication link required for a fully functional interface. The I/O list shall contain all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner/Engineer, as well as the final controller program native file.

e. Civil/Structural Data Requirements:
1) Code calculations.
2) Structural steel plans and elevations.
3) Platform, ladder, and stair drawings.
4) Foundation loading diagram (Static and Dynamic).
5) Location, size, and projection of anchor bolts, sleeves, and/or imbeds.
6) Equipment weights (dry and operating).
7) Field erection drawings and details.
8) Equipment grouting requirements and/or recommendations.

2. Include identifying symbols, tag names, and equipment numbers which are coordinated with the Process SCADA System (PSS) standards as defined herein to allow for full integration with the installation design documents for all equipment and material submitted.
3. Include in submittals sufficient plans, elevations, sections, performance data, dimensions, bolt locations, ratings, sound data, weights and schematics to clearly describe the equipment and to show compliance with these Specifications. Provide a cover or title sheet for the submittal containing the following:
a. Name of Supplier originating the submittal.
b. Name of project for which the submittal is made.
c. An index of all items submitted including:
1) Mark of equipment on drawings.
2) Manufacturer.
3) Catalog number.
4) Specific section number.
5) Date of submittal and date of each revision.
6) Supplier’s certification of review.
7) Supplier’s certification of compliance.

C. Operation and Maintenance Manuals:

1. Supplier shall provide Operations and Maintenance Manuals for all equipment and auxiliaries provided in accordance with Section 01 78 23, Operations and Maintenance Data. Cloud based documentation hosted by the turbine manufacturer is encouraged when live updates to the manuals are anticipated.
2. Organize binders to contain similar equipment such as piping, valves, transmitters, terminal boxes, sight glasses, relief valves, etc., in separate divisions. Provide a complete index for each binder to include:
    a. An alphabetized list of manufacturers whose products have been incorporated in the work.
3. For each section of product, equipment or system, organize the data as follows:
    a. Furnish a general description of the equipment or system listing the major components, intended service and other general data.
    b. Furnish technical data including nameplate data (on a separate excel file), design parameters, normal operating bands, ratings, capacity, performance data, operating curves, etc. Clearly distinguish between information which does and does not apply.
    c. List warnings and cautions to be observed during both installation and operations.
    d. Fully detailed installation and operation instructions including special tools required, alignment instructions, start up and shut down sequences, emergency and casualty step-by-step procedures, and extended lay-up step-by-step procedures.
    e. Furnish maintenance, service and repair instructions including maintenance and service schedules, materials, and methods for performing routine and annual service.
    f. Furnish a Cause and Effects matrix where the ‘Cause’ is in a row the reflects a process change, the ‘Effect’ is in the column that reflects a process action, and the ‘Intersection’ is marked to show the cause/effect relation.
    g. Furnish a troubleshooting guide and check list indicating common failures, test methods and procedures for determining component fault or failure.
    h. Furnish a spare parts list indicating part and order number with name, address, and telephone number of Supplier. Include current prices of replacement parts and supplies.
    i. Furnish diagrams including controls, wiring, installation or operation of the equipment or system.
    j. HMI Graphics screens (complete - listing and color screen shots).
    k. Furnish cyber security controls procedure/methodology as to how the system is protected from cyber-attacks during production and how software upgrades are implemented post installation for future upgrades.

l. Furnish list of all Set points, Interlocks, Alarms and Trip Points in MS EXCEL file format.
m. Furnish copies of all final, approved submittal Drawings and documents.
n. Furnish all warranties and guarantees.

D. Routine Maintenance Schedule, Parts and Service:

1. Provide a complete schedule of normally required inspection, preventative maintenance, predictive maintenance, and overhaul tasks and the outage hours required for all of the equipment supplied under this purchase order, plus replacement parts associated with each task. Provide inspection and maintenance plan required to support the minimum on-line availability specified herein. List requirements by year with a list of recommended spare parts for each through one entire cycle. Spare parts list shall consist of total/in-service quantity, recommended spare quantities, lead times and criticality factor.
2. Submit a line item pricing (bid alternate) for recommended spare parts for 2 years of normal operation, including expendables, beyond first year of operation.
3. Submit an itemized list and pricing (bid alternate) for all required tools including any special lifting fixtures to support on-site maintenance of CTG Package(s).
4. Submit itemized pricing (bid alternate) for Long Term Service Agreement (LTSA). Service agreement term to be no less than 5 years.
5. For each inspection, preventative maintenance and overhaul task, list the following:
   a. Tools required.
   b. Materials required.
   c. Associated warnings and cautions.
   d. Initial system conditions required.
   e. Procedure (step-by-step).

E. Software:

1. Provide licenses/copies of all proprietary software required for installation, testing, tuning, or operation of the equipment, instrumentation, and/or protective devices.
2. For any instrument or component which must be connected to a computer for testing, tuning, or programming and utilizes a proprietary cable, provide a minimum of two cables to the Owner.
3. Provide software patches (bug fixes) during the LTSA term.

SECTION 48 58 68
WELDING OF POWER PLANT PIPING

A. N/A for CP-1419

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES SUPPLEMENT
PROJECT SPECIFIC RECORDS MANAGEMENT INFORMATION

PROJECT SPECIFIC INFORMATION

Owner	Sewerage and Water Board of New Orleans
Project Name	CP-1419 CTG-7 Equipment Procurement
Records Management Software	SharePoint and ProLog
Managing Company	Jacobs Engineering
Contact Name	Pam Newsom
Contact Email	Pam.Newsom@Jacobs.com

RECORDS MANAGEMENT SOFTWARE BY SUBMITTAL TYPE

Submittal Type	Records Management Software
Design Documents	SharePoint and ProLog
Contractor Submittals	SharePoint
Contractor RFIs	SharePoint
Progress Schedules	SharePoint
Meeting Minutes	SharePoint
Contractor Pay Applications	ProLog
Work Change Directives	ProLog
Project Photos	ProLog
Daily Reports	ProLog

SHAREPOINT UPLOAD PROCEDURES

General: Contractors and Suppliers will transmit submittals by uploading them electronically into the following project specific Library on SharePoint.

SWBNO Contract Administration

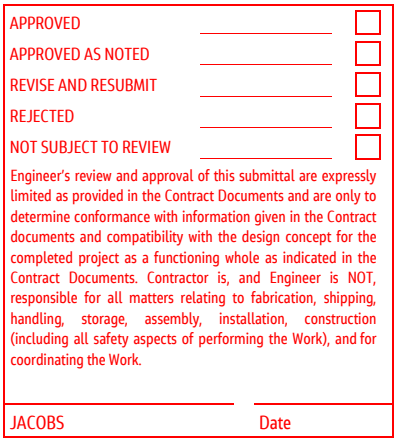
Submittal Requirements: To be accepted for review, all Submittals uploaded to SharePoint must include the following:

- Transmittal Cover Sheet – the Transmittal cover sheet should be uploaded as an individual file.
  - Specification Section
  - Accurate sequential numbering
  - Date
  - Correct Status: New or Re-Submittal
  - Correct Project Number
  - Correct Submittal Type

- Submittal Documents - It is important that each individual document or drawing be uploaded as an independent file that matches the document/drawing file name, such that these individual documents or drawings can be tracked as individual documents or drawings through the review process.
    - Document Type: Submittals, RFIs
    - Submittal Type: Datasheet, Drawing, Specification, Action Submittal, Informational Submittal, RFI, Progress Schedule
    - Submittal Number: Sequential Number associated with Submittal Type
    - Submittal Revision: 0 for initial submittal; sequential numbering for re-submittals
    - Specification Section
    - Originated By: Contractor or Supplier name
    - Date Originated: Date uploaded to SharePoint
    - Date Required: Submittal response date required
    - [Document] Title: name of individual document within a submittal package
    - [Document] Revision: revision of individual document within a submittal package
    - Revision Date: date of revision for individual document within a submittal package

RECORDS MANAGEMENT STATUS STAMP

The following stamp will be affixed to each individual document or drawing reviewed by the Engineer, which will indicate the specific disposition of the individual document.



SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 SUBMITTALS

A. Informational Submittals:

1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 60 days prior to start of equipment testing and startup and revise as necessary for acceptance.
2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
3. Training Session Documentation: Furnish Owner with one complete electronic set of documentation of the training sessions.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized technical representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Further, the technical representative responsible for Owner Training shall have the preceding qualifications plus have received formal training for conducting formal training sessions, including use of audio-visual and other training aids, and have conducted at least five such training sessions prior to those addressed herein. Additional qualifications may be specified in the individual Specification section.

B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services as required to meet the requirements of this Contract. At a minimum such services are required for all major mechanical, electrical and control equipment.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.

F. Manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Providing, on a daily basis, copies of manufacturers' representatives field notes and data to Owner's representative.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
6. Assistance during functional and performance testing, and facility startup and evaluation.
7. Training of Owner's personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. The Manufacturer shall provide technical representation to the field to perform a pre-startup check that will ensure the Manufacturer and the Owner that the Contractor has, in fact, properly installed the equipment and, in fact, performed the required installation checks. Upon so doing, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

3.03 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 91 14, Equipment Testing and Facility Startup.

C. Lesson Plan: When supplier training of Owner personnel is specified, prepare a lesson plan for each required course containing the following minimum information:

1. Title and objectives.
2. Recommended attendees (such as, managers, engineers, operators, maintenance).
3. Course description, outline of course content, and estimated class duration.
4. Format (such as, lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.
6. Resumes of instructors providing training.

D. Prestartup Training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
2. Complete no more than 14 days prior to beginning of facility startup, but no less than 7 days prior to.

E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section", is part of this Specification.

1. Form: Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections installed in accordance with manufacturer's requirements.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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SECTION 01 58 53
PROJECT EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE

A. This Document specifies the overarching Project Equipment Identification, or alternately referred to as equipment/item tagging, requirements that may be further augmented by equipment specific specifications and/or Project Documents. The general format/structure, application/purpose, materials of construction will be defined herein with detailed definitions included as supplements as appropriately noted.

B. The objective of this Project Equipment Identification specification is to promote uniform equipment tagging throughout the application to which this Specification is being applied and further establish a consistent equipment tagging scheme across separately executed projects.

C. In general, the universal equipment tag format/structure is as follows and includes the following elements:

<**AREA**>-<**UNIT**>-<**SYSTEM**>-<**TYPE**>-<**SEQ#**>-<**MODIFIER**>

AREA: Is the physical area of the facility that the equipment is located in.
UNIT: Is the primary differentiator between multiple trains of similar purpose equipment systems.
SYSTEM: Is the process system within which the equipment is in.
TYPE: Is the equipment type.
SEQ#: Is the incremental sequence number of the equipment within the ‘type’ group.
MODIFIER: Is an optional suffix to emphasize multiple equipment with the same purpose or enable uniqueness where the preceding alpha-numeric string does not result in a unique identifier.

D. In general, the application or purpose of Project Equipment Identification is to uniquely identify logical functional equipment that require discrete distinction for safety, operation, or maintenance. Project Equipment Identification is also commonly referred to as and shall be alternately recognized with the same requirements:

1. Equipment Tag.
2. Item Tag.
3. Nameplate.

E. In general, the materials of construction are stainless steel unless specified otherwise.

1.02 REFERENCE DOCUMENTS/SUPPLEMENTS

A. AREA Index: The AREA Index lists SWBNO defined areas.

B. UNIT Index: The UNIT Index lists SWBNO defined units.

C. SYSTEM Index: The SYSTEM Index lists SWBNO defined systems.

D. TYPE Index: The TYPE Index lists SWBNO defined equipment types.

1.03 COORDINATION WITH OTHER REQUIREMENTS

A. It is important to recognize that this Specification section is not a stand-alone document that defines all requirements for Project Equipment Identification. These requirements must be used in conjunction with equipment specific specifications and/or Project Documents. Equipment specific specifications and/or Project Documents will continue to utilize the universal equipment tag format/structure but may further define specific tag elements unique to the application.

1.04 GENERAL REQUIREMENTS

A. The range of process numbers to be used for Supplier equipment shall be confirmed with Owner/Engineer prior to development of Supplier’s P&ID’s.

B. A nameplate schedule shall be developed for integration into the Project Master Tag Registry.

C. Provide nameplates for each instrument, transformer, light, meter, switch, control, terminal strip, panel mounted component (including fuses), fuse blocks, timers, relays, auxiliary relays, etc., in accordance with a nameplate schedule. Color coding shall be used for equipment and functional identification.

D. Nameplates shall be corrosion resistant metal for items exposed to process or other severe conditions, or laminated two-ply plastic (white face to black core) with legend/text engraved to black core for items such as electrical and control panels which are not exposed to process conditions.

E. Emergency nameplates and warning labels shall be phenolic, corrosion resistant, laminated, two-ply composition (red face to white core) with legend/text engraved to white core.

F. Characters shall be uniform block style not smaller than 1/2 inch for switchgear sections, switching devices, and panelboards, and not smaller than 1/4 inch for instrument transformers, relays, alarms, instruments, and control devices.

G. Nameplates and tags shall be provided for all valves, steam traps and other equipment. Label all piping.

H. Nameplates shall be secured using No. 4-36 RH nickel-plated brass machine screws or attached to each tagged item with a stainless steel wire.

I. All items listed on the Bill of Materials shall be identified by assigned tag numbers and fully described by manufacturer, type and model numbers as applicable.

J. All parts, components, assemblies and items shall be clearly and permanently match-marked for field assembly and installation. The match-marks shall be marked by letters or numbers and shall be cross referenced to the shipping paperwork and erection drawings and instructions.

K. Corrosion resistant metal nameplates shall be attached at easily accessible locations for all equipment and components. The name plates shall be stamped with the information required by the applicable Code and shall also include the Supplier's name, Supplier's serial number, and equipment tag number.

1.05 MAJOR EQUIPMENT MASTER NAMEPLATE

A. Each major piece of equipment shall have a master nameplate securely affixed showing the tag number; the name and address of the Manufacturer; serial and model number; and such other information as the Supplier may consider necessary to complete the identification of the item.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Equipment supply schedules and construction sequencing is extremely important for this Project. An overall equipment supply schedule is required for incorporation in the overall project construction schedule.

END OF SECTION

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SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Owner or SWBNO refers to Sewerage and Water Board of New Orleans.

B. Engineer or Owner's Engineer refers to Jacobs Engineering Group (Jacobs).

C. Contractor refers to any and all individuals, companies, or entities performing construction activities related to the demolition, installation, excavation, startup, testing and commissioning of equipment, structures, or systems as specified.

D. Packager refers to the entity that coordinates and repackages the equipment from each OEM for the Work, generally referred to as Supplier.

E. OEM or Manufacturer refers to the Original Equipment Manufacturer, generally referred to as Supplier.

F. Vendor refers to the entity that represents the OEM for various services, generally referred to as Supplier.

G. Supplier refers to Packager, OEM or Vendor.

H. Commissioning Agent/Representative is an independent entity that is responsible for the commissioning of the Work.

I. Drawings: Drawings includes all technical drawings and documentation used to define the system (or systems) and equipment specified herein or in other sections for the Work.

J. Contract Documents refer to the project's commercial terms and conditions as well as all conformed Drawings and Documentation.

K. Work refers to the Project Scope of Work paragraph in Section 01 11 01, Project Summary of Work.

L. Products:

1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.

2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 PROJECT ACRONYMS

ANSI	American National Standards Institute
ASA	Acoustical Society of America
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATC	Air Throat Connection
AWG	American Wire Gauge
AWS	American Welding Society
BOP	Balance of Plant
BPVC	Boiler Pressure Vessel Code
CENELEC	European Committee for Electrotechnical Standardization
CFR	Code of Federal Regulations
CPT	Control Power Transformer
CT	Current Transformer
CTG	Combustion Turbine Generator
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
ECS	Electrical Control System
EMC	Electromagnetic Compatibility
EN	European Standard
ESO	European Standardization Organization
FO	Fiber Optic
HMGP	Hazard Mitigation Grant Program
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IGBT	Insulated-Gate Bipolar Transistor
kCMIL	(kilo = 1,000) Circular Mils
kg	kilogram
kV	Kilovolt
kVA	Kilovolt-Ampere
kW	Kilowatt
MV	Medium Voltage
MVA	Megavolt-Ampere
MW	Megawatt

NEHRP	National Earthquake Hazards Reduction Program
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NEC	National Electrical Code
NFPA	National Fire Protection Association
PCS	Plant Control System
PDCS	Power Distribution Control System
PF	Power Factor
PLC	Programmable Logic Controller
PT	Potential Transformer
R	Resistance
RMS	Root Mean Square
RIV	Radio Influence Voltage
RTAC	Real-Time Automation Controller
RTU	Remote Terminal Unit
SA	Surge Arrester
SCADA	Supervisory Control and Data Acquisition
SFC	Static Frequency Converter
SWB	Sewerage & Water Board
SWBNO	Sewerage & Water Board of New Orleans
SWC	Surge Withstand Capability
THD	Total Harmonic Distortion
UL	(formerly known as Underwriters Laboratory)
V	Volt
VAC	Volts (Alternating Current)
VAR	Volt-Amp Reactance
VDC	Volts (Direct Current)
X	Reactance (Capacitive or Inductive)
XFMR	Transformer
Z	Impedance

1.03 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of 2015 International Building Code (IBC) by International Code Council.

B. Contractor shall plan and perform work in accordance with these site conditions:

1. Temperature and Precipitation:

Parameter	Value and Unit
Temperature and Humidity:	
Mean annual dry bulb (DB) temperature	68.6 degrees F
Mean annual wet bulb (WB) temperature	63.3 degrees F
Mean summer dry bulb (DB) temperature	80.9 degrees F
Mean summer wet bulb (WB) temperature	74.9 degrees F
Mean winter season dry bulb (DB) temperature	56.7 degrees F
Mean winter season wet bulb (WB) temperature	52.6 degrees F
Mean Barometric Pressure	14.609 psia
Plant Elevation	4 feet above sea level
Design Conditions:	
Indoor Design Temperature (DB) for Equipment Design	122 degrees F
Design low temperature (DB) for Equipment Design	12 degrees F
Summer Ambient Design Conditions	97.0 degrees F, 54.2 percent RH
Precipitation and Snow:	
Average monthly rain fall	5.2 inches
Average annual rain fall	62.44 inches
Highest average monthly rain fall	6.77 inches (June and September)
100-year, 1-hour rainfall	9.75 inches
Snow fall annual average	0 inches

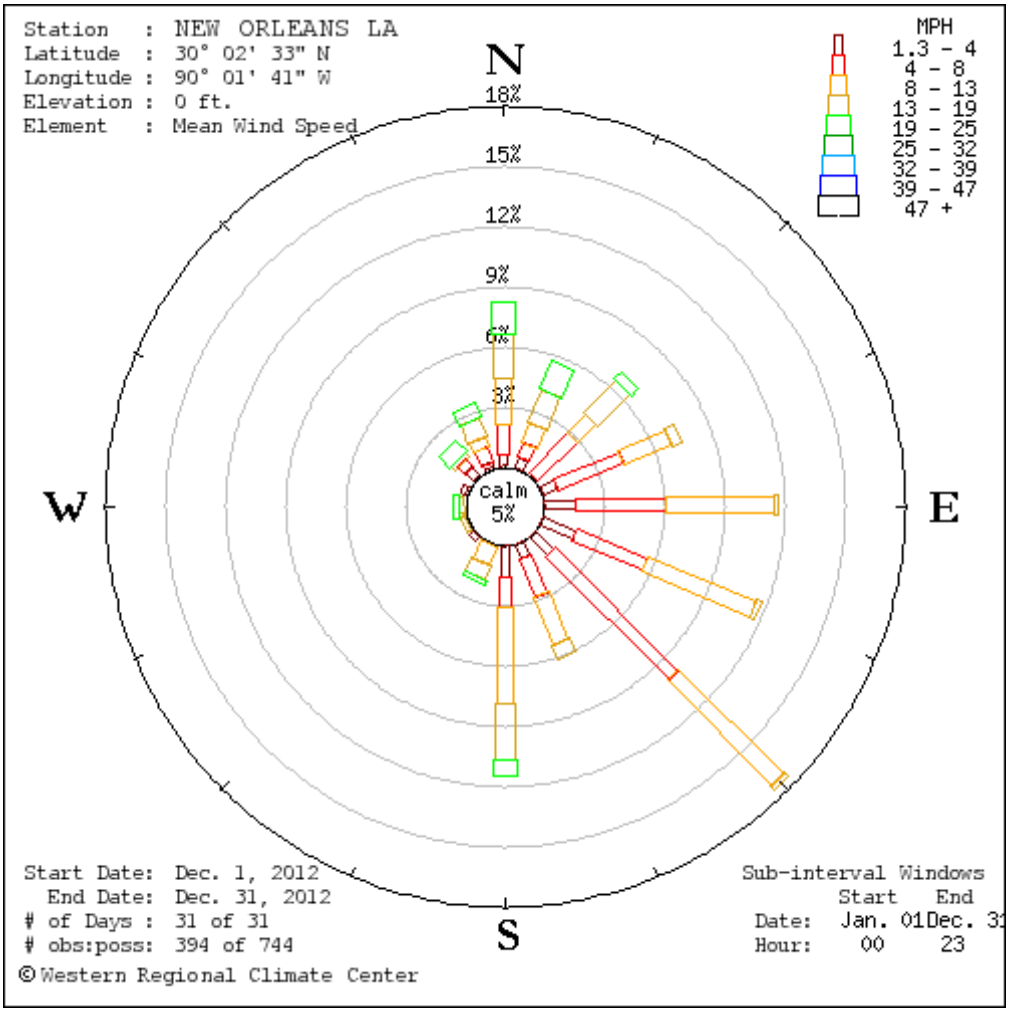
2. Wind Speeds:

a. Structures shall be designed for wind loads in accordance with ASCE 7-16 for Orleans Parish and the following parameters:

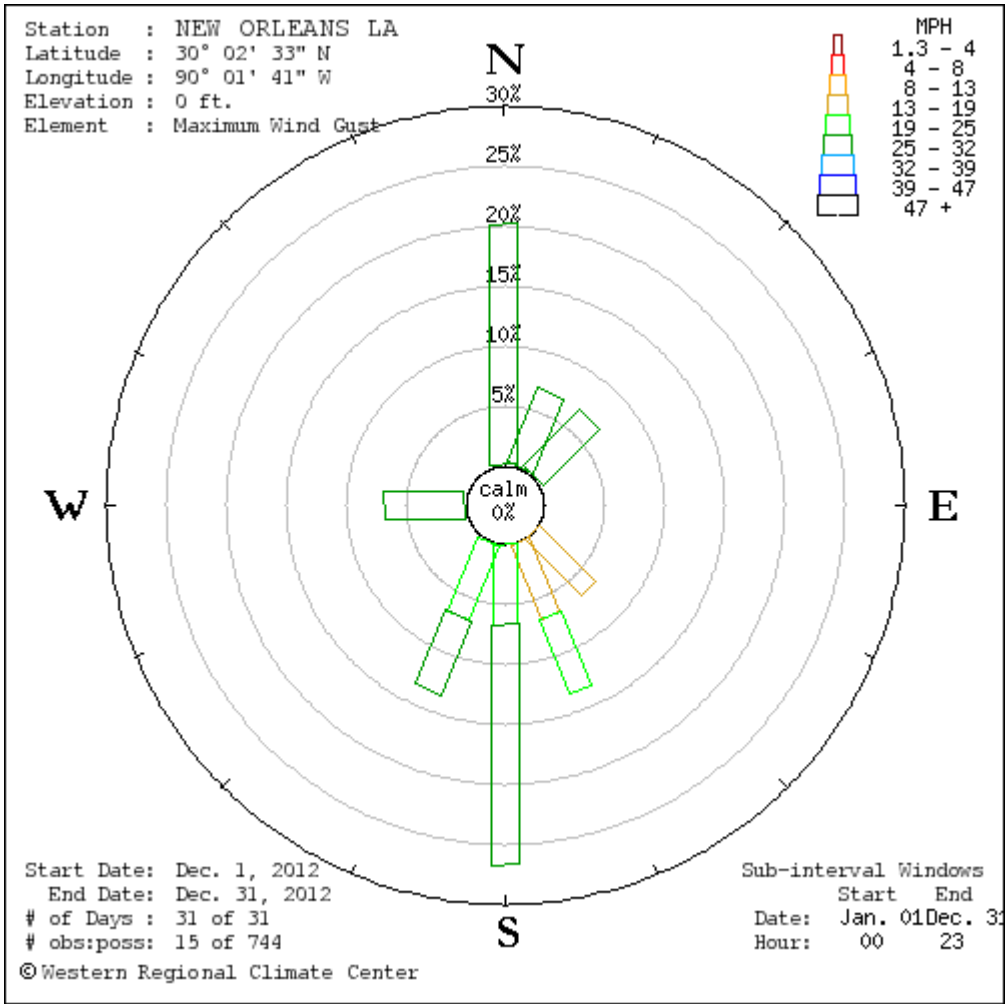
Parameter	**Value and Unit**
Ultimate Design Wind Speed	157 MPH
Exposure Category	C
Risk Category	IV Essential Facility per Table 1604.5

b. The following USGS Wind Rose Diagram is from New Orleans, LA.

1) Mean Wind Speeds:



2) Maximum Wind Speeds:



1.04 SEISMIC DESIGN CRITERIA

A. Structures shall be designed for seismic loads in accordance with the ASCE 7-16 for Orleans Parish and the following parameters:

Parameter	**Value and Unit**
Site soil Class	E
Seismic Design Category	C
Importance Factor (IE)	1.5
Risk Category	IV Essential Facility per Table 1604.5
SS	0.086g
S1	0.053g

1.05 PREPARATION FOR SHIPMENT

A. For factory assembled products, mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and outdoor storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual Specifications.
2. Schedule:
    a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    b. Transfer to Owner shall occur immediately subsequent to Contractor’s acceptance of equipment from Supplier.
3. Packaging and Shipment:
    a. Package and ship extra materials and special tools to avoid damage during long term outdoor storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    b. Prominently displayed on each package, the following:
        1) Manufacturer’s part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
        2) Applicable equipment description.
        3) Quantity of parts in package.
        4) Equipment manufacturer.
4. Deliver materials to Site.
5. Notify Owner upon arrival for transfer of materials.
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.06 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.07 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections (as specified by the Supplier's written instructions) of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.

E. Store fabricated products above ground on blocking or skids and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

J. Equipment Finish:

1. Provide manufacturer’s standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with finish as approved by Owner.

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

N. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Owner or Engineer, notify Owner and Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.

G. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

A. In accordance with individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENTS

A. The supplement listed below, following “END OF SECTION”, is part of this Specification.

1. Form: Manufacturer’s Certificate of Compliance.

END OF SECTION

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MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

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SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Approved Shop Drawings and Samples: As required in the General Conditions.
   c. Special bonds, Special Guarantees, and Service Agreements.
   d. Consent of Surety to Final Payment: As required in General Conditions.
   e. Releases or Waivers of Liens and Claims: As required in General Conditions.
   f. Releases from Agreements.
   g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   h. Extra Materials: As required by individual Specification sections.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.

B. In the event Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on the Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from the Drawings.
      2) Red when showing information added to the Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
   b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner and Engineer.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touchup marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Regrade/patch road.
10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer's review prior to final data being accepted by Engineer.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

A. Equipment and System Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
   b. Submit prior to shipment date.
2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing. Submit Instructional Manual Formatted and Electronic Media Formatted data prior to Substantial Completion of Project.

B. Materials and Finishes Data:

1. Preliminary Data: Submit at least 21 days prior to request for final inspection.
2. Final Data: Submit within 10 days after final inspection.

1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual. Also prepare final data in electronic media format.

B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover: Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
   a. Project title.
   b. Designate applicable system, equipment, material, or finish.
   c. Identity of separate structure as applicable.
   d. Identify volume number if more than one volume.
   e. Identity of general subject matter covered in manual.
   f. Identity of equipment number and Specification section.
4. Spine:
   a. Project title.
   b. Identify volume number if more than one volume.
5. Title Page:
   a. Contractor name, address, and telephone number.
   b. Subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
      1) Identify area of responsibility of each.
      2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
   a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
   b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer’s printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Electronic Media Format:

1. Portable Document Format (PDF):
   a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on secure file share site and on a flash drive.
   b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by Specification number and name.
   c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

2. Manufacturers' standard electronic format may be acceptable upon acceptance by Engineer.

1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit an electronic copy of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit one electronic copy for Engineer's review.
   b. If data does not meet conditions of the Contract:
      1) Data will be returned to Contractor with Engineer's comments (on separate document) for revision.
      2) Engineer's comments will be retained in Engineer's file.
      3) Resubmit revised version in accordance with Engineer's comments.
3. Final Data: Submit one hard copy and one electronic copy in format specified herein.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content for Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.
   f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
   g. Spare parts ordering instructions.
   h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.

4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
   a. Format:
      1) Provide reinforced, punched, binder tab; bind in with text.
      2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
      3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
      4) Identify Specification section and product on the Drawings and envelopes.
   b. Relations of component parts of equipment and systems.
   c. Control and flow diagrams.
   d. Coordinate Drawings with Project record documents to assure correct illustration of completed installation.
5. Instructions and Procedures: Within text, as required to supplement product data.
   a. Format:
      1) Organize in consistent format under separate heading for each different procedure.
      2) Provide logical sequence of instructions for each procedure.
      3) Provide information sheet for Owner's personnel, including:
         a) Proper procedures in event of failure.
         b) Instances that might affect validity of guarantee or Bond.
   b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
   c. Operating Procedures:
      1) Startup, break-in, routine, and normal operating instructions.
      2) Test procedures and results of factory tests where required.
      3) Regulation, control, stopping, and emergency instructions.
      4) Description of operation sequence by control manufacturer.
      5) Shutdown instructions for both short and extended duration.
      6) Summer and winter operating instructions, as applicable.
      7) Safety precautions.
      8) Special operating instructions.
   d. Maintenance and Overhaul Procedures:
      1) Routine maintenance.
      2) Guide to troubleshooting.
      3) Disassembly, removal, repair, reinstallation, and re-assembly.
6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit directories of panelboards.
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.
7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Startup and shutdown sequences, normal and emergency.
   c. Safety precautions.
   d. Special operating instructions.
10. Maintenance Procedures:
   a. Routine maintenance.
   b. Guide to troubleshooting.
   c. Adjustment and checking.
   d. List of relay settings, control and alarm contact settings.
11. Manufacturer’s printed operating and maintenance instructions.
12. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
   a. Use Maintenance Summary Form bound with this section or Manufacturer’s standard.
   b. Each Maintenance Summary may take as many pages as required.
   c. Use only 8-1/2-inch by 11-inch size paper.
   d. Handwritten summary documents will not be accepted.

3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
    a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
    b. "Unit" is the unit of measure for ordering the part.
    c. "Quantity" is the number of units recommended.
    d. "Unit Cost" is the current purchase price.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
    a. Catalog number, size, and composition.
    b. Color and texture designations.
    c. Information required for reordering special-manufactured products.
2. Instructions for Care and Maintenance:
    a. Manufacturer's recommendation for types of cleaning agents and methods.
    b. Cautions against cleaning agents and methods that are detrimental to product.
    c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
    a. Applicable standards.
    b. Chemical composition.
    c. Details of installation.
2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENTS

A. The supplement listed below, following "End of Section" is part of this Specification.

1. Form: Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name_____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	"Or-equal"
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.

C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function.

E. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:

1. Step-by-step instructions for startup of each unit process and the complete facility.
2. Coordination meeting schedule and agenda. Establish meeting frequency as necessary to effectively test and startup equipment and systems under the scope of this Project. Comply with technical Specifications regarding Manufacturer's Representatives and Owner coordination. Coordination meetings are to be incorporated into the project schedule and will commence no less than 2 months prior to the first scheduled testing/startup activity.
3. System Startup Form (sample attached), to minimally include the following:
    a. Description of the system, including equipment numbers/nomenclature of each item of equipment and all included devices.
    b. Identification and definition of any special safety precautions or procedures that must be instituted during demonstration.
    c. Detailed procedure for startup of the system, including all controls to be operated, devices/controls/valves/switches to be opened/closed or on/off, order of equipment startup, etc.
    d. Startup requirements for each system, including service, power, cooling water, ventilation, chemicals, etc.
    e. Personal protective equipment for those participating in the process.
    f. Space for evaluation comments.
4. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
    a. Description of systems included in the facility startup.
    b. Sequence of system(s) startup to achieve facility startup.
    c. Description of computerized operations, if any, included in the facility.
    d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation, if applicable.
    e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Startup Meetings: To discuss test schedule, test methods, materials, special requirements, facilities operations interface, and Owner involvement, including provision of external products, services, and/or utilities.

B. Contractor's Testing and Startup Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

C. Provide all temporary measures, test equipment and other materials and equipment required for testing and startup NOT provided by Owner (see subparagraph E, below).

D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.

3.02 EQUIPMENT TESTING

A. NOTE: Chapter 9 of API's Recommended Practice 686 for Machinery Installation and Installation Design, entitled "Machinery Installation: Commissioning", to serve as a guidance document for Contractor's use during pre-commissioning and commissioning activities. The Contractor shall meet the intent of this guidance document as part of the testing and startup of each unit process system.

B. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.

3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
    a. Owner/Project Name.
    b. Equipment or item tested.
    c. Date and time of test.
    d. Type of test performed (Functional or Performance).
    e. Test method.
    f. Test conditions.
    g. Test results.
    h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
    a. Calibrate testing equipment in accordance with manufacturer's instructions.
    b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
    c. Lubricate equipment in accordance with manufacturer's instructions.
    d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
    e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
    f. Check power supply to electric-powered equipment for correct voltage.
    g. Adjust clearances and torque.
    h. Test piping for leaks.
6. Ready-to-test determination will be by Engineer based at least on the following:
    a. Acceptable Operation and Maintenance Data.
    b. Notification by Contractor of equipment readiness for testing.
    c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
    d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
    e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
    f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
    g. Equipment and electrical tagging complete.
    h. Delivery of all spare parts and special tools.

C. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

D. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.03 STARTUP OF OPERATING UNITS/SYSTEMS

A. Prior to operating unit/system startup, equipment within unit/system shall be accepted by Engineer as having met functional and performance testing requirements specified.

B. Startup sequencing of operating unit/system shall be as identified by Contractor within the Facility Startup Plan in order to meet schedule requirements and comply with Contract milestones and completion dates.

C. Make adjustments, repairs, and corrections necessary to complete unit process startup.

D. Startup shall be considered complete when, in opinion of Engineer, system, systems, components, processes, elements, hardware, software, equipment, and the like, have operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional and/or performance test periods specified elsewhere.

E. Significant Interruption: May include any of the following events:

1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
2. Failure to meet specified functional operation for more than 2 consecutive hours.
3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.

F. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start anew.

3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all operating units/systems has been achieved, sequence each operating unit/system to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the complete and overall performance of the facility and all related systems, subsystems, components, ancillary elements, and anything associated with operation of said.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic (and computerized, as applicable) operation.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are a part of this Specification:

1. System Startup Form.
2. Facility Performance Demonstration/Certification Form.

END OF SECTION

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SYSTEM STARTUP FORM

OWNER: _____ **PROJECT:** _____

Unit Process Description: (Include description and equipment number of all equipment and devices):

_____

_____

_____

_____

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

_____

_____

_____

_____

_____

Startup Requirements (Water, power, chemicals, etc.): _____

_____

_____

Evaluation Comments: _____

_____

_____

_____

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FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:_____ **PROJECT:**_____

Unit Processes Description (List unit processes involved in facility startup):

_____

_____

_____

_____

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

_____

_____

_____

_____

_____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ **Date:** _____**, 20**____

Engineer: _____ **Date:** _____**, 20**____

(Authorized Signature)

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SECTION 09 90 01
PAINTING AND PROTECTIVE COATINGS

PART 1 GENERAL

1.01 SCOPE

A. Section includes: all materials, labor, and equipment necessary to prepare surfaces to be coated, apply protective coatings, and properly cure and finish protective coatings for the Site equipment, structural steel, miscellaneous platforms and supports, CMU walls, piping, pipe supports, and plate ductwork.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness Per Coat, mils.
6. Mil: Thousandth of an inch.
7. PSDS: Paint System Data Sheet.
8. PVC: Polyvinyl Chloride.
9. SFPG: Square Feet per Gallon.
10. SFPGPC: Square Feet per Gallon per Coat.
11. SP: Surface Preparation.

1.03 REFERENCES

A. The following is a list of standards, which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. Standard Colors for Color Identification and Coding.
   b. A13.1, Scheme for the Identification of Piping Systems.
2. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipe.
   b. C209, Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings.
   c. C214, Tape Coating Systems for Steel Water Pipe.
3. NACE International: SP0188-2006, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. Occupational Safety and Health Act (OSHA).

5. The Society for Protective Coatings (SSPC):
    a. SP 1, Solvent Cleaning.
    b. SP 2, Hand Tool Cleaning.
    c. SP 3, Power Tool Cleaning.
    d. SP 5, White Metal Blast Cleaning.
    e. SP 6, Commercial Blast Cleaning.
    f. SP 7, Brush-Off Blast Cleaning.
    g. SP 10, Near-White Blast Cleaning.
    h. PA 1, Shop, Field, and Maintenance Painting.
    i. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
    j. PA 3, Guide to Safety in Paint Applications.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Data Sheets:
        1) For each paint system, furnish a Paint System Data Sheet (PSDS), Material Safety Data Sheet (MSDS), the manufacturer's technical data sheets, and paint colors available (where applicable) for each product used in paint system. The PSDS form is appended to the end of this section.
        2) Technical and performance information that demonstrate compliance with Specification.
        3) Submit required information on a system-by-system basis.
        4) Furnish copies of paint system submittals to the coating applicator.
        5) Indiscriminate submittal of manufacturer's literature only is not acceptable.
    b. Detailed chemical and gradation analysis for each proposed abrasive material.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.
2. Coating manufacturer's Certificate of Compliance stating coating system meets or exceeds requirements specified.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.

5. Manufacturer's written instructions and special details for applying each type of paint.
6. Manufacturer's written verification that submitted material is suitable for the intended use.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Applicator: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. SSPC PA 3, Guide to Safety in Paint Applications.
   c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of Work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar Work throughout the Project.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.
2. Shop painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	**Definition**
Bituminous Paint	Single-component, coal-tar pitch based.
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service.

Product	Definition
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required.
Epoxy Phenolic	Two-component phenolic/novolac epoxy coating specifically designed to provide a corrosion resistant barrier when used to protect steel beneath thermal insulation. Capable of providing corrosion protection in both atmospheric service and under thermal insulation operating in thermal cyclical conditions up to 400 degrees F.
Epoxy Primer – Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments.
Epoxy Primer – Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated.
High Heat	High temperature resistant coating specifically designed to provide a corrosion resistant barrier when used to protect steel beneath thermal insulation. Capable of providing corrosion protection in both atmospheric service and under thermal insulation operating in thermal cyclical conditions up to 1200 degrees F.
Universal Primer	Epoxy or other type coating capable of application over a variety of generic coatings and can be top-coated with a variety of generic coatings without lifting or blistering.
Inorganic Zinc Primer	Solvent or water based, having 85 percent metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating.
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish.
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based.
Silicone Zinc Dust Primer	High temperature, corrosion resistant primer formulated from silicone resins and zinc dust.
Air Drying Silicone Coating	Air drying, high temperature silicone resin formulation, suitable for operating temperatures to 1,200 degrees F.

Product	Definition
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference paragraph Shop Coating Requirements, this section.

B. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer’s standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer’s standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer’s standard coating with field coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.02 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect all surfaces adjacent to, or downwind of Work area from overspray.

3.03 SURFACE PREPARATION

A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer’s recommendations, the more stringent shall apply.

B. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
   a. SP1, Solvent Cleaning: Removal of all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
   b. SP2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
   c. SP3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
   d. SP5, White metal Blast Cleaning: Removal of all visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
   e. SP6, Commercial Blast Cleaning: Removal of all visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
   g. SP10, Near-White Blast Cleaning: Removal of all visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.

5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
    a. Prepare such that there is:
        1) No undercutting or reverse ridges on weld bead.
        2) No weld spatter on or adjacent to weld or any area to be painted.
        3) No sharp peaks or ridges along weld bead.
    b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. Pre-Blast Cleaning Requirements:
    a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
    c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
9. Blast Cleaning Requirements:
    a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
    a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    b. Paint surfaces the same day they are blasted. Re-blast surfaces that have started to rust before they are painted.

C. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.

2. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

D. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
    a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
    b. Brush-off blasting.
    c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

E. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
    a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
    b. Check compatibility by application to a small area prior to starting painting.
    c. If lifting or other problems occur, request disposition from coating manufacturer.

8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.04 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods, which involve a solvent or cleaning action.
2. Meets requirements of SSPC SP 1.

3.05 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise.
2. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
4. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
5. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
6. Keep paint materials sealed when not in use.

7. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Porous Surfaces, Such as Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

C. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with Specification.
   c. All coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.06 PROTECTIVE COATINGS SYSTEMS

A. System No. 5 Exposed Metal – Mildly Corrosive, 250 Degrees F Maximum:

Surface Prep.	Paint Material	Min. Coats, Cover
SP10 Near-White Blast Cleaning	Epoxy Primer – Ferrous Metal	1 coat, 4-6 MDFT
	Polyurethane Enamel	1 coat, 4-6 MDFT

B. System No. 9 Special Coatings – Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
	Primer: Shop-primed with inorganic zinc	1 coat, 3 MDFT
Wash to remove dirt from shop-primed surface	Polyamide Epoxy	1 coat, 4-6 MDFT

C. System No. 9A Previously Painted Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP2 or SP3	Universal Primer	1 coat, 2-3 MDFT
	Polyamide Epoxy	1 coat, 4-6 MDFT

D. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer – Other	As recommended by the coating manufacturer Remaining coats as required for exposure

E. System No. 14 High Heat-Resistant – 1200 Degrees F Maximum:

Surface Prep.	Paint Material	Min. Coats, Cover
SP10 Near White Blast Cleaning	High Heat	2 coat, 8-10 MDFT

1. Specification is based on Jotun Jatatemp 650. Consult manufacturer for the latest technical advice. Alternate Suppliers may be approved by the Engineer.

F. System No. 15 Heat-Resistant – 400 Degrees F Maximum:

Surface Prep.	Paint Material	Min. Coats, Cover
SP10 Near White Blast Cleaning	Epoxy Phenolic	2 coat, 8-12 MDFT

1. Specification is based on Jotun Epoxy HR. Consult manufacturer for the latest technical advice. Alternate Suppliers may be approved by the Engineer.

G. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

H. System No. 117 Concrete Masonry, Gloss Epoxy:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Water Base Epoxy (Gloss)	2 coats, 300 SFPGPC

1. Use on the following items or areas: CMU walls.

3.07 COLORS

A. Provide colors per paint schedule at the end of this section or as selected by Owner.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Pipe and Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners.
2. Paint equipment one color as selected by Owner.
3. Paint piping systems per the paint schedule at the end of this section or as selected by Owner.

3.08 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit to be as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188-2006.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: If requested by Engineer, leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.09 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.10 APPLICATION SCHEDULE

A. Surfaces Not Requiring Painting: Unless otherwise stated or shown below or in other sections, the following areas or items will not require painting or coating:

1. Concrete surfaces.
2. Reinforcing steel.
3. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, Monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
   a. Required for electrical insulation between dissimilar metals.
   b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
   c. Color coding of equipment and piping is required.
4. Nonmetallic materials such as glass, wood, and porcelain, except as required for architectural painting or color coding.
5. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches (if prefinished in OSHA yellow), acoustical tile, cabinets, elevators, building louvers, and wall panels; color coding of equipment is required.
6. Electrical conduits.
7. Cathodic protection anodes.
8. Items specified to be galvanized after fabrication, unless specified elsewhere.

B. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

C. System No. 5 Exposed Metal – Mildly Corrosive: Use on the following items or areas: Exposed metal surfaces, new, located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas. For uninsulated piping and equipment operating at temperatures up to 250 degrees F maximum.

D. System No. 9 Special Coatings – Metal: Use on the following items or areas: Structural and miscellaneous steel that has been shop primed with inorganic zinc primer.

E. System No. 9A Previously Painted Metal: Use to repaint finish painted item only when directed to do so by Engineer.

F. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning: Use on the following items or areas:

1. Galvanized surfaces requiring painting.
2. After application of System No. 10, apply finish coats as required for exposure.

G. System No. 14 High Heat-Resistant: 1200 Degrees F Maximum: Use on the following items or areas: For insulated (or uninsulated) piping, equipment, and ductwork operating at temperatures up to 1200 degrees F maximum. This system shall be specifically designed for protecting against corrosion under insulation.

H. System No. 15 Heat-Resistant: 400 Degrees F Maximum: Use on the following items or areas: For insulated (or uninsulated) piping, equipment, and ductwork operating at temperatures to 400 degrees F maximum. This system shall be specifically designed for protecting against corrosion under insulation.

I. System No. 27 Aluminum and Dissimilar Metal Insulation: Use on aluminum surfaces embedded or in contact with concrete.

J. System No. 117 Concrete Masonry, Gloss Epoxy: Use on new or existing interior concrete masonry walls.

3.11 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Paint System Data Sheet (PSDS).
2. Painting Schedule.

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PSDS for each coating system.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	**50/50**	**70/30**	**90/25**
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.: max.:_____

Surface Temperature Limitations: min.: max.:_____

Surface Profile Requirements: min.: max.:_____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

PAINTING SCHEDULE

EQUIPMENT/ MATERIAL DESCRIPTION	SHOP PAINTING			FIELD PAINTING		FINISH COLOR	REMARKS
	PRIMER	INTERMEDIATE COAT	FINISH	FINISH COAT	TOUCHUP COAT		
Miscellaneous Pipe Supports	Manu. Std.	Manu. Std.	Manu. Std.	None	Manu. Std.	Manu. Std.	Subject to Engineer's Approval
Structural Steel and Platforms	System No. 9, Section 09 90 01			None	Yes	TBD	Field Touchup at Field Welds or Damaged Areas
Transformers	Manu. Std.	Manu. Std.	Manu. Std.	None	Yes	Light Gray	
Handrails and Ladders	System No. 9, Section 09 90 01			None	Yes	ANSI Safety Yellow	Field Touchup at Field Welds or Damaged Areas
Sump Pumps	Manu. Std.	Manu. Std.	Manu. Std.	None	None	Blue	Subject to Engineer's Approval
Switchgear	Manu. Std.	Manu. Std.	Manu. Std.	None	None	Per Owner	Subject to Engineer's Approval
Outdoor Bus Duct	Manu. Std.	Manu. Std.	Manu. Std.	None	None	ANSI-61 Gray	
CMU Walls				System No. 117, Section 09 90 01		Per Owner	

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SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
2. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. D709, Standard Specification for Laminated Thermosetting Materials.
3. International Code Council (ICC):
   a. A117.1, Accessible and Usable Buildings and Facilities.
   b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
4. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.
2. Samples: One full size for each type of nameplate, sign, and label specified.

B. Informational Submittals: Manufacturer’s installation instructions.

PART 2 PRODUCTS

2.01 DOOR NAMEPLATES

A. Material: Plastic with square corners.

B. Thickness: 1/8 inch.

C. Height: 2 inches.

D. Finish: Nondirectional matte.

E. Background: Black.

F. Letters: Engraved.

1. Size: 1-inch high.
2. Color: White.
3. Style: Helvetica medium upper case.

G. Manufacturers and Products:

1. Best Manufacturing Co., Kansas City, MO; System A-101.
2. Andco Industries Corp., Greensboro, NC; 1400 series.

2.02 SIGNS

A. Plastic Sign (Type A):

1. Exterior: Laminated plastic subsurface image type, 3/16-inch thick with high-gloss finish.
2. Interior: Plastic, 1/8-inch thick with nondirectional matte finish and engraved letters.

B. Fiberglass Sign (Type C):

1. Material: Three-ply laminated fiberglass, minimum 1/8-inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.
2. Manufacturers:
   a. Best Manufacturing Co.
   b. Brady Signmark.

C. Exit Sign (Type G):

1. Material: Plastic, 1/8-inch minimum thickness.
2. Letters:
   a. 6 inches high, with 3/4-inch stroke.
   b. 2 inches wide, except for letter “I”, with spacing of 3/8 inch.
3. Colors: Red letters and direction arrows on white background.

2.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Labels: Self-adhesive tape, with separate directional flow arrows.
2. Material: Pressure sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: ASME A13.1.

5. Message: Piping system name as indicated on Piping Schedule.
6. Manufacturers and Products:
    a. Brady Signmark; B-946 Self-Sticking Vinyl Pipe Markers and Vinyl Arrows.
    b. Seton Identification Products; Opti-Code Markers and Directional Arrows.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: Black bold face, 3/4-inch minimum high.
3. Background: OSHA safety yellow.
4. Materials: Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.
6. Size:
    a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
    b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
    a. Brady Signmark.
    b. Seton Identification Products.

2.04 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Wood Posts: Preservative treated 4 by 4 wood as specified.

C. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.

D. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

E. Manufacturer’s standard brackets for wall mounting of two-sided exit signs.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer’s recommendations.

B. Mount securely, plumb, and level.

3.02 SIGNS

A. General:

1. Fasten to walls or posts, or hang as scheduled.
2. Anchor in place for easy removal and reinstallation with ordinary hand tools.

B. Information, Exit, and Safety Signs: Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.

3.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
5. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
6. Install in accordance with manufacturer’s instructions.

B. Equipment Labels:

1. Locate and install on equipment or concrete equipment base or as shown on Drawings.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

END OF SECTION

SECTION 25 05 11
CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS
TURBINE 7 PROCUREMENT PACKAGE

PART 1 GENERAL

1.01 RISK MANAGEMENT FRAMEWORK

A. The Sewerage & Water Board New Orleans (SWBNO) operates significant, critical water and wastewater infrastructure and is committed to fostering a holistic and galvanized cyber security environment. This is being achieved through the diligence of key stakeholders and the application of new standards and frameworks to safeguard critical control systems and information assets owned and operated by or on behalf of SWBNO. To address the unknowns, and to inform upon the level of protection required to safeguard its assets, SWBNO is committed to understanding the true and perceived risk threatening its critical control systems as well as the potential implications should any perceived risk become reality.

B. In response to the heightened state of threat awareness surrounding critical infrastructure, given the significant rise of cyber-attacks threatening water and wastewater utilities across the country, SWBNO seeks to formalize its approach to securing supervisory control systems utilizing reputable standards and frameworks from the National Institute of Standards and Technology (NIST). The NIST Risk Management Framework (RMF), as defined by the Special Publication 800-37 Standard, provides holistic means to quantify the response to risk from a cyber security perspective, and align countermeasures required to effectively reduce, transfer, or remove risk to key systems and critical assets across the industrial control system network (ICS).

Figure 1: NIST Risk Management Framework (RMF)

C. Subsequent Cyber Security specifications are aligned to phase 3 of the RMF - Select Controls - in order to provide guidance on how unique device types must be properly configured and secured prior to integration onto an ICS network and communication with live/production supervisory control system assets.

1.02 CYBER SECURITY SPECIFICATIONS

A. Operator Interface Terminals (OITs):

1. Relevant NIST 800-82 Rev 2 Controls:

a. CONTROL	TITLE / DESCRIPTION
1) PE-3	PHYSICAL ACCESS CONTROL
2) PE-6	MONITORING PHYSICAL ACCESS
3) RA-5	VULNERABILITY SCANNING
4) AC-2	ACCOUNT MANAGEMENT
5) AC-6	LEAST PRIVILEGE

2. Specifications:
    a. All OIT's shall be mounted externally to control panels/MCC/PLC Cabinets within the production environment which are locked and physically secured.
    b. All ethernet and USB ports must be physically inaccessible from the outside of the enclosure.
    c. Physical access to USB ports used to upload/download configuration files, applications and firmware shall be highly restricted to a privileged group of engineering personnel only.
    d. OIT's must be assessed for software vulnerabilities daily and patched immediately should any Common Vulnerability or Exposure (CVE) be detected.
    e. Default account credentials shall be changed and/or disabled prior to installation.
    f. OIT's must require a unique user login when making changes to process setpoints.
    g. Unique logins shall be administered from a centralized repository whereby credentials and permissions remain consistent across the supervisory control system.
    h. User accounts must provide limited privileged access to the OIT to fulfill the requirements of roles/responsibilities only.
    i. Administrative access to the OIT must be highly restricted to authorized users only – separate and unique Admin Accounts must be created and used to make changes to the programs and firmware only.
    j. Administrative accounts shall not be provided to, or used by operators, to log into OIT's to make changes.
    k. OIT's may present a view/read only status screen depicting the process area that does not require a login.
    l. OITs shall have the system clock synchronized with a GPS and/or NTP time source.

B. Operator Workstations:

1. Relevant NIST 800-82 Rev 2 Controls:

	CONTROL	TITLE / DESCRIPTION
1)	RA-5	VULNERABILITY SCANNING
2)	AC-2	ACCOUNT MANAGEMENT
3)	AC-7	UNSUCCESSFUL LOGIN ATTEMPTS
4)	AC-6	LEAST PRIVILEGE
5)	AC-11	SESSION LOCK
6)	AU-10	NON-REPUDIATION

2. Specifications:
    a. Operator Workstations must be assessed for software vulnerabilities daily and patched immediately should any Common Vulnerability or Exposure (CVE) be detected.
    b. Operator workstations must be connected to a centralized domain to ensure account management, permissions, access control and policy enforcement are applied consistently across all stations.
    c. Operators are required to use a unique account to login to the workstation and HMI software.
    d. Operator user accounts must provide limited privileged access to the workstation to fulfill the requirements of roles/responsibilities only.
    e. The local administrative account shall be disabled.
    f. The system shall lockdown after three concurrent unsuccessful login attempts (regardless of input delay) with notifications sent to incident responders requiring immediate investigation.
    g. Administrative access to the workstation / domain must be highly restricted to authorized users only – separate and unique Admin Accounts must be created.
    h. Administrative accounts shall not be provided to, or used by operators, to log into workstations.
    i. The HMI software must be connected to the centralized domain account repository.
    j. The HMI software shall log all user actions - logs/records must be kept for no less than 90 days.
    k. The workstation must automatically lock after more than 30 minutes of in-activity.
    l. Biometric access may be used to simplify operator login to the workstation and HMI.
    m. Removable USB Drives are strictly prohibited and shall not be connected to any operator workstation.
    n. USB port restrictions must be applied via domain/group policies to prevent removable media mounting to the operating system.
    o. Workstation shall have the system clock synchronized with a GPS and/or NTP time source.
    p. Policies shall be applied to whitelist authorized applications only and prevent the installation of unauthorized and/or malicious software and applications.
    q. Workstation policies must be created to prevent the execution of (but not limited to) PowerShell or batch file scripts.
    r. Workstation policies must prevent access to the CLI and internal hard drives / file system.

s. Workstation policies must restrict the use of (but not limited to) SMB, RDP and Telnet protocols.
t. Endpoint protection shall be installed on all Operator Workstations and receive hourly updates to signature and malware databases.

C. SCADA Servers:

1. Relevant NIST 800-82 Rev 2 Controls:
   a. CONTROL TITLE / DESCRIPTION
      1) RA-5 VULNERABILITY SCANNING
      2) AC-2 ACCOUNT MANAGEMENT
      3) AC-7 UNSUCCESSFUL LOGIN ATTEMPTS
      4) AC-6 LEAST PRIVILEGE
      5) AC-11 SESSION LOCK
      6) AU-10 NON-REPUDIATION
2. Specifications:
   a. SCADA Servers shall be rack mounted within a dedicated and environmentally controlled server room which is locked and physically secured.
   b. Physical access to the servers must be controlled and highly restricted – with entry (to the server room) requiring key/card/code or biometric access credentials.
   c. Servers must be assessed for software vulnerabilities daily.
   d. Critical and Security related updates and patches must be thoroughly tested prior to installation onto production servers.
   e. Servers must be connected to a centralized domain to ensure account management, permissions, access control and policy enforcement are applied consistently across all stations.
   f. Local administrative accounts shall be disabled.
   g. The system shall lockdown after three concurrent unsuccessful login attempts (regardless of input delay) with notifications sent to incident responders requiring immediate investigation.
   h. Administrative access to the workstation / domain must be highly restricted to authorized users only – separate and unique Admin Accounts must be created.
   i. Administrative accounts shall not be provided to, or used by operators, to log into SCADA servers.
   j. Any active user session (either direct or remote) must automatically lock after more than 15 minutes of in-activity.
   k. Removable USB Drives are strictly prohibited and shall not be connected to any SCADA server.
   l. USB port restrictions must be applied via domain/group policies to prevent removable media mounting to the operating system.

m. Servers shall have the system clock synchronized with a GPS and/or NTP time source.
n. Policies shall be applied to whitelist authorized applications only and prevent the installation of unauthorized and/or malicious software and applications.
o. Server policies must be created to prevent the execution of (but not limited to) PowerShell or batch file scripts.
p. Server policies must restrict the use of (but not limited to) SMB, RDP and Telnet protocols.

D. Programmable Logic Controllers (PLCs):

1. Relevant NIST 800-82 Rev 2 Controls:
   a. CONTROL — TITLE / DESCRIPTION
      1) PE-3 — PHYSICAL ACCESS CONTROL
      2) PE-6 — MONITORING PHYSICAL ACCESS
      3) RA-5 — VULNERABILITY SCANNING
      4) AC-2 — ACCOUNT MANAGEMENT
      5) AC-6 — LEAST PRIVILEGE
      6) AU-9 — PROTECTION OF AUDIT INFORMATION
      7) SI-7 — SOFTWARE, FIRMWARE, AND INFORMATION INTEGRITY
2. Specifications:
   a. All PLCs shall be mounted securely via DIN rail or equivalent inside PLC Cabinets / Enclosures within the production environment which are locked and physically secured.
   b. Direct physical access to the PLC shall be restricted to authorized engineering staff or developers only.
   c. Physical access to USB ports used to upload/download configuration files, applications and firmware shall be highly restricted to a privileged group of engineering personnel only.
   d. PLCs must be assessed for software vulnerabilities daily – critical CVE's (rating 7 and above) shall be acted upon immediately.
   e. All firmware updates / patches must be thoroughly tested prior to installation onto production PLCs.
   f. PLCs shall have the system clock synchronized with a GPS and/or NTP time source.
   g. Administrative access to the PLC via programming or administrative software must be highly restricted to authorized users only – separate and unique administrative and/or engineering accounts must be created, stored and synchronized within a centralized database.

h. Default account credentials shall be changed and/or disabled prior to installation.
i. All web interfaces must be disabled.
j. The ability to upload programs from the PLC must be highly restricted to authorized administration, development, or engineering staff only.
k. All PLC configuration/programs files must be secured, stored and backed up (with versioning controls enabled) within a centralized repository that is highly restricted to authorized administration, development, or engineering staff only.
l. Diagnostic audits shall be used to log all user actions when accessing and making changes to PLC configuration files / programs - logs must be kept for no less than 90 days.
m. The ability to download programs to the PLC must be highly restricted to authorized administration, development, or engineering staff only.
n. Online editing must be highly restricted to authorized administration, development, or engineering staff only – if online editing permission is granted, all changes shall be captured by an audit log and stored for no less than 90 days.
o. All changes (including keyswitch changes) to the controller shall be added to the audit log with notifications sent to incident responders.

E. Industrial Network Switches:

1. Relevant NIST 800-82 Rev 2 Controls:
   a. CONTROL TITLE / DESCRIPTION
      1) AC-5 SEPARATION OF DUTIES
      2) RA-5 VULNERABILITY SCANNING
      3) AC-2 ACCOUNT MANAGEMENT
      4) AC-6 LEAST PRIVILEGE
2. Specifications:
   a. All industrial network switches shall be mounted securely via DIN rail or equivalent inside Cabinets / Enclosures within the production environment which are locked and physically secured.
   b. Direct physical access to the switches shall be restricted to authorized administrative or engineering staff only.
   c. Default account credentials shall be changed and/or disabled prior to installation.

d. Administrative access to the switch via console and/or remote terminal connections must be highly restricted to authorized users only – separate and unique administrative and/or engineering accounts must be created, stored and synchronized within a centralized database.
e. No local user accounts shall be present on any switching hardware.
f. All user authentication requests must be directed to a RADIUS server or equivalent to control privileged access to the switch from a centralized repository.
g. SSH shall be used to enable remote access, support and monitoring of the switch – Telnet is prohibited.
h. Web Interfaces shall be disabled.
i. SNMPv3 may be enabled to provide remote centralized monitoring.
j. Switch shall have the system clock synchronized with a GPS and/or NTP time source.
k. Unused network edge ports shall be administratively shut down.
l. All edge ports shall have port-fast enabled with BPDU guard enabled.
m. All required networks shall be logically isolated at layer 2 of the OSI model using VLANs.
n. ICMP, CDP and LLDP shall not be permitted on any production switch and must be disabled post installation.
o. Layer 2 (MAC SEC) shall be implemented on all network switch interconnecting (trunk) links.
p. Port-based security shall be used to restrict devices - authorized devices will have their MAC addresses bound to a specific port.
q. MAC Address labels on authorized devices must be concealed or removed to avoid spoofing.
r. All trunk links will have VLAN ID’s explicitly defined – all unused VLAN’s must be pruned from 802.1q trunk links.
s. Authorized devices shall be connected to the switch only.
t. DHCP services will not be permitted across the industrial network.
u. DHCP Snooping, dynamic ARP Protection and IP Source Guard shall be enabled as a preventative measure on all switching equipment.
v. Un-authorized devices such as operator/contractor personal workstations, portable gateways and removable media are strictly forbidden.

F. Firewalls:

1. Relevant NIST 800-82 Rev 2 Controls:
   a. CONTROL TITLE / DESCRIPTION
      1) AC-4 INFORMATION FLOW ENFORCEMENT
      2) AC-3 ACCESS ENFORCEMENT
      3) RA-5 VULNERABILITY SCANNING
      4) AC-2 ACCOUNT MANAGEMENT
      5) AC-6 LEAST PRIVILEGE
2. Specifications:
   a. Firewalls shall be mounted securely via DIN rail or equivalent inside Cabinets / Enclosures within the production environment which are locked and physically secured.
   b. Direct physical access to the firewalls shall be restricted to authorized administrative or engineering staff only.
   c. Default account credentials shall be changed and/or disabled prior to installation.
   d. Administrative access to the firewall via console and/or remote web or terminal connections must be highly restricted to authorized users only – separate and unique administrative and/or engineering accounts must be created, stored and synchronized within a centralized database.
   e. No local user accounts shall be present on any switching hardware.
   f. All user authentication requests must be directed to a RADIUS server or equivalent to control privileged access to the firewall from a centralized repository.
   g. SSH and/or HTTPS (web) access shall be used to enable remote access, support and monitor the firewalls – Telnet and HTTP protocols are prohibited.
   h. SNMPv3 may be enabled to provide remote centralized monitoring.
   i. Firewall shall have the system clock synchronized with a GPS and/or NTP time source.
   j. Unused firewall ports shall be administratively shut down.
   k. Firewalls shall be licensed appropriately to provide premium hardware support, warranty replacement and a full suite of UTM features including IPS, DoS, AV, DNS, WEB, Proxy, Application, BOTNET Detection and DPI/SSL Inspection.
   l. Firewalls shall provide network separation, policing and filtration on data transmitted across the industrial control network between PLC’s and workstations, servers and HMI/OIT’s.

m. Anti-Virus (AV) security profiles shall be applied to all firewall policies – all AV profiles shall use proxy-based inspection.
n. A global Denial of Service profile shall be configured to alert the nominated monitoring system of an increase in incomplete sessions or TCP-SYN floods. The nominated security appliances shall have the latest virus and IPS signatures automatically applied upon release by the vendor.
o. The use of protocols including (but not limited to) DHCP, ICMP and LLDP is prohibited.
p. Changes to firewall configuration must be captured by audit logs and retained for no less than 90 days with notifications sent to incident responders.

G. Printers:

1. Relevant NIST 800-82 Rev 2 Controls:
   a. CONTROL TITLE / DESCRIPTION
      1) AC-3 ACCESS ENFORCEMENT
      2) AC-2 ACCOUNT MANAGEMENT
      3) AC-6 LEAST PRIVILEGE
2. Specifications:
   a. Only authorized administrative or engineering staff shall be permitted to print ICS related material - access to printer queues from engineering workstations connected to the SCADA network shall be restricted and controlled.
   b. Printed material shall be kept safe and secure at all times by the document owner or authorized staff member and never transmitted or disclosed to unauthorized personnel.
   c. Printed materials to be discarded must be destroyed and disposed of using a secure shredding service.
   d. Any uncontrolled printed documentation related to any aspect of the SCADA system configuration, function or security must be immediately destroyed with notifications sent to incident responders and site supervisors.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26 00 00
ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 PURPOSE OF DOCUMENT

A. This document specifies the engineering and design criteria, Electrical General Requirements, pertinent to the Electrical discipline that are used to develop the Project Engineering design documents (Documents) for the Work.

B. Of emphasis is the principle that the Documents are functional and schematic in nature. Contractor is responsible to prepare detailed final drawings based on the equipment selected by the Contractor and provide a completely operational system that meets the requirements of the Documents. Any conflict between the design criteria and the Documents shall be brought to the notice of the Owner. Owner's decision shall be final and followed by the Contractor for implementation at no extra cost to the Owner.

1.02 SITE CONDITIONS

A. See Section 01 61 00, Common Product Requirements.

1.03 APPLICABLE CODES AND STANDARDS

A. The electrical system design will be executed in accordance with the applicable industry standards as listed in this section. This is not a comprehensive list.

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 666, Design Guide for Power Systems for Generating Stations.
   b. 841, Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370kW (500 hp).
   c. 946, Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations.
   d. 1100, Recommended Practice for Powering and Grounding Electronic Equipment.
   e. C2, National Electrical Safety Code (NESC).
   f. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.

g. C37.16, Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635V and below) and DC (3200V and below) Power Circuit Breakers.
h. C37.17, Standard for Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
i. C37.20.2, Metal Clad Switchgear.
j. C37.21, Standard for Control Switchboards.
k. C37.22, Preferred Ratings and Related Required Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear.
l. C57.12.00, Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
m. C57.12.50, Requirements for Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low Voltage 120 to 600 Volts.
n. C57.13, Requirements for Instrument Transformers.
o. C57.91, Guide for Loading Mineral-Oil-Immersed Power Transformers.
p. C62.11, Standard for Metal Oxide Surge Arresters for AC Power Circuits (>1kV).

2. National Electrical Manufacturers Association (NEMA): MG-1, Motors and Generators.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

B. Related Sections, applicable, and not limited to the following:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 10, Electrical Summary of Work.
5. Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.
6. Section 26 05 50, Electrical Equipment Installation.
7. Section 26 05 75, Basic Electrical Materials and Methods.

NOTE: Where a more restrictive or stringent requirement is specified in a related section, the more restrictive or stringent requirement shall apply.

PART 2 PRODUCTS

2.01 TOOLS AND SOFTWARE

A. Design automation tools and software utilized for the performance of the Project Electrical Design by the Engineer, beyond standard word processing, spreadsheet, and database tools, include the following key applications:

1. SmartPlant Electrical (SPEL); a non-physical electrical design tool. SPEL shall be utilized in an 'integrated' SmartPlant environment to share data between disciplines and create non-physical electrical design work products out of SPEL that include:
   a. One Line Diagrams (part of E-N series).
   b. Cable Block Diagrams (as required).
   c. Schematic Diagrams (part of E-K series).
   d. Wiring Diagrams (part of E-K series).
   e. Electrical Equipment List (part of E-S series).
   f. Electrical Cable Schedule (part of E-S series).
   g. Electrical Panel Schedules (part of E-S series).
2. SmartPlant 3D (SP3D); a three-dimensional (3D) physical design tool. SP3D shall be utilized in an 'integrated' SmartPlant environment to share data between SP3D and SPEL as well as to create electrical physical electrical design work products out of SP3D that include:
   a. Electrical Location Plans (E-P series).
   b. Electrical Lighting Plans (E-L series).
   c. Electrical Above Ground Raceway Plans (E-T series).
   d. Electrical Underground Raceway Plans (E-U series).
   e. Electrical Hazardous Area Plans (E-H series).
   f. Electrical Grounding Plans (E-G series).
3. AutoCad and/or MicroStation; non-integrated drafting tool for non-SmartPlant drawings. AutoCad and/or MicroStation can be utilized to create electrical design work products not otherwise created in SmartPlant that generally include:
   a. Electrical Installation Details: often design standards that are typical in nature.
   b. Other miscellaneous Electrical design work products not otherwise created in SmartPlant.
4. ETAP; an electrical system modeling tool, shall be utilized for electrical system studies.

PART 3 EXECUTION

3.01 DESIGN CRITERIA

A. The electrical design will be prepared in accordance with local, state, and federal standards and the appropriate codes of practice and standards as referred to herein. Electrical construction documents will be sealed and signed by a licensed Professional Engineer as required.

B. Project voltages and frequencies are both standard and non-standard; great care shall be taken to assure the proper voltage and frequency is utilized and coordinated throughout the design. Typical project voltages and frequencies are as follows:

Voltage	Frequency	Phase
24kVAC	60Hz	3PH, 3W
13.8kVAC	60Hz	3PH, 3W
6.6kVAC	25Hz	3PH, 3W
4.16kVAC	60Hz	3PH, 3W
3.3kVAC	25Hz	3PH, 3W
480VAC	25Hz and 60Hz	3PH, 3W and 3PH, 4W
208VAC	25Hz and 60Hz	3PH, 4W
120VAC	25Hz and 60Hz	1PH, 2W
125VDC	--	2W

3.02 POWER TRANSFORMERS

A. Medium voltage power transformers shall be station class outdoor rated liquid filled specified to conform with IEEE C57.12.00 configured to conform with the requirements of the Contract Documents.

3.03 DISTRIBUTION TRANSFORMERS

A. Small power distribution transformers shall be of the dry type. Only copper windings shall be used. Rated for the environment in which the Drawings require. If small power distribution transformers derive a neutral, they shall be K rated such that the neutral K rating is at least equivalent to the phase rating.

3.04 MEDIUM VOLTAGE SWITCHGEAR

A. Medium voltage, 24kV, 13.8kV, 6.6kV, or 4.16kV, switchgear (SWGR) shall be specified to conform with IEEE C37.20.2 and suitable for operation on a three-phase, three-wire, 25Hz or 60Hz system, as required by the system within which they operate and as shown in the Contract Documents.

B. Medium voltage switchgear shall be of the metal-clad type and adequate to meet the parameters derived from the system model analysis.

C. Medium voltage switchgear shall be designed and built for the environment and application required by the system within which they operate and shall be free-standing fully enclosed. Where a ‘sheltered aisle’ style enclosure is utilized, the sheltered aisle shall be illuminated and of sufficient clear space to comply with code required working clearances and to allow for reasonable maintenance access.

D. Only copper buses shall be used with silver plating at joints.

E. All power circuit breakers shall utilize vacuum interrupters. All power circuit breakers shall have remote close/open/trip capability. All power circuit breakers shall be configured for remote racking. A shared remote racking device shall be provided. All power circuit breakers shall be removable for testing and service.

F. Indicating lights shall be supplied and provide, at a minimum, “closed” and “open” statuses. Red shall be used for closed and positioned on the right. Green shall be used for open and positioned to the left.

G. Humidistatically controlled space heaters shall be provided in each vertical section.

3.05 LOW VOLTAGE SWITCHGEAR

A. Low voltage, 480V, switchgear (SWGR) shall be 600V class suitable for operation on a three-phase, three-wire, 25Hz or 60Hz system, as required by the system within which they operate and as shown on the Drawings.

B. Low voltage switchgear lineup shall be of the metal-enclosed type and adequate to meet the parameters derived from the system model analysis. Only tin-plated copper buses shall be used.

C. Remote start/stop capability shall be provided for those elements shown on the Drawings with remote start/stop capability.

D. Power circuit breakers shall be configured for remote racking. A shared remote racking device shall be provided.

E. Indicating lights shall be supplied and provide, at a minimum, “off” and “run” statuses. Red shall be used for “run” and positioned on the right. Green shall be used for “off” and positioned to the left.

F. Humidistatically controlled space heaters shall be provided in each vertical section.

3.06 PROTECTIVE RELAYS

A. All new protective relays shall be of the solid-state microprocessor multifunction type and networked protection IEC 61850 compatible. New protective relays shall, as much as practical, match the existing solid-state microprocessor multifunction type relays found in the facility to enable improved safety and operations through consistency of understanding for the plant personnel, as well as potential efficiency in spare parts through common equipment. In general Schweitzer Engineering Laboratories (SEL) microprocessor multifunction type relays are the basis of design for medium voltage (24kV, 13.8kV, 6.6kV, and 4.16kV) applications and GE Multilin relays are the basis of design for low voltage (480V) applications.

B. A general protective relaying principle is to focus the protections functionality as close to the action-device as practical to improve system resiliency and reliability. This principle is consistent with electrical control system objectives outlined elsewhere in this Specification. Illustrative example would include locating the protective relay associated with a power circuit breaker, an ‘action-device’, in the power circuit breaker cubicle inclusive of the electrical control system local input/output signals associated with that ‘action-device’. Another similar example would be locating a power transformer protection relay within the power transformer control cabinet inclusive of the electrical control system local input/output signals associated with that power transformer.

3.07 CRITICAL POWER SYSTEM

A. Critical Power Systems shall comply with Sections 26 24 16, Panelboards, and 26 33 55, DC/AC UPS Systems, as well as any additional requirements listed in this Specification.

B. Where required, a 120V ac single phase, ferroresanent, uninterruptible power supply (UPS) shall be provided to service all new Project uninterruptible instrumentation and process critical 120V ac 60Hz single phase loads. The UPS system shall include a 120V ac single phase power distribution panel. The UPS system shall include a power quality transformer to allow for filtered power via a bypass source in the event that the UPS inverter malfunctions.

C. The UPS stored energy system shall be a 125V dc 60-cell sealed maintenance free battery system or be supported by a maintainable flooded cell station type battery system. The 125V dc battery system shall be part of a 125V dc system that provides stored energy for the UPS, services new 125V dc loads, and includes redundant chargers that utilize either 60Hz and/or 25Hz sources.

D. Where required and there is a sufficient quantity of control system loads that require filtered quality power supply but can be interrupted, a Filtered Control Power System shall be provided. The Filtered Control Power System is supplied by house power but has a power quality transformer to shield the connected loads from power irregularities that may exist on the house power system.

E. Where required, the Critical Power System shall include an Essential Power System that is interruptible but is backed up by a standby generator. The Essential Power System may include low voltage three phase elements and is intended to support critical loads that are interruptible but are required for critical operation and safe shutdown. The Essential Power System typically services one of two sources into redundant UPS stored energy systems, life safety systems, freeze protection, and other components deemed essential for critical operation and safe shutdown.

F. The Critical Power System shall have sufficient redundancy such that loss of any one source does not interrupt either the UPS or DC system.

3.08 CONTROL POWER

A. Control power for process critical systems shall be provided from sources that are supplied by redundant sources and/or include battery backed source. Control power will generally be 120V ac 60Hz single phase or 125V dc.

3.09 GROUNDING

A. All new equipment will be tied to the plant ground grid. If the equipment is outdoors and interconnection to the existing plant ground grid is not practical, a localized ground shall be derived per the Drawings utilizing both ground rod(s) and buried grounding conductor. All above grade grounding connections will be made using mechanical connections (Burndy G Series or equivalent) while all below grade connections shall be made with exothermic welds.

3.10 MOTORS

A. All new motors shall be Premium Efficiency Totally Enclosed Fan Cooled (TEFC) Squirrel cage induction motors, with a service factor of 1.15, and shall be acceptable for across-the-line starting, unless the process conditions and/or application require an alternate form of construction.

B. Aluminum enclosures are not acceptable. Only cast iron or steel shall be acceptable.

C. All motors shall be equipped with space heaters, unless less than 20 hp, and Inpro bearing seals.

D. All exposed metal surfaces shall be protected with a corrosion-resistant polyester paint or coating.

E. Terminal irons shall be cast iron, gasketed, and water-tight. Adequate room shall be supplied to meet cable training radius requirements. Motor terminal boxes shall be oversized by at least one size to ensure adequate room for potentially oversized feeder cable.

F. All insulated windings shall be copper. The winding insulation shall be Class F with temperature rise not to exceed NEMA MG-1 class B insulation temperature values given in NEMA MG-1 table 12.43.

3.11 RACEWAY SYSTEMS

A. Above ground raceway systems shall utilize aluminum cable tray and aluminum rigid conduit. Minimum conduit size is 3/4 inch.

B. Underground raceway systems shall generally be concrete encased PVC schedule 40 conduit, as further detailed on the Drawings. Minimum conduit size for medium voltage circuits is 5-inch diameter.

C. Direct buried conduit is not acceptable.

3.12 CABLE SYSTEMS

A. All cables shall be rated for the proper voltages, color-coded, and generally tray rated. Control cables shall be color coded by the ICEA E2 Color code table, unless specified otherwise in an application-specific Specification section. Refer to sections 26 05 13 and 26 05 19 for cable color coding of Medium Voltage Cable and Low Voltage Wire and Cable, respectively.

B. Direct buried cable is not acceptable, unless approved otherwise.

3.13 LIGHTING

A. All new lighting shall be design in accordance with IESNA and calculate average illumination levels with 0.8 maintenance factor.

B. Lighting shall be high efficiency. LED class fixtures shall be utilized where available. Lighting shall be optimized for the intended service and facilitate operations objectives while also enabling safe maintenance. Where practical, fixtures of the same manufacturer and series shall be utilized to reduce maintenance costs via shared spare parts.

C. Lighting shall be generally 120V ac or 277V ac to match existing lighting systems. If required to replace fixtures on DC sourced circuits, retain DC source and confirm circuit capacity is not adversely affected. New fixtures providing emergency egress shall be equipped with self-contained battery with a minimum 90-minute rating.

D. Care shall be given to matching the fixture rating to the environment in which the fixture will be installed.

E. Illumination levels shall be as follows:

1. Mechanical/Electric Rooms: 30 FC.
2. Emergency Lighting: 1.5 FC.

F. Emergency Exit Signs shall be provided at exit doors and as required by local building codes. Features shall include:

1. Die cast with universal mounting.
2. Emergency long life battery with automatic battery charger.
3. White background with green letters and universal chevrons.

G. Initial loading of lighting transformers shall not exceed 60 percent of base rating of transformer.

3.14 ELECTRICAL CONTROL SYSTEM

A. The electrical control system (ECS) is either part of the more general Plant Control System (PCS) or part of the Power Distribution Control System (PDCS), or may be neither up-to and even a stand-alone implementation that is not integrated into any other control system. The reason for this article is that input/output interfaces specified in the electrical Specification sections may not explicitly indicate which control system those interfaces are intended for nor may the Drawings include all input/output points, yet are a requirement and shall be included in the coordinated control system implementation. This requirement is included with emphasis to highlight that not all input/output points are explicitly shown on the Drawings and review of all Specification Sections for input/output requirements is the responsibility of the Supplier and exclusion of input/output points from the Drawings is not a basis for change.

B. Several control system Specification sections may be included as appropriate based on the Scope of Work. It is important to recognize that these Specification sections do not stand alone and must be read with all control system sections coordinated per the Scope of Work. Some of the PDCS control system Specification Sections include:

1. 40 94 23.PDCS – PDCS Electrical Control System (ECS).
2. 40 94 24.PDCS – PDCS Human Machine Interface (HMI).
3. 40 94 25.PDCS – PDCS Data Exchange Interface (DEI).

END OF SECTION

SECTION 26 00 10
ELECTRICAL SUMMARY OF WORK
COMBUSTION TURBINE GENERATOR SYSTEM

PART 1 GENERAL

1.01 ELECTRICAL

A. The Combustion Turbine Generator (CTG) System Project, (the "CTG Project", "CTG System", or "Project") electrical scope of work (the "Work") combines several functional elements to achieve a mega-watt scale industrial power plant to augment the SWBNO managed electrical network power supply infrastructure.

B. The design and supply of equipment unique to the CTG System or that which logically/materially impacts the CTG System design shall be provided by the Supplier. The various principle elements of the electrical Work by the Supplier include the following items categorized as the CTG Power Block Electrical System(s):

1. CTG System medium voltage (MV) switchgear, including all circuit breaker positions indicated on Electrical One Line Diagram Sketch 1419-WPCCTG-E-SK-01 'COMBUSTION TURBINE GENERATOR SCOPE'.
2. CTG System auxiliary power system.
3. CTG System electrical intra-CTG interconnection infrastructure.
4. CTG System electrical protection system.
5. All CTG System required miscellaneous electrical system elements for a safe, complete, and operable CTG System electrical system.
6. Electrical system analysis to characterize the impact(s) of the CTG System on the existing SWBNO managed electrical network.

C. For information only, a separate contract will be awarded for the CTG Project Balance of Plant (CTG BOP) Work, where the balance of interface design and equipment not unique to, nor supplied with the CTG System, will be completed. The various principle elements of the electrical CTG BOP Work include the following items categorized as the CTG BOP Electrical System(s):

1. Modification of existing and/or addition of new 60 Hz interface electrical distribution equipment.
2. Modifications to electrical Power Distribution Control System (PDCS).
3. Interconnecting ductbank/manhole system.
4. Associated CTG BOP interconnecting medium voltage power cables, low voltage power cables, control cables, and communications cables.

5. All required CTG BOP miscellaneous electrical system elements for a safe, complete, and operable electrical system.

D. Further characterization of the overall project by major project element, project phase, and responsible party is included in the Project Division of Responsibility (DOR), which is a supplement to Section 01 11 01, Project Summary of Work. The DOR provides an overview by major project element of the primary, and where applicable a secondary, responsible party(ies) and should be applied in conjunction with the Specification sections to guide scope of work understanding.

1.02 CTG SYSTEM ELECTRICAL SYSTEM GENERAL REQUIREMENTS

A. The CTG System must integrate into the overall SWBNO managed electrical network, which is dominantly operated as an islanded electrical distribution network with a wide mix of generating assets, including atypical megawatt-scale stating frequency converter(s). The SWBNO managed electrical distribution network is experiencing several changes during the planning, design, and execution of the CTG Project and eventually the SWBNO managed electrical distribution network will have connectivity to the local Utility via a transmission line connected utility substation with the capability of non-export parallel operation.

B. An additional unique aspect of the SWBNO managed electrical distribution network and generation assets is the presence of both 25 Hz and 60 Hz electrical equipment and systems. The electrical equipment system codes include, where relevant, include the frequency ‘25’ or ‘60’.

C. The equipment supplied under the Work is intended to be modularized in outdoor enclosures designed for all-weather access to reliably operate and maintain the equipment in extreme site operating conditions, such as hurricanes and during events requiring life critical SWBNO municipal system operation.

D. The equipment will be installed on a new concrete foundation(s) in an arrangement that facilitates coordination and integration with existing and new utilities.

E. The CTG System is, one of multiple generating assets to be managed by the SWBNO grid control system, within the existing Power Distribution Control System (PDCS), independently or dependently.

1.03 CTG SYSTEM ELECTRICAL SYSTEM(S)

A. The CTG System Electrical System(s) is defined as the focused equipment design and supply of the system elements that are unique to a CTG System and for which the Supplier can guarantee performance. The CTG System Electrical System(s) scope of supply shall be as self-contained as practical to reduce external material supply / quantity uncertainty risk.

B. CTG System Electrical System(s) equipment shall be of the Supplier's proven design configured to provide the performance specified in this Specification. The Supplier's Electrical System(s) equipment is purposefully notated to include all electrical equipment of the overall CTG System electrical system(s) necessary to operate the CTG System.

C. CTG System interconnection equipment is considered integral to the CTG System electrical system(s) to enable the Supplier the ability to define the explicit interface points and from an electrical protection aspect to drive a solution that the Supplier can define and manage. The standard electrical equipment requirements are specified in the various electrical sections of this Specification and are minimum requirements.

D. CTG System auxiliary power system is considered integral to the CTG System electrical system to enable the Supplier the ability to define the explicit interface points and be responsible for the variability of an auxiliary power system. The auxiliary power system is essentially a catchall for any auxiliary power requirements for equipment within the Supplier's scope of supply. The CTG System shall be as self-contained as practical and reduce the number of external interfaces and associated reliability uncertainty of those external interfaces. The CTG System shall derive and supply all of its own auxiliary power when in operation. The standard equipment within a typical auxiliary power system are specified in various sections of this Specification and are minimum requirements.

E. CTG System interconnecting medium voltage non-segregated phase bus, medium voltage power cables, low voltage power cables, control cables, and communications cables is the general characterization that the required interconnection between Supplier supplied equipment shall be within the Supplier's scope of supply. The Supplier is expected to provide an explicit equipment arrangement design such that the Supplier can supply the interconnecting electrical materials and be responsible for the variability of the interconnecting electrical materials as a catchall for any interconnecting electrical materials within the CTG System. The Supplier shall supply all interconnecting electrical materials noted above as part of the CTG Project scope of supply. The standard electrical materials are specified in various sections of this Specification and are minimum requirements.

F. CTG System required miscellaneous electrical system elements for a safe, complete, and operable CTG System electrical system(s) requirement is a generalization for electrical system elements that are not otherwise explicitly specified and could be reasonably known to be required and included by a specialty system supplier such as the Supplier.

G. An electrical system analysis is required to characterize the impact(s) of the CTG System on the existing SWBNO managed electrical network to demonstrate by both calculation and installed system testing that the integration of the CTG System on existing equipment within the SWBNO operated electrical network are controlled as designed and guaranteed by the Supplier.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Equipment supply schedules and construction sequencing is extremely important for this project. An overall equipment supply schedule is required for incorporation in the overall project construction schedule.

END OF SECTION

SECTION 26 05 04
ELECTRICAL REQUIREMENTS
FOR PACKAGED MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the general requirements for the electrical design and construction of electrical components furnished as part of mechanical equipment. Reference relevant Mechanical Specifications for further mechanical equipment requirements.

B. Supplier's Scope and Responsibility:

1. All assembly and wiring within the package.
2. Electrical power supply feeder and grounding to the termination point of equipment.
3. Wiring between pieces of the equipment that is too large to be shipped assembled.

C. Substitutions/Exceptions:

1. Note exceptions and advise of deviations, additions, deletions, or other changes to specified requirements.
2. Deviations are permitted only if outlined in full detail. Written approval of those deviations will constitute acceptance.

D. Related Sections, as applicable, and not limited to the following:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work.
6. Section 26 05 75, Basic Electrical Materials and Methods.

NOTE: Where a more restrictive or stringent requirement is specified in a Related Section, the more restrictive or stringent requirement shall apply.

1.02 REFERENCES

A. The following codes and standards shall be applied to all work. Note that this list is not all inclusive, and where additional codes and standards are listed, those additional codes and standards shall apply by reference.

1. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
2. National Electric Code (NEC).
3. UL.
4. Institute of Electrical and Electronics Engineers (IEEE):
    a. C2 National Electrical Safety Code.
    b. C62.37 Standard Specification for Thyristor Diode Surge Protective Devices.
    c. 666 Design Guide for Electric Power Service Systems for Generating Stations.
    d. 835 Standard Power Cable Ampacity Tables.
    e. 1185 Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities.
5. National Electrical Manufacturers Association (NEMA):
    a. HP 100 High Temperature Instrumentation and Control Cables.
    b. TR 1 – Transformers, Regulators, and Reactors.
    c. WC 26 Binational Wire and Cable Packaging Standard.
    d. WC 57 Standard for Control, Thermocouple Extension, and Instrumentation Cables.
    e. WC 70 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
6. American National Standards Institute (ANSI): ANSI/TIA 568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
7. International Electrical Testing Association (NETA).

B. Where two or more codes or standards establish different or conflicting requirements, the more stringent standard shall apply.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, or required elsewhere in this section, the following Drawings and data shall be submitted for approval:

1. Equipment outlines including junction box size and location.
2. Elementary diagrams and schematic diagrams.

3. Connection Wiring diagrams indicating terminal points for external wiring.
4. Control Panel arrangement drawings.
5. Bill of materials listing each device by manufacturer's part number.
6. Load List information for all equipment supplied.
7. Motor data sheets.
8. Packaged Mechanical Equipment Cable Schedule listing cable tag number, cable type, cable from, cable to, cable scope of design, cable scope of supply, cable scope of installation, and cable function. All cables required for a complete and functional package shall be included in Packaged Mechanical Equipment Cable Schedule.
9. Packaged Mechanical Equipment Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
10. Installation and Operating Manuals.
11. Manufacturer Drawings and Catalog Cut Sheets for all components.
12. Test Reports for all components.

B. Additional Documentation:

1. Submit complete engineering information for electrical items being furnished. The information shall include but not be limited to: horse power ratings, operating voltage, frequency, amperage, power factor, demand factor, and other data which can help the adequate sizing of the power supply.
2. Submit electrical documentation indicating sensors, RTDs, and control devices as well as their operating voltage.
3. List required external power sources indicating voltage, number of phases, frequency, maximum and nominal kW and kVA requirements.
4. Submit design data sheets, descriptive literature, outline dimensions, anchor bolt location drawings, junction box locations, and other conduit interface points.

PART 2 PRODUCTS

2.01 CONTROL PANEL ENCLOSURES

A. Provide dead-front control panels. Provide NEMA 12 enclosures (minimum) for indoor use (control panels in indoor process areas shall be NEMA 4X minimum), and NEMA 4X for outdoor use unless specifically stated otherwise. Provide enclosures with hinged doors complete with three-point latching devices.

B. Control pushbuttons, selector switches, gauges, meters, indicating lights, phenolic labels (i.e., emergency tags, equipment tags, nameplates, item tags, etc.), digital displays, communication ports, HMI/touchscreen devices, or other similar control interface equipment or identification shall be surface-mounted on control cabinet door.

C. If the final location of the skid is in a location requiring enclosure rating different than generally specified herein, such as a hazardous location defined by the NEC, the Supplier shall provide equipment listed for the location. Particular attention shall be given to hazardous, corrosive, and areas subject to wash-down. In hazardous area all equipment shall be listed for installation in hazardous location of the same Class, Division, and Group. The electrical equipment and wiring method shall comply with applicable sections of NEC.

D. Enclosures shall have adequate HVAC for space heating and cooling to prevent condensation and keep components within manufacturer's recommended operating temperature. Enclosure HVAC shall not compromise enclosure NEMA rating.

2.02 WIRING

A. No splices allowed in raceways. If splicing of wires is required, it shall be performed in a junction box on a terminal strip. All circuits shall be appropriately labeled. Wire nuts are not acceptable.

B. Route wiring for the installation of external connections to identified, adequately rated enclosed terminal strips. Label and crimp internal wiring at both ends. Segregate control voltage wiring and terminals with a grounded separation barrier within panels. Wire skid-mounted instruments to a signal interface box with location clearly identified on submittal Drawings. Control cables shall be terminated with ring tongue terminals.

C. Enclose wiring inside the panel in plastic wiring duct. Identify wires with preprinted, slide-on type or heat-shrink type markers at each end. 120V ac and 480V ac circuits shall be separated from signal wiring inside panel and run in wireway. Provide hinge wiring for front panel devices. Wrap wiring with plastic cable stays. Secure hinged wiring at each end so that bending, or twisting will be around the longitudinal axis of the wire. Protect the bend area with a sleeve.

D. Show the location of cable entries to electrical equipment on arrangement Drawings.

E. Provide an internal high efficiency totally enclosed light for the enclosure section. Provide a light switch and 120V ac convenience outlet with NEMA 5-20R configuration in the panel. Light and outlet shall be fed separately from other equipment in the panel.

F. Individually fuse devices utilizing blown-fuse-indicating fusible terminal blocks.

2.03 RACEWAY

A. All wiring to be enclosed in rigid aluminum conduit.

B. Utilize Schedule 80 PVC conduit in corrosive environments.

C. Conduit shall be 3/4-inch minimum.

D. Liquid-tight or explosion-proof flexible conduit shall be used for connections to all equipment where adjustment or vibration requires flexible connections. Maximum length of flexible conduit shall be 30 inches.

E. Conduit penetrations for panels located in corrosive or wet areas are permitted only through the bottom of the panel.

2.04 TERMINAL BLOCKS

A. Provide terminal blocks for all field wiring, capable of accepting a minimum of two ring tongue terminated 12 AWG wires and rated no less than 20A.

B. Group terminal blocks according to function and voltage level. Provide minimum 20 percent spare terminals at each voltage level.

C. Permanently identify terminal block groups with an engraved nameplate. Individual terminals shall be labeled.

D. Keep field side of terminal block free of wiring. Provide an empty run of plastic wiring duct for field wiring. Terminate external device wiring at terminal blocks.

E. Provide a clear protective cover for exposed terminals with a voltage above 50V to eliminate accidental contact.

F. For thermocouple wiring, provide thermocouple terminal blocks of the same type (J, K, etc.) as the associated thermocouple.

2.05 NAMEPLATES, NAME TAGS, AND SERVICE LEGENDS

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Provide components with permanently-mounted nametags bearing the entire tag number of the component. Nameplates shall be laminated plastic with black engraved characters on white background.

C. Affix exterior front of panel nameplates to the panel using stainless steel screws.

D. Affix interior nameplates next to the device with industrial-grade adhesive.

2.06 GROUNDING

A. Install grounding in accordance with the Drawings, NEC, and other applicable codes and ordinances.

B. Provide grounding conductors in continuous lengths. Splices or joints are not permitted.

C. Provide lug or bus for connection to equipment grounding conductor.

D. Provide two grounding connections per skid, diagonally opposite of each other.

2.07 POWER SUPPLIES

A. Provide dc power supplies to power instruments requiring external dc power. Power supplies shall convert 120V ac, 60HZ power to dc power of the appropriate voltages with sufficient voltage regulation and ripple control to ensure the instruments being supplied can operate within their required tolerances. Provide power supplies with output overvoltage and overcurrent protective devices to protect the instruments from damage due to power supply failure and to protect the power supply from damage due to external failure. Mount power supply within control cabinet or junction box on skid or provide enclosure of similar rating as other enclosures on the skid for power supplies. Mount power supplies such that dissipated heat does not adversely affect other components.

B. Provide power supply with a rating of minimum 50 percent greater than calculated requirement.

C. Provide control transformers with a rating minimum 50 percent greater than calculated requirement.

D. Provide clear protective cover for exposed terminals on the power supply with a voltage above 50V to eliminate accidental contact.

2.08 CONTROL CIRCUITS

A. All control and alarm circuits shall be wired according to fail safe logic. Alarm circuits shall open to alarm.

B. 120V ac power supplies to Supplier's PLCs, where applicable, shall be supplied from Owner's UPS.

C. Suitable circuit protections shall be provided so that any one electrical fault does not affect more than one unit or system. The protection can be accomplished by either circuit breaker or fuse.

D. Auxiliary control relays shall have contacts rated 10A at 30V dc and 120V ac.

E. Provide control relay with screw terminal interface between the PLC output and motor starters.

F. All relays shall be provided with at least 2 NO and 2 NC spare contacts for use by the Owner. In the event that this requirement will result more contacts that can be mounted on a relay or contactor, the Supplier shall provide auxiliary relay.

G. Mount relays such that the terminal identifications are clearly visible, and terminals are readily accessible.

H. A disconnecting means shall be provided to permit servicing of individual system or control components. Where all power to a packaged unit is supplied by one main feeder, Supplier shall provide a main disconnecting means so that the entire package may be deenergized from one location on the skid. Equipment skids provided with two 100 percent redundant components shall be provided with individual disconnects so that each redundant component can be taken out of service without affecting the other component. Disconnecting means shall be capable of being locked out in the off position only.

I. Indicating lights and pushbutton color shall be red for operating and green for not operating.

J. All Motor Operated Valves (MOV) shall be provided with integrally mounted combination starters for remote operation by Owner's PLC. MOV starters shall also have provision for local operation.

K. Supplier furnished motors shall be supplied with motor starters with overloads unless otherwise noted. Motor starter shall include a disconnecting device capable of being locked in the open position.

L. All wiring terminal points between the Supplier and others (customer interface wiring) shall be made in a terminal box supplied by Supplier and mounted on skid.

2.09 LOW VOLTAGE CIRCUITS

A. Where the control panel contains electronics such as PLCs, DDCs, or other programmable devices and no UPS power is available, provide a power filter which meets the following requirements:

1. Provides protection from voltage spikes, sags, and surges.
2. Provides minimum 40 dB reduction of electrical noise for frequencies from 50kHZ to 50MHZ.
3. Complies with UL 1449 for surge withstand capability.

B. Communication Links: Where cables and conductors serve as communication links between programmable controllers, provide surge-protection circuits at each end which meet IEEE Standard C62.37 surge withstand capability tests.

PART 3 EXECUTION

3.01 WIRING AND IDENTIFICATION

A. Each circuit/wire and cable shall be clearly identified at each end and in junction, terminal, or pullbox with proper and unique identifying number. Individual wires shall have the same identifier at both ends where they terminate. Labels shall be firmly attached and shall be of permanent non weathering type. Affixing labels using wire straps or similar devices that can easily be removed is not acceptable.

B. Between termination points, wires shall be installed in adequately sized and properly supported raceways. Raceways shall be of material suitable for the location. In highly corrosive applications raceways shall be either PVC, PVC coated, galvanized steel, or fiberglass. PVC conduits shall not be acceptable in hazardous areas.

C. Use of wire nuts shall not be permitted.

D. Provide nameplate for each panel, junction box or pullbox. Labels shall be affixed to the cover using stainless steel screws or other permanent method. Gluing the nameplates is not acceptable. Nameplates for emergency equipment or for warning shall be red background and white engraved lettering in conjunction with requirements set forth in Section 01 58 53, Project Equipment Identification.

E. All control and measurement devices, switches, relays, contactors and indicating lights shall be labeled. The tag number of each device shall be the same as indicated in Drawings, elementary control diagrams, or other schematic diagrams. Any discrepancies found will be fixed at the expense of the Supplier.

3.02 TESTING

A. Prior to shipment, check tags, labels, and nameplates for correct inscription, color, size, letter size, spelling, and location.

B. At the panel factory, perform a continuity test of wiring to verify conformance of wiring circuits to the Drawings. Correct discrepancies prior to shipment to Site.

C. A functional test of each individual component shall be performed in the shop, before assembly. The functional test shall consist of simulating the Owner's devices and complete exercising of each circuit while observing for proper operation.

D. Wiring 480V and above shall be checked for insulation resistance. Values above 10 MOhm shall be considered acceptable.

3.03 INSPECTIONS

A. Materials, equipment, and workmanship are subject to inspection at any time. Correct Work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to Owner at no additional cost.

END OF SECTION

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SECTION 26 05 13
MEDIUM VOLTAGE CABLE

PART 1 GENERAL

1.01 SUMMARY

A. This Specification covers the requirements for the procurement of Medium Voltage Cable for systems operating at 2001 volts through 35,000 volts.

1.02 REFERENCES

A. The material furnished shall be in accordance with, but not limited to, the following Codes and Standards.

1. National Fire Protection Association (NFPA): 70, National Electrical Code.
2. UL: 1072, Medium-Voltage Power Cables.
3. American Society for Testing and Materials (ASTM):
   a. B8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   b. B496, Compact Round Concentric-Lay-Stranded Copper Conductors.
4. National Electrical Manufacturers Association (NEMA): WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. Insulated Cable Engineers Association (ICEA):
   a. P-45-482, Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables.
   b. P-46-426, Power Cable Ampacities.
   c. P-54-440, Ampacities of Cables in Open-Top Cable Trays.
   d. S-93-639, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
   e. T-26-465, Guide for Frequency of Sampling Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test.
   f. T-27-581, Test Methods for Extruded Dielectric Cables.
   g. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour.
6. Institute of Electrical and Electronics Engineers (IEEE):
   a. C2, National Electrical Safety Code.
   b. 383, Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations (flame test requirements only).
   c. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

d. 422, Guide for the Design and Installation of Cable Systems in Power Generating Stations.
e. 532, Guide for Selecting and Testing Jackets for Power, Instrumentation, and Control Cables.
f. 575, Guide for the Application of Sheath-Bonding Methods for Single- Conductor Cables and the Calculation of Induced Voltages and Currents in Cable Sheaths.
g. 576, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.
h. 666, Design Guide for Electric Power Service Systems for Generating Stations.
i. 835, Standard Power Cable Ampacity Tables.
j. 1185, Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities.

B. Related Sections:

1. Section 01 11 01, Project Summary of Work, Further characterization of the overall project by major project element, project phase, and responsible party is included in the Project Division of Responsibility (DOR), which is a supplement to Section 01 11 01, Project Summary of Work. The DOR provides an overview by major project element of the primary, and where applicable a secondary, responsible party(ies) and should be applied in conjunction with the Specification sections to guide scope of work understanding.
2. Section 01 33 00, Submittal Procedures.
3. Section 26 00 00, Electrical General Requirements.
4. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Supplier’s data cut sheets.
2. Certified Factory Test Reports.
3. Supplier’s installation instructions.
4. Recommended field tests.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers: single source manufacture is required for medium voltage cable specified in this section.

1. Okonite or approved alternate.
2. Furnish cable bearing UL label.

2.02 CABLE CONSTRUCTION

A. Single Conductor:

1. Soft-drawn, annealed copper conductors with Class “B” stranded.
2. Insulation: EPR insulation compounded and mixed by cable manufacturer, rated for 105 degrees C, with thickness appropriate for 133 percent insulation level, minimum thickness according to NEC table 310.13(E).
3. Semi-conducting: strand and insulation shields of thermosetting compound.
4. Shield: helically applied Copper wire (concentric neutral-drain wire).
5. Jacket: UL listed “MV-105”, rated for use in cable tray.
6. Color coding of Medium Voltage (MV) cable shall be solid-black jacketed conductors with color tape wrapped around each terminated end of a conductor. Phase conductor color coding for Phase A, Phase B, and Phase C conductors shall be BROWN, ORANGE, and YELLOW, respectively. Neutral conductors, where applicable, shall also be solid-black jacketed with a GRAY tape wrapped around each terminated end of the conductor.

B. Multi-conductor:

1. Soft-drawn, annealed copper conductors Class “B” stranded.
2. EPR insulation compounded and mixed by cable manufacturer, rated for 105 degrees C, with thickness appropriate for 133 percent insulation level, minimum thickness according to NEC table 310.13(E). Semi-conducting: strand and insulation shields of thermosetting compound.
3. Shield: helically applied Copper wire (concentric neutral-drain wire).
4. Ground: one overall bare grounding conductor rated according to UL 1072.
5. Jacket: one overall jacket UL listed “MV-105”, rated for use in cable tray.

6. Color coding of Medium Voltage (MV) cable shall be solid-black jacketed conductors with color tape wrapped around each terminated end of a conductor. Phase conductor color coding for Phase A, Phase B, and Phase C conductors shall be BROWN, ORANGE, and YELLOW, respectively. Neutral conductors, where applicable, shall also be solid-black jacketed with a GRAY tape wrapped around each terminated end of the conductor.

2.03 CABLE FLAME TEST

A. All cables shall pass IEEE 1202 vertical tray 70,000 btu/hr flame test.

2.04 CABLE JACKET MARKINGS

A. Conductor Size.

B. Insulation Type.

C. Shield Type.

D. Tray Cable Type TC.

E. Voltage.

F. Flame Test.

G. Date of Manufacture.

H. Footage Markers.

PART 3 EXECUTION

3.01 PACKAGING AND SHIPPING

A. Reel Construction:

1. Standard non-returnable wood reels and meet requirements of NEMA WC 26. These reels, while using the most economic construction, must withstand shipping, normal handling in the field, and outdoor storage up to three years in all weather conditions.
2. Reels 36 inches and larger must have steel arbor hole inserts.
3. Plywood flange reels are not acceptable.
4. Each reel of cable protected by a weather-resistant covering of suitable grade to meet the requirements for class 4, extra-heavy duty physical protector in accordance with NEMA WC 26.

B. Reel Identification:

1. Each reel must have a visible waterproof tag on the outside of each flange.
2. Tags shall be 4 inches by 6 inches and larger for a total of two tags per reel.
3. Tags must include:
   a. Job name.
   b. Supplier and Supplier purchase order number.
   c. Purchase order line item number.
   d. Cable description.
   e. Cable code.
   f. Cable length.
   g. Sequential footage markers which match exposed ends.
   h. Gross weight of the reel.
   i. Supplier name.
   j. Non-repetitive reel number (matches packing slip).
   k. Custom reel identifier which will be provided to Supplier at the time of release for shipment.
   l. Reel storage requirements shall be shown on reel tag.

C. Delivery:

1. Reels must be transported and delivered standing on flanges.
2. If palletized, reels must be standing on flanges and strapped to pallet.
3. Cable reels must be delivered on flat bed only. Material must be tarped.
4. Each cable reel must have 3 feet exposed test lead on each end.
5. Medium voltage cable ends must be heat shrink capped.

D. Storage and Handling:

1. Storage: Protect cable from elements during storage.
2. Handling: Do not remove protective lagging from reels until ready to commence pulling operations.

END OF SECTION

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SECTION 26 05 19
LOW VOLTAGE WIRE AND CABLE

PART 1 GENERAL

1.01 SUMMARY

A. This Specification covers the technical and associated requirements for the procurement of Low Voltage Wire and Cable used on systems operating at 600 volts or less.

1.02 REFERENCES

A. The material furnished shall be in accordance with, but not limited to, the following Codes and Standards:

1. National Fire Protection Association (NFPA): 70, National Electrical Code.
2. UL:
   a. 44, Thermoset-Insulated Wires and Cables.
   b. 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   c. 1581, Reference Standard for Electrical Wires, Cables, and Flexible Cords.
   d. 1685, Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
   e. 2225, Cables and Cable Fittings for Hazardous Locations.
   f. 2250, Instrumentation Tray Cable.
   g. E38916, Type MC-HL Cable.
   h. VW-1, Vertical Wire Flame Test.
3. American Society for Testing and Materials (ASTM):
   a. B3, Specification for Soft and Annealed Copper Wire for Electrical Purposes.
   b. B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   c. B33, Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
   d. B172, Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors.
   e. B496, Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
4. National Electrical Manufacturers Association (NEMA):
   a. WC 26, Binational Wire and Cable Packaging Standard.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.

c. WC 70, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
d. HP 100, High Temperature Instrumentation and Control Cables.

5. Insulated Cable Engineers Association (ICEA):
   a. P-45-482, Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables.
   b. P-54-440, Ampacities of Cables in Open-Top Cable Trays.
   c. S-73-532, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   d. S-90-661, Category 3, 5 and 5e Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring.
   e. S-95-658, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   f. S-104-696, Indoor-Outdoor Optical Fiber Cable.
   g. T-26-465, Guide for Frequency of Sampling Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test.
   h. T-27-581, Test Methods for Extruded Dielectric Cables.
6. American National Standards Institute (ANSI): TIA 568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
7. Institute of Electrical and Electronics Engineers (IEEE):
   a. C2, National Electrical Safety Code.
   b. 1202, Standard for Flame-Propagation Testing of Wire and Cables.
   c. 422, Guide for Design of Cable Raceway for Electrical Generating Facilities.

B. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 26 00 00, Electrical General Requirements.
3. Section 26 00 10, Electrical Summary of Work.

1.03 DEFINITIONS

A. Drawings: Drawings includes all technical drawings and documents used to define the system(s) and equipment specified herein.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Supplier’s data cut sheets.
2. Certified Factory Test Reports.

3. Supplier’s installation instructions.
4. Recommended field tests.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. Okonite.
2. Southwire.
3. General Cable.
4. Corning.
5. Prysmian (Pirelli).
6. Houston Wire and Cable.
7. Anixter.
8. US Wire and Cable (distributor).
9. Calvert.
10. C.I.E.

B. Furnish soft drawn, annealed copper, wire, cable (Class “B” Stranding), associated connectors, and termination hardware bearing UL label.

C. Submit Product Data on each type of cable.

2.02 CABLE CONSTRUCTION

A. Power Wire and Cable General Requirements:

1. General: Conform to UL 83 (thermoplastic insulation), UL 44 (thermoset insulation) and ICEA S-95-658/NEMA WC70.
   a. Multi-Conductor Cable: Rated 600 volts, with ground wire, conductor insulation [EPR or XLPE], NEC type XHHW-2 (90 degrees C wet/dry), having prescribed size and number of conductors, cabled together with an outer CPE, or XLP, or PVC jacket, per NEC and UL listed as Type TC suitable for tray installation.
   b. Single-Conductor Cable: Rated 600 volts, conductor insulation XLPE, NEC type XHHW-2 (90 degrees C wet/dry), with XLP or PVC jacket, per UL listed as Type CT suitable for tray installation. Cable #4/0 AWG and above may be without color code.
   c. Ground Conductor: Rated 600 volts, conductor insulation PVC, NEC type TW (60 degrees C wet/dry), no jacket required.

2. Color coding:

Voltage	ØA	ØB	ØC	Neutral
< 250 volts	Black	Red	Blue	White
250 – 600 volts	Brown	Orange	Yellow	Natural Gray

a. For specified insulations and jackets not manufactured with integral colors, use conductors with black insulation or jacket and color coding tape.
b. Ground Conductors:
1) For 6 AWG and smaller: Green.
2) For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

B. Control Cable General Requirements:

1. General: Conform to UL 83 (thermoplastic insulation), UL 44 (thermoset insulation) and ICEA S-95-658/NEMA WC70.
a. Multi-Conductor Cable: Rated 600 volts, unshielded, with ground wire, conductor insulation XLPE, NEC type XHHW-2 (90 degrees C wet/dry), having prescribed size and number of conductors, cabled together with an outer CPE, or XLP, or PVC jacket, per NEC and UL listed as Type TC suitable for tray installation.
2. Color Coding: Per ICEA Method 1, Table E-2. Minimum conductor size No. 14 AWG.

C. Signal Cable General Requirements:

1. General: Type PLTC (Power Limited Tray Cable). Labeled and approved for use in cable tray. Conform to UL 83 (thermoplastic insulation), UL 44 (thermoset insulation) and ICEA S-95-658/NEMA WC70.
a. Multi-conductor:
1) General: Rated 300 volts, conductor insulation XLPE 90 degrees C, single pair (pr.), triad (tri.), or quad (qd.).
2) Single Pr., Tri., or Qd.: No. 16 AWG, stranded copper conductors, twisted and covered with a 100 percent aluminum-mylar shield, with drain wire and overall PVC or CPE jacket.
3) Multiple Pr., Tri., or Qd.: Same as single construction except an overall aluminum-mylar shield in addition to individual shields.

b. Thermocouple Extension Wire:
   1) Two 16 AWG solid alloy conductors matched and calibrated to ANSI MC96.1 type E, J, K, T, or other specific type indicated on the Drawings.
   2) Full coverage aluminum-mylar shield and drain wire.
   3) XLPE 90 degrees C conductor insulation and overall PVC or CPE jacket.
c. Resistance Bulb Wiring (RTD):
   1) 3-Wire RTDs: No. 16 AWG, stranded copper conductors with a 100 percent aluminum-mylar triad shield, with drain wire, conductor insulation rated 90 degrees C and overall PVC or CPE jacket.
   2) 4-Wire RTDs: Two 16 AWG twisted pairs each with a 100 percent aluminum shield, with drain wire, conductor insulation rated 90° C and overall PVC or CPE jacket.

2. Cat 5E: Four pair 24 AWG unshielded, twisted pair, with an overall PVC or CPE jacket.
3. Fiber Optic Cable:
   a. Environment: Indoor/Outdoor.
   b. Fiber Core Diameter: 62.5 microns.
   c. Construction: Dielectric, tight-buffered; UV resistant, flame-retardant black jacket.
   d. Manufacturer:
      1) 12 Fiber Count: Corning FREEDM® One Tight-Buffered Cable Riser, P/N 012K8F-31130-29 (Multimode); No substitution.
      2) 2 Fiber Count: Corning: FEEDM® Fan-Out Tight Buffered Cable Riser, P/N 002K6F-31330-29 (Multimode); No substitution.
      3) 12 Fiber Count: Corning: FREEDM® One Tight-Buffered Cable, Riser; P/N 012E8F-31131-29 (Single Mode); No substitution.
4. Color Coding:
   a. Signal Cables: Comply with ICEA S-82-552, “Method 9”, Table E-2. In addition, number multiple pairs, triads, and quads.
   b. Thermocouple Extension Wire: ANSI MC96.1 and ICEA S-82-552, Table E-4.
   c. RTDs:
      1) 3-Wire: Black, White, and Red.
      2) 4-Wire: One pair red and black and other pair green and white.

D. General-purpose building conductor used on interior lighting circuits and general-purpose branch circuits routed entirely in conduit shall be single conductor.

1. Voltage rating: 600V.
2. Conductor: Class B, solid or stranded, annealed, uncoated copper, minimum size No. 12 AWG.
3. Insulation: PVC complying with physical and electrical requirements of UL for type THHN/THWN.
4. Jacket: Overall clear nylon jacket applied over conductor insulation, UL-listed as gasoline and oil resistant.
5. Provide conductor sizes No. 8 AWG and smaller in colors to match wire color-codes. Sizes No. 6 AWG and larger shall be color-coded with field-applied tape.
6. Rated continuous operating temperature shall be 90 degrees C in wet and dry locations for operation at maximum 75 degrees C.

E. Single-conductor, low-voltage power cable for motors, feeders, branch circuits, and DC circuits routed in conduit, duct bank, or cable tray:

1. Voltage rating: 600V.
2. Conductor: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG.
3. Insulation: Ethylene propylene rubber (EPR), complying with physical and electrical requirements for NEC Type XHHW-2.
4. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked low-smoke, non-halogen polyolefin (XLPO).
5. Conductor sizes No. 8 AWG and smaller shall be provided in colors to match wire color-codes. Sizes No. 6 AWG and larger may be color-coded with field applied tape.
6. Wire shall be identified by surface marking indicating manufacturer, conductor size, conductor material, voltage rating, UL symbol, and listed type.
7. Cables smaller than No. 1/0 AWG shall be routed entirely in conduit and duct bank in. Sizes No. 1/0 AWG and larger may be routed in cable tray, if so rated.
8. Conductors shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and UL VW-1 vertical flame test.
9. Temperature rating shall be 90 degrees C for normal operation in wet or dry locations.

F. Multiconductor, low-voltage power cables for motors, feeders, and branch circuits routed in cable tray, conduit or duct bank:

1. Voltage rating: 600V.

2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG.
3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO), complying with physical and electrical requirements for NEC Type XHHW-2.
4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; cross-linked, low-smoke, non-halogen polyolefin (XLPO).
5. Phase conductors shall be cabled together with Class B stranded, uncoated copper grounding conductor and fillers. Ground wire size shall comply with requirements of UL 1277.
6. Cover cable assembly with helically applied polyester binder tape with minimum 10 percent overlap.
7. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing as suitable for cable tray use.
8. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
9. Conductors shall be temperature rated for 90 degrees C maximum continuous operating temperature in wet or dry locations.

G. Multiconductor, low-voltage power cables for motors fed from adjustable speed drives, any installation.

1. Voltage rating: 600V.
2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 10 AWG.
3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) complying with physical and electrical requirements for NEC Type XHHW-2.
4. Jacket: Flame-retardant, polyvinyl chloride (PVC).
5. Armor/shield: Continuously welded and corrugated high conductivity aluminum.
6. Ground conductors: Three segmented Class B strand, annealed copper conductors sized to meet requirements of UL 1569.
7. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing.
8. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL-approved and marked with FT-4 designation.
9. Conductors shall be temperature rated for 90 degrees C maximum continuous operating temperature in wet or dry locations.

H. Multiconductor cable for control, interlocks, current transformers (CTs), voltage transformers (VTs), meters, and relays routed in cable tray and conduit:

1. Voltage rating: 600V.
2. Sizes:
   a. Motor control, switchgear and breaker control, interlock control, metering, relaying, and general power control circuits shall be minimum size No. 14 AWG.
   b. CT and VT circuits shall be minimum No. 10 AWG.
3. Conductors: Annealed, bare copper, Class B, stranded.
4. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO), complying with physical and electrical requirements for NEC Type XHHW-2.
5. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked, low-smoke, non-halogen polyolefin (XLPO).
6. Conductors shall be cabled together with nonhygroscopic fillers.
7. Cover cable assembly with helically applied binding tape with minimum 10 percent overlap.
8. Marking:
   a. Insulated conductors shall have colored insulation meeting ICEA Method 1, Table 2 color code to identify conductors.
   b. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and UL listing as rated for cable tray.
9. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
10. Temperature rating shall be 90 degrees C maximum continuous operating temperature in wet or dry locations.

I. Instrumentation cable installed indoor or outdoor routed in cable tray, conduit, and ducts:

1. Voltage rating: 600V.
2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 16 AWG.
3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO).
4. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked, low-smoke, non-halogen polyolefin (XLPO).
5. Pairs/triads: Each twisted with lay not exceeding 2 inches.
6. Color code: Pairs black/white, Triads black/white/red.

7. Assembly:
   a. Each pair or triad shall be cabled together with aluminum/polyester tape shield helically wrapped with minimum lap of 15 percent of tape width and isolation tape. Entire cable assembly shall have overall aluminum/polyester tape shield helically wrapped.
   b. Flexible strand tin-coated No.18 AWG copper drain wire shall be helically wound between twisted conductors and tape shield.
8. Each instrumentation cable shall be identified by means of surface ink printing indicating manufacturer, conductor size, and quantity, UL listing.
9. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
10. Temperature rating shall be 90 degrees C maximum continuous operating temperature in wet or dry locations.

J. Thermocouple extension cable circuited in cable tray or conduit:

1. Voltage rating: 600V.
2. Conductors: Minimum No. 16 AWG solid alloy (+Chromel / -Constantan) in accordance with ANSI and ASTM/ISA Type EX, KX or JX as indicated on the Drawings.
3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO).
4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; cross-linked, low-smoke, non-halogen polyolefin (XLPO).
5. Color code: Yellow (+Chromel) and red (-Constantan), meeting requirements of UL, type “PLTC”.
6. Assemble insulated conductors with 1.5 to 2.5-inch twisted lay.
7. Assembly: Provide with helically applied, laminated aluminum/polyester tape shield, with minimum lap of 15 percent of tape width. Flexible strand tin-coated No.18 AWG copper drain wire shall be helically wound between twisted conductors and tape shield.
8. Each thermocouple cable shall be identified by means of surface ink printing indicating manufacturer, conductor size, UL listing as “PLTC,” thermocouple type.
9. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
10. Temperature rating shall be 90 degrees C maximum continuous operating temperature in wet or dry locations.

K. Provide high-temperature wire around process equipment operating at temperatures exceeding standard cable ratings.

1. Voltage rating: 600V.
2. Temperature rating: Up to 1,000 degrees C.
3. Conductor: Stranded, “A” nickel.
4. Insulation: Layers of ceramic fiber braids.
5. Jacket: Overall metallic sheath.

L. Category 6 communication cable circuited in tray, conduit or used for field wiring internal to cabinets.

1. Conductor: Solid, bare copper minimum No. 23 AWG.
2. Insulation: Fluorinated ethylene propylene (FEP) insulated singles.
3. Insulated conductors: Unshielded, twisted four pairs enclosed with a spline fluorinated ethylene propylene filler material.
4. Cable assembly shall be covered with clear “Flamearrest” jacket, sequentially marked at 2-foot intervals. Ripcord shall be integrally installed to allow easy removal of jacket material.
5. Each communication cable shall be identified by means of surface ink printing indicating manufacturer, model, or catalog number. Cable shall meet TIA/EIA Draft 9A CAT6.
6. Cables shall be capable of passing UL flame test Type CMP.

M. Twin-axial communication cable installed indoors in cable tray and conduit:

1. Voltage rating: 600V.
2. Conductor: One pair, bare copper, No. 18 AWG with 7 by 26 stranding.
3. Insulation: Flame-retardant polyolefin.
4. Assembly: Aluminum foil-polyester tape shield with No. 20 AWG, 7 by 28 stranded tinned copper drain wire with 100 percent shield coverage, and tinned copper braid shield with minimum 55 percent coverage. Overall cable assembly shall be Type “PLTC”.
5. Jacket: Polyvinyl chloride (PVC).
6. Cable shall be UL-listed 1581 for flame resistance.

N. Temperature rating shall be 75 degrees C in dry maximum operating temperatures in dry locations.

PART 3 EXECUTION

3.01 PACKAGING AND SHIPPING

A. Reel Construction:

1. Standard non-returnable wood reels and meet requirements of NEMA WC 26. These reels, while using the most economic construction, must withstand shipping, normal handling in the field, and outdoor storage up to three years in all weather conditions.
2. Reels 36 inches and larger must have steel arbor hole inserts.
3. Plywood flange reels are not acceptable.
4. Each reel of cable protected by a weather-resistant covering of suitable grade to meet the requirements for Class 4, extra-heavy duty physical protector in accordance with NEMA WC 26.

B. Reel Identification:

1. Each reel must have a visible waterproof tag on the outside of each flange.
2. Tags shall be 4 inches by 6 inches and larger for a total of two tags per reel.
3. Tags must include:
   a. Job name.
   b. Supplier purchase order number.
   c. Purchase order line item number.
   d. Cable description.
   e. Cable code.
   f. Cable length.
   g. Sequential footage markers which match exposed ends.
   h. Gross weight of the reel.
   i. Manufacturer name.
   j. Non-repetitive reel number (matches packing slip).
   k. Custom reel identifier which will be provided to Supplier at the time of release for shipment.
   l. Storage requirements shall be shown on reel tags.

C. Delivery:

1. Reels must be transported and delivered standing on flanges.
2. If palletized, reels must be standing on flanges and strapped to pallet.
3. Cable reels must be delivered on flat bed only. Material must be tarped.
4. Each cable reel must have 3 feet exposed test lead on each end.

D. Storage and Handling:

1. Storage: Protect cable from elements during storage.
2. Handling: Do not remove protective lagging from reels until ready to commence pulling operations.

END OF SECTION

SECTION 26 05 33
CONDUIT INSTALLATION

PART 1 GENERAL

1.01 SUMMARY

A. This Specification covers the requirements for the installation of electrical conduit systems.

B. Metallic and Nonmetallic conduit, as well as flexible conduit, fittings, and conduit bodies are covered by this Specification.

1.02 REFERENCES

A. The material provided and methods used shall be in accordance with, but not limited to the following Codes and Standards:

1. National & Local Electric Codes.
2. UL.
3. American Society for Testing and Materials (ASTM).
4. National Electrical Manufacturers Association (NEMA).
5. Insulated Cable Engineers Association (ICEA).
6. Institute of Electrical and Electronic Engineers (IEEE).
7. American National Standards Institute (ANSI).

B. In case of conflict between the requirements of the various parts of these Documents, the requirements of the different parts shall govern to the extent of such conflict in the following sequence: mandatory governmental regulations; the Specification Data Sheets and Drawings provided by the Engineer; this Specification; and the referenced industry codes and standards.

C. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

1.03 DEFINITIONS

A. Drawings: Drawings includes all technical Drawings and Documents used to define the system(s) and equipment specified herein.

B. Conduit Bodies: A portion of a conduit system that provides access through a removable cover or covers to the interior of the raceway.

C. Conduit Fittings: Fittings at the end of a conduit portion, such as a coupling or nipple to provide for additional conduit unit connection or terminus.

D. Electrical Metallic Tubing: A comparatively thin walled raceway for cable installation.

E. Hazardous Locations: Those locations indicated on the Drawings that require special consideration in selection of equipment, e.g., explosion proof areas, due to atmospheric conditions; reference NEC for area classification criteria.

F. Minimum Bending Radius: The minimum radius around which a cable must be installed in order to maintain insulation integrity.

G. Minimum Pulling Radius: The minimum radius through which a cable can be pulled and avoid insulation damage. Note that this includes all components of the pull, including the cable reel, sheaves and blocks around which the cable is pulled, the raceway itself, as well as temporary geometries induced by the pull setup.

H. Pullboxes: Conduit fittings that provide a pull point for cable installation.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the Documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Manufacturer’s data cut sheets.

B. Conduit Schedule; a conduit schedule shall be maintained for all installed conduits recording the following information:

1. Conduit Number.
2. Conduit Type.
3. Conduit Size.
4. Conduit run Length.
5. Conduit FROM equipment tag.
6. Conduit TO equipment tag.
7. Listing of cable numbers installed in conduit.
8. Conduit fill tabulation.
9. Conduit Hazardous Area boundary flag (Y/N); this ‘flag’ is true/Yes if conduit required hazardous area seal to be installed in conduit.

PART 2 PRODUCTS

2.01 CONDUIT

A. Rigid Metallic Conduit:

1. Rigid metal shall be hot dip galvanized steel and conform to ANSI C80.
2. Rigid metal conduit shall be used where indicated on the Drawings.
3. Minimum conduit size shall be per Section 26 00 00, Electrical General Requirements. Conduit sizes from 1 to 6 inch shall be in whole and half sizes.

B. Rigid Aluminum Conduit:

1. Rigid Aluminum Conduit shall conform to ANSI C80.
2. Rigid Aluminum Conduit shall be used where indicated on the Drawings, and in general should be used in indoor above grade runs other than lighting circuits.
3. Minimum conduit size shall per Section 26 00 00, Electrical General Requirements. Conduit sizes from 1 to 6 inch shall be in whole and half sizes.

C. Rigid PVC:

1. Rigid PVC conduit shall be used where indicated on the Drawings, and in general should be used in all below grade applications unless otherwise noted.
2. Schedule 40 is for concrete encased applications and as indicated on the Drawings. Schedule 80 is for use in direct-buried or exposed applications.
3. Minimum conduit size shall per Section 26 00 00, Electrical General Requirements. Conduit sizes from 1 to 6 inch shall be in whole and half sizes.

D. Liquid-tight Flexible Metallic Conduit:

1. Liquid-tight Flexible Metallic Conduit shall be used where indicated on the Drawings, and in general is used for connection to equipment, cable trays, motors, devices, instruments, and any equipment that will need service in the future.
2. Minimum conduit size shall be per Section 26 00 00, Electrical General Requirements. Conduit sizes from 1 to 6 inch shall be in whole and half sizes.

2.02 CONDUIT BODIES

A. In order to avoid galvanic corrosion, all conduit bodes shall be of the same material as the conduit to which they are installed.

B. C’s, LB’s LL’s, LR’s, T’s and TB’s may be used as pull points. Care must be exercised that the internal radius of the body does not exceed the minimum radii of the cables to be installed.

2.03 CONDUIT FITTINGS

A. All fittings shall come complete with a gasket and cover. The cover shall be made of the same material as the fitting and by the same manufacturer.

B. Conduit couplings shall be of the same material as the conduit to which they are attached.

C. Nipples shall be installed at the end of conduit runs. Bare threads at a cable exit are not acceptable.

D. Watertight Hubs shall be Meyers, Appleton "HUB" or "HUB-U" Series, or Thomas & Betts "370" Series, “Or-equal.”

E. Unions shall be Appleton Type “EC” of Thomas & Betts “Erickson Coupling”. Watertight conduit unions shall be Crouse Hinds Type UNF.

F. Liquid-tight Flexible Metallic Conduit Fittings shall be Appleton “ST” series, “Or-equal.” All fittings for liquid-tight flexible metallic conduit fittings shall bear the UL label.

G. All metal conduit fittings shall conform to the requirements of ANSI/NEMA FB1 and UL 514 where these standards apply. For rigid steel conduit provide galvanized iron or galvanized steel fittings or cast malleable ferrous metal threaded fittings. For rigid aluminum conduit provide copper free threaded aluminum fittings.

H. Provide insulated bushings with insulating inserts in metal housings for the termination of all conduit not terminated in hubs and couplings. Grounding type-insulated bushings shall be provided for all conduit containing power circuits and all unused conduits in ductbank risers. Standard bushings shall be galvanized for rigid steel conduit and aluminum for rigid aluminum conduit. All metal type bushings with insulated throat shall come complete with a grounding lug and attachment means sized properly for the purpose. The grounding lug shall be attached to the bushing with hardware so as not to allow movement of the lug after tightening.

2.04 CONDUIT BODIES AND FITTINGS IN HAZARDOUS LOCATIONS

A. All fittings shall be UL listed for the specific hazardous area classification.

B. Where indicated on the Drawings, explosion-proof fittings shall be used.

C. Appleton, O-Z Gedney, or Crouse-Hinds explosion proof seals shall be used at hazardous area boundaries. Seals installed vertically shall be the drain type. Type "GUA" boxes with sealing covers may be used as seals. Use Supplier's recommended fiber filler and cement.

2.05 PULLBOXES

A. Pullboxes can be installed in conduit runs to ease the cable installation, and to meet the maximum bending requirements of the National Electric Code.

B. Pullboxes shall be selected such that the bend and pull radii of the cables is not exceeded during the cable pull.

2.06 CONDUIT SUPPORTS

A. Maximum Spacing Between Supports, Horizontal Runs:

1. Maximum spacing shall not exceed any such dimensions stated on the Drawings.
2. If such dimensions are not specified, the following spacings shall not be exceeded.

Conduit Material Trade Size	**Rigid Metallic**	**Rigid Aluminum**	**Schedule 40 PVC**	**Schedule 80 PVC**
1"	12 feet	12 feet	3 feet	3 feet
1-1/2"	14 feet	14 feet	5 feet	5 feet
2"	16 feet	16 feet	5 feet	5 feet
3"	20 feet	20 feet	6 feet	6 feet
4"	20 feet	20 feet	7 feet	7 feet
5"	20 feet	20 feet	7 feet	7 feet
6"	20 feet	20 feet	8 feet	8 feet

B. Maximum Spacing Between Supports – Vertical Runs:

1. Maximum spacing shall not exceed any such dimensions stated on the Drawings.

2. If such dimensions are not specified, the following spacings shall not be exceeded.

Rigid Metallic	20 feet
Rigid Aluminum	20 feet
Schedule 40 PVC	8 feet
Schedule 80 PVC	8 feet

C. Supports Near Equipment and fittings: Conduit should be supported within 3 feet of any fitting or body as well as equipment. In no case shall the support placement exceed 5 feet from the equipment, fitting, or body.

2.07 CONDUIT SEALS

A. Conduit shall be sealed after cable installation at equipment or panel entry.

B. Fireproofing foam shall be Dow-Corning 3-6548 Silicone RTV Foam.

2.08 PENETRATION SEALS

A. At wall and floor penetrations, the void space between the conduit and the wall shall be sealed.

2.09 EXPANSION FITTINGS AND FLEXIBLE CONDUIT

A. For runs over 100 feet in length, expansion fittings shall be installed, to allow for thermal expansion:

1. Exposed Expansion Fittings shall be O.Z. Gedney Type "AX" or "EX" expansion fittings.
2. Flexible Metallic Conduit is acceptable to satisfy this requirement.

2.10 JOINT LUBRICANT

A. Joint Lubricant shall be Thomas & Betts KOPR-SHIELD “Or-equal” for steel conduit.

B. Thomas & Betts ALUMA-SHIELD “Or-equal” shall be used for aluminum conduit.

2.11 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. All conduits shall be identified with its appropriate conduit number by means of a self-adhesive tag or engraved tag; where outdoors, engraved tag shall be used. Letters of tag shall be at least 2 inches in height. Conduits shall be labeled every 100 feet maximum, at every junction, and at conduits end. Identifying letters shall be black on yellow background.

PART 3 EXECUTION

3.01 PREPLANNING

A. Route, Bend, Fitting, and Body Requirements:

1. The conduit route shall account for the minimum bend and pull radii of the cables to be installed. In no case shall the conduit radii exceed this requirement.
2. In no case shall the route contain more than 360 total degrees of bend between pull points.

B. Receiving and Storage:

1. Conduit shall be inspected for damage prior to being accepted on Site.
2. All conduit shall be stored above grade with appropriate covering to protect it from corrosion and entrance of debris. All PVC conduit shall be protected from sunlight.

3.02 INSTALLATION

A. All conduit shall be installed in accordance with NEMA “Standard of Installation” and per seismic zone conditions and the “Site Conditions” portion of the Specification. All conduit installation shall adhere to NEC requirements.

B. Conduits and supports shall be arranged in a neat and organized manner. All overhead conduits shall be installed such that a minimum of 8 feet of clear space is maintained, including bottom of supports. Conduit shall be installed in a manner that does not hinder access to other equipment and does not create tripping or step-over hazards. Further, conduit shall be installed where one can walk under conduit or easily step over it without such conduit posing the aforementioned tripping hazard.

C. The installation of adhesives, for both metallic and nonmetallic conduit, shall be in accordance with the manufacturer’s instructions.

D. All supports shall be hot dipped galvanized coated steel or malleable iron straps.

E. Related conduits shall be grouped together and supported using a conduit rack. The conduit rack shall be constructed of hot dipped galvanized steel or Uni-strut and shall provide space on each layer for 10 percent future conduits. Where above grade conduit is to be routed in pipe racks the conduit(s) shall be securely and adequately supported and grouped in a selected portion of the pipe rack.

F. Install supports in a manner that does not interfere with or weaken the bolts or the supporting structure. Obtain the Engineer's written approval prior to drilling, welding, or cutting any structural steel.

G. Exposed conduit shall be routed parallel and perpendicular to walls, structures, columns, ceilings, etc.

H. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

I. Adequate clearance between conduit and piping shall be maintained. A minimum of 12-inches clearance shall be maintained between conduit and surfaces with temperatures exceeding 104 degrees F. Conduit that is installed near piping must consider and provide sufficient space for the possibility of pipe insulation that will be installed at a later date.

J. Conduit shall be cut square using a saw or pipe cutter and cut ends shall be de-burred. Conduit shall be threaded with NPSM type threading dies only.

K. Bring conduit to shoulder of fittings; fasten securely. Conduits found to have more than 2 threads showing after installation shall be removed and re-installed (No running threads).

L. Join nonmetallic conduit using cement as recommended by Manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply a full even coat of cement to the entire area to be inserted in the fitting and allow the joint to cure for a minimum of 20 minutes.

M. When conduit attachment to electrical equipment is subjected to moisture, water, or other liquid, a sealing type of conduit connector shall be used such as a Meyers Hub. This type of connector shall be made wrench tight to maintain an adequate seal and effective ground continuity.

N. Metallic conduit attachment to all electrical equipment, such as junction boxes, pull boxes, switches, etc., shall be made with steel locknuts. Grounding type insulated bushings shall be used for complete grounding continuity as required on the Drawings. Electrical continuity shall be maintained through all metallic conduit connections.

O. Conduits with ends terminating at cable tray shall have their ends sealed with duct seal or approved waterproof foam after all conductors have been installed.

P. Conduit terminating at cable tray shall be terminated horizontal or parallel to the cable tray to prevent rainwater from entering the conduit system. It is unacceptable to terminate conduit at cable tray with the conduit facing upwards.

Q. Conduit raceway systems will require a low point drain at all outdoor and non-air-conditioned locations. The low point drain shall be installed at the lowest point in the raceway system to ensure that there is no water accumulation in the raceway. A Crouse hinds ECD Universal type drain is an acceptable drain. The use of a close nipple and a stainless steel bug screen with a hard fiber bushing shall be approved for non-classified areas only.

R. In Hazardous area locations only Crouse Hinds “or-equal” EYD Seals and drains shall be used. The raceway should be inclined such that water will not accumulate in enclosures or seals. The system shall be installed to ensure the fluid will flow towards the low point drain and discharge. The drain location shall be such that the discharge does not splash on installed equipment.

S. All circuits located in hazardous areas must be properly sealed according to the NEC and verified prior to energizing.

T. Suitable caps shall be used to protect installed conduit against entrance of dirt and moisture prior to completion of installation and once complete, prior to the pulling of cable.

U. All spare conduits shall be identified and shall have sealing pennies/plugs and grounding bushings installed.

V. The preferred conduit entrance to any device shall be from the bottom. If this is not feasible, then side entry is the next preferred method. Top entry shall only be used as the least favorable option. Entrances into the top of any device or enclosure shall be approved by Engineer prior to installation.

W. All rigid conduit stub-ups through concrete shall be a minimum of 1-inch plus the length of the threads above finished concrete elevations. No couplings shall be flush with the floor. Conduit shall be installed in such a manner so as not to allow couplings or nipples to be installed between the maximum elevation for stub-ups and a minimum of 1-inch coverage of concrete below finished elevations. Conduits shall be verified plumbed with a four foot level by extending the conduit with a nipple a minimum of 4 feet above final elevation and then plumbing before supporting. Unused conduits shall not extend more than 12 inches above final elevation. The Contractor shall slope all underground conduits for proper drainage as specified on the Drawings.

X. No teeth or wrench marks shall be left on the conduit or plug.

Y. Liquid Tight Flexible Conduit:

1. Light tight flexible conduit shall be installed with sufficient slack to prevent excess stress on conduit connectors.
2. All liquid tight flexible conduit 1-1/2 inch and greater shall have an external bonding jumper installed to maintain electrical continuity between the two fittings.
3. Liquid tight flexible metal conduit shall be installed at the end of nonflexible conduit runs near the terminating equipment. Liquid tight flexible metal conduit shall be limited to a length based on the following table:

Raceway Size	Max Length
1/2″ to 1-1/2″	36″
1 -1/2″ to 3″	48″
3-1/2″ or greater	60″

4. Flexible metal conduit shall be securely fastened in place within 1 foot of box, equipment, or conduit termination.
5. Where conduit is subject to high temperatures, the appropriate liquid tight flexible metal conduit temperature rating shall be used.

Z. All conduits shall be identified with its appropriate conduit number as defined elsewhere in this Specification section.

3.03 BENDING

A. Metallic Conduit:

1. Factory Bends: Factory manufactured elbows are acceptable, but must meet or exceed all Specification requirements.
2. Field Bends:
   a. All bends shall be made such that the effective inner diameter is not reduced.
   b. Not more than three 90-degree elbows or equivalent bends up to 360 degrees shall be installed in any run between pulling and access fittings.
   c. All bends shall have a bend radius equal to or greater than the minimum bending radius allowed by the NEC.

B. Non-metallic Conduit:

1. Factory Bends: Factory manufactured elbows are acceptable, but must meet or exceed all Specification requirements.
2. Field Bends:
   a. All bends shall be made such that the effective inner diameter is not reduced.

b. PVC shall be heated using equipment and methods recommended by manufacturer.

3.04 INSPECTION PRIOR TO CABLE PULL

A. All conduit shall be inspected for burrs or other irregularities that may cause cable damage.

B. In situations where nipples have not been installed, or there is elevated risk of damage to the jacket during the pull, softeners shall be installed to preclude cable damage during the pull.

C. Swab and clean all conduit prior to cable pulling.

D. All conduits intended for medium or high voltage cable shall be proven de-burred and full-inside-diameter (i.e. no reduced diameter cross sections due to conduit deformation) with use of proving mandrel prior to cable installation.

END OF SECTION

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SECTION 26 05 73
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 SUMMARY

A. This Specification covers the technical requirements for electrical systems analysis for the electrical equipment and systems within the Work.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with the Section 01 33 00, Submittal Procedures. In addition to these Documents, supply engineering data, as listed below:

1. Load Flow Study.
2. Short Circuit Study.
3. Harmonics Study.
4. Protective Device Coordination Study; submit after approval of the Short Circuit Study.
5. Arc Flash Study.
6. Relay-ready program files once all studies have been approved and a minimum of 45 days prior to commissioning of protective relays.

1.04 QUALITY ASSURANCE

A. Short circuit and protective device coordination studies shall be prepared by a professional electrical engineer registered in the State of Louisiana, in accordance with IEEE 242 and IEEE 399.

1.05 GENERAL REQUIREMENTS

A. The initial short circuit study must be submitted, reviewed, and approved before the Engineer will approve any Shop Drawings for any major electrical equipment. It is imperative that the Supplier begin this Work immediately after award of the contract. This task requires extensive coordination and may potentially require field data collection, verification of existing equipment make and model numbers, and data input from others. Failure of the Supplier to gain approval of the short circuit study before Shop Drawings for any major electrical equipment will result in rejecting the Shop Drawings without review due to the lack of design basis for the equipment fault duty.

B. The Owner has retained a subconsultant to perform systems analysis of the Owner's entire power system in OTI ETAP software. Coordinate with the Owner and the Owner's subconsultant to obtain the required data, if available, to establish fault current at the Work electrical interfaces.

C. Based on the Drawings and system data collected, prepare a network model specific to the Work in OTI ETAP software. Contractor shall verify with Owner what version of OTI ETAP software to use, and where the Owner does not specify this, the Contractor shall use the latest software version available for this task.

D. Using the network model as the basis for the required electrical system studies.

E. Arc Flash labelling is required on all electrical equipment installed as part of the Work.

1.06 SEQUENCING AND SCHEDULING

A. The initial and complete short circuit study must be submitted, reviewed, and approved before Engineer will approve Shop Drawings for electrical equipment included in the Work.

B. The initial and complete protective device coordination study will only be accepted for review after approval of short circuit study.

C. The short circuit, protective device coordination, and arc flash studies shall be updated prior to Project Substantial Completion. Utilize characteristics of as-installed equipment and materials.

1.07 OTHER REQUIREMENTS

A. Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings.

B. Perform complete fault calculations for defining source combination(s).

C. Source combination may include present and future power supply circuits, large motors, or generators.

D. Existing Equipment:

1. Include fault contribution of existing motors in the study.
2. Obtain required existing equipment data.

E. Device coordination time-current curves for medium and low voltage distribution system(s).

PART 2 PRODUCTS

2.01 COMMON

A. General:

1. All cable and electrical equipment impedances shall be based on relevant system frequency.
2. Use cable impedances based on copper conductors.
3. Use bus impedances based on copper bus bars.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use medium voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
6. Use 600V cable reactances based on use of typical dimensions of XHHW conductors.
7. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagrams.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Impedance diagrams.
6. Zero sequence impedance diagrams.
7. Typical calculation.
8. Tabulations of calculated quantities.
9. Results, conclusions, and recommendations.

2.02 LOAD FLOW STUDY

A. Calculate load flow values to prove adequacy of system components.

B. Bus loading shall include all discrete loads within the Work. The use of ‘lump loads’ will not be accepted.

C. Scenarios of operation for computation of load flow values shall be coordinated with the Engineer; a minimum of four configuration cases shall be studied and evaluated separately:

1. Minimum system load.
2. Maximum system load.
3. 70 percent system load.
4. Other.

D. Provide nominal circuit current, voltage, and voltage drop values.

E. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Circuit elements are within their nominal operating ranges.

2.03 SHORT CIRCUIT STUDY

A. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Medium voltage bus in the Work.
2. Low voltage bus in the Work.
3. Where applicable, derate all short circuit current values for 25Hz power supply.

B. Scenarios of operation for computation of short circuit currents shall be coordinated with the Engineer; a minimum of eight source configuration cases shall be studied and evaluated separately.

C. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

D. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

E. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Adequacy of medium voltage and low voltage equipment bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Cable and busway sizes for ability to withstand short circuit heating under short circuit conditions.

2.04 HARMONICS STUDY

A. Calculate system harmonics at the point of common coupling, generally equivalent to the Work electrical interfaces, as well as at all busses within the Work.

B. Scenarios of operation for computation of system harmonics shall be coordinated with the Engineer; a minimum of four configuration cases shall be studied and evaluated separately:

1. Minimum system load.
2. Maximum system load.
3. 70 percent system load.
4. Other.

C. Provide nominal total harmonic distortion (THD) and all prominent, greater than 10 percent distortion, multiples.

D. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Circuit elements are within their nominal operating ranges.

2.05 PROTECTIVE DEVICE COORDINATION STUDY

A. Separate coordination studies are required for all scenarios of operation specified in Short Circuit Study.

B. Protective device coordination time-current curves (TCC) for electrical system in the Work, graphically displayed on conventional log-log curve sheets. Provide device coordination curves with protective device settings for all equipment in the Work, including protective devices at the Work electrical interfaces.

C. Each TCC sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet.

D. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

E. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous setting(s).

F. TCCs shall be provided to include, at a minimum, in addition to the equipment and/or system elements noted above:

1. Fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.

2. Circuit breaker trip devices, including manufacturers tolerance bands.
3. Transformer full-load currents at 100 percent and 600 percent.
4. Transformer magnetizing inrush currents.
5. Transformer damage curves.
6. ANSI transformer withstand parameters.
7. Ground fault protective device settings.
8. Other system protective devices.

G. Separate protection characteristic curves devices by at least 0.4-second time margin.

2.06 ARC FLASH HAZARD ANALYSIS:

A. Calculate Arc Flash energy levels for all electrical equipment in the Work for all operating scenarios specified in Short Circuit Study and TCC characteristics determined in the Protective Device Coordination Study. Coordination with and/or modification of the Protective Device Coordination Study shall be such that incident energy levels are a maximum Level 4 and are subject to Engineer's approval. Prepare Arc Flash warning labels based on approved operating scenario, generally the worst case.

2.07 TABULATIONS

A. General Data:

1. Short circuit reactances of rotating machines.
2. Cable and conduit material data.
3. Bus data.
4. Transformer data.
5. Circuit resistance and reactance values.
6. CT saturation curves.

B. Short Circuit Data:

1. Fault impedances.
2. X to R ratios.
3. Asymmetry factors.
4. Motor contributions.
5. Short circuit kVA.
6. Symmetrical and asymmetrical fault currents.

C. Protective Device Settings (as applicable):

1. Relays: All protective device settings necessary to have a relay-ready settings file.

2. Circuit Breakers:
   a. Adjustable pickup.
   b. Adjustable time-current characteristic.
   c. Adjustable instantaneous pickup.

2.08 STUDY ANALYSES

A. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit and coordination studies.
6. Comments or suggestions.
7. Study elements requiring confirmation.
8. Seal of Professional Engineer licensed in the State of Louisiana.

B. Suggest changes and additions to equipment rating and/or characteristics.

2.09 DATA COLLECTION

A. Supplier shall furnish all field data as required by the power system studies. The Supplier performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Supplier with a listing of required data immediately after award of the contract. The Supplier shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. The Supplier shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by Protective Device Coordination Study.

B. Notify Engineer in writing of any unprotected equipment.

C. Affix Arc Flash Hazard warning labels on electrical equipment in the Work.

END OF SECTION

SECTION 26 05 75
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. General electrical requirements for equipment and services including, but not limited to:

1. Field wiring.
2. Low voltage field wiring.
3. Low voltage splices and terminations.
4. Low voltage cabinets and miscellaneous electrical enclosures.
5. Equipment safety grounding.
6. Low voltage fuses and fuse blocks.
7. Electrical meters.
8. Control relays and switches.
9. Pushbuttons.
10. Indicating lights.
11. Alarm and trip contacts.
12. Low voltage starters.
13. Low voltage circuit breakers and disconnect switches.
14. Auxiliary power transformers.
15. Power factor correction capacitors.
16. Enclosures.
17. Outlet, pull, and junction boxes.
18. Plates and covers.
19. Wiring devices.
20. Welding receptacles.
21. Panelboards.
22. Welding.
23. Shop finish.
24. Rust-inhibiting compounds.
25. Galvanizing.
26. Packaging, identification, and tagging.
27. Nameplates.
28. Trip setting coordination.
29. Fireproofing and fire ratings.
30. Testing and demonstration.

B. Substitutions/Exceptions:

1. Note exceptions and advise of deviations, additions, deletions, or other changes recommended to meet specified requirements.

2. Deviations are permitted only if outlined in full detail, and reasons for them are given. Written approval of those deviations will constitute acceptance.

C. Compliance:

1. Design in compliance with this section is responsibility of Supplier.
2. Provide manufacturer's standard products unless otherwise specified or approved.

D. Related Sections, as applicable, and not limited to the following:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

Note: Where a more restrictive or stringent requirement is specified in a Related Section, the more restrictive or stringent requirement shall apply.

1.02 REFERENCES

A. Materials and equipment shall be manufactured to applicable industry Standards including, but not limited to:

1. AISC – American Institute of Steel Construction.
2. AISI – American Iron and Steel Institute.
3. ANSI – American National Standards Institute.
4. ASTM – American Society for Testing and Materials.
5. EIA – Electronic Industries Association.
6. FM – Factory Mutual.
7. IEEE – Institute of Electrical and Electronics Engineers.
8. IES – Illuminating Engineering Society.
9. ISA – Instrument Society of America.
10. NEMA – National Electrical Manufacturer's Association.
11. NETA – International Electrical Testing Association.
12. NFPA – National Fire Protection Association.
13. OSHA – Occupational Safety and Health Administration.
14. UL.

B. All electrical construction shall be performed in accordance with the National Electrical Code, state, local, and Federal Codes, as applicable to the project site.

1.03 DEFINITIONS

A. Not used.

1.04 SUBMITTALS

A. Provide all cut sheets, Shop Drawings, certified drawings, test reports, maintenance and service instructions, and all related data in accordance with Section 01 33 00, Submittal Procedures.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer of supplied equipment shall be recognized in industry for normally supplying the provided equipment.
2. Provided equipment shall meet all applicable Codes and Standards.
3. Manufacturer shall be ISO certified.

B. Installer Qualifications:

1. Installer shall be skilled in trade or craft and shall have thorough knowledge of products and equipment specified and provided.
2. All cutting, drilling, trenching, or channeling necessary to properly install equipment shall be performed by competent, skilled crafts people in a safe, professional manner.

C. Materials and equipment furnished for permanent installation shall be new, unused, and undamaged.

D. Materials and products provided shall contain no asbestos, mercury, or other hazardous materials except where allowed by law.

E. Parts shall be manufactured to United States industry standard sizes and gauges to facilitate maintenance and interchangeability. Metric sized parts shall not be allowed unless specifically requested and approved.

PART 2 PRODUCTS

2.01 DESIGN REQUIREMENTS

A. Equipment and materials provided shall be suitable for intended service and installation at location indicated.

B. Low-voltage auxiliary and control power:

1. Electrical power for AC control and instrumentation equipment:
   a. Provide devices necessary for proper operation and protection of equipment during electrical power supply and ambient temperature fluctuations specified.
   b. Design for continuous operation at any voltage from 85 percent to 110 percent of nominal voltage. Dropout voltage shall be 60 percent of nominal for relays and 75 percent for contactors and starters.
2. Electrical power for DC devices:
   a. Design for continuous operation on ungrounded station battery system, capable of maintaining operation at any voltage from 80 percent to 112 percent of nominal voltage.
   b. Electrical devices served shall not impose a ground connection on the DC power supply system.

C. Auxiliary power:

1. Design auxiliary equipment for low voltage service with electrical power designed to operate from one of the nominal electrical power sources defined in Section 26 00 00, Electrical General Requirements.

2.02 FIELD WIRING

A. Nationally or internationally recognized cable manufacturer shall produce cable provided.

1. Metal-clad cable, NEC Type MC, may not be substituted in place of cable and conduit unless specified otherwise, or unless approved by Purchaser.
2. Comply with code and Project requirements directly associated with use of each cable type.

B. Wiring shall be bare copper with not less than 98 percent conductivity, unless specified otherwise.

2.03 SPLICES AND TERMINATIONS

A. Splices, except in lighting and general purpose power circuits specified below, are not allowed unless specifically indicated on the Drawings or required for connection to equipment.

B. Temperature rating of splices and terminations shall be rated no less than 75 degrees C.

C. Splices allowed in lighting and general-purpose power circuits.

1. Provide wire and cable connectors of high-conductivity, corrosion-resistant material with contact area equal to at least current carrying capacity of wire or cable.
2. General lighting and general-purpose building power circuits:
   a. Twist-type, insulated spring connectors for splices on solid or stranded conductors smaller than No. 6 AWG.
   b. Use indent, hex screw, or bolt clamp-type connectors, with or without tongue for splices on solid or stranded conductors No. 6 AWG and larger.
   c. Apply insulating 600V tape.

D. Insulating tapes and compounds for terminations and splices shall be UL-listed for intended use, location, and voltage by manufacturer.

E. Termination of conductors to equipment with bolted connections:

1. Use compression type lugs.
2. Compression lugs for cables 250 kcmil and larger shall have at least two clamping elements of compression indents, and provision for at least two bolts for joining to apparatus terminals.
3. Crimping hand tools used for securing conductors in compression type connectors or terminal lugs shall be made for purpose and conductor sizes involved.
4. Crimping tools shall be ratchet-type preventing tool from opening until crimp action is completed.
5. Tools shall be product approved by connector manufacturer.

F. Terminals:

1. Conductors larger than No. 4/0 AWG: Terminate to tinned copper bus bar drilled and tapped with standard NEMA sized and spaced holes.

G. Coordinate sizes and types of conductor terminals for 600V power cable terminations in equipment with furnished conductor and terminal connector data.

H. Provide 600V rated terminal blocks for instrumentation and control conductors for connection to circuits external to specified equipment, and for internal circuits crossing shipping splits.

1. Use crimp-on terminals matching termination point terminations in manufacturer-furnished panels. Splices not allowed.
2. Terminal blocks for thermocouple extension wire: Buchanan “Medium Duty” with thermocouple contacts or Marathon 200 Series with Omega Engineering, Inc. Type TL terminal lugs.

3. Furnish with white marking strips.
4. Where permitted by safety codes and standards, provide without covers. Neither step-type terminal blocks nor angle mounting of terminal blocks allowed.
5. Fuses may be mounted on terminal blocks.
6. Maximum two conductors in accordance with termination point.

I. Terminal blocks for external connections shall leave from centrally mounted location, not from individual devices in enclosure, unless shown otherwise on the Drawings.

J. Group terminal blocks in instrument and control compartment for easy accessibility.

1. Provide sufficient space on each side of each terminal block to allow orderly arrangement of leads to be terminated on block.
2. Locate auxiliary equipment in compartments, enclosures, or junction boxes so service personnel will have direct access without interference from structural members and instruments without removal of barriers, cover plates, or wiring.
3. Do not mount terminal blocks in compartments containing cables or buses operating at voltages above 600V.
4. Size for wire sizes of incoming conductors.

K. Install shorting-type terminal blocks nearest current transformer in accessible location for each set of CTs supplied with furnished equipment. No other shorting-type terminal blocks are allowed, unless specified otherwise.

L. Install din-rail mounted miniature circuit breakers for protection of VT circuits on line and load side. Breakers shall have alarm contacts wired to terminal blocks.

M. Terminate each conductor in multiconductor control cable or as shown on the Drawings. Provide 10 percent spare terminals for circuit modifications.

N. Each control switch and lockout relay shall have minimum of four spare normally open and four spare normally closed contacts wired out to terminal blocks.

O. Circuit identification number listed on the Drawings shall be used to identify circuit, positioned as near as possible to end of each conductor on multiple single wire circuits and on cable jacket for multiconductor cables.

P. Cable designations shall be visible after installation without requiring physical movement of cable.

2.04 MISCELLANEOUS ELECTRICAL ENCLOSURES

A. Size junction boxes, pull boxes, and enclosures in accordance with requirements of NEC.

B. Junction boxes and pull boxes 4 inches trade size or smaller in any dimension shall be galvanized malleable iron or cast ferrous metal NEMA rated for installed location. Do not use concentric knockouts.

C. Junction boxes, pull boxes, and miscellaneous electrical enclosures larger than 4 inches trade size in any dimension shall be as follows, unless required otherwise.

1. NEMA rating for miscellaneous electrical enclosures installed in nonhazardous locations:
    a. Indoor:
        1) Dry environmentally controlled area: NEMA 1 or 12.
        2) Noncorrosive wet or hose-down area: NEMA 4.
        3) Corrosive wet or hose-down area: NEMA 4X.
    b. Outdoor:
        1) Corrosive area: NEMA 4X.
        2) Noncorrosive area hose-down or spray area: NEMA 4.
        3) Noncorrosive area nonhose-down area NEMA 3R.
2. Construct noncast-metal miscellaneous electrical enclosures from reinforced steel plate capable of supporting devices mounted on or within enclosure without deflection. Steel plate thickness shall conform to UL requirements.
3. Enclosures shall be of adequate strength to support mounted components during shipment and installation.
4. Conduit entrances shall be field drilled.
5. Miscellaneous electrical enclosures located in outdoor, wet, or hose down areas shall be provided with space heaters. Provide space heaters completely wired within enclosure. Provide following:
    a. Space heater.
    b. Adjustable thermostat with set point temperature indicator.
    c. One miniature circuit breaker protective device.
    d. Space heaters, thermostat, and protection shall not interfere with cable into or out of enclosure, or with maintenance or replacement of devices within enclosure.
    e. Use of space heaters shall not change or discolor any painted surface.
    f. Space heater capacity shall maintain enclosure internal temperature above dew point under specified service conditions.
    g. Space heaters shall be rated for 240 volts ac minimum, and shall be sized for operation on applied voltage of 120 volts ac.

D. Outdoor miscellaneous electrical enclosures with ventilating openings:

1. Louver on outdoor electrical equipment and protect in accordance with NEMA type.
2. Equip openings on outdoor electrical equipment with fine mesh filters and stainless steel bug screens.

2.05 OUTLET BOXES

A. Outlet boxes for concealed wiring systems shall be sheet metal, galvanized or cadmium plated.

B. Boxes shall be minimum 4 inches square, 1-1/2-inch deep, sized to accommodate devices and number of conductors in accordance with NEC. Equip with plaster ring or cover as necessary for flush finish.

C. Exposed conduit systems shall have surface-mounted boxes unless specified otherwise. Boxes for exposed wiring in nonhazardous, noncorrosive, and nonweatherproof locations shall be malleable iron, cadmium finish or cast aluminum alloy, minimum 4 inches square, 1-1/2-inch deep.

D. Enclosures shall be as required for areas in which they are installed and as specified.

1. Boxes shall be installed flush in masonry construction and be designed for intended use.
2. Recessed boxes where fixture will be mounted shall be minimum 4 inches and octagonal in shape or 4 inches square by 1-1/2-inch deep with round plaster ring. Where used as junction box, boxes shall be minimum 4 inches square by 2-1/8 inches deep.
3. Outlet boxes for wall concealed telephone and signaling systems shall be 4 inches square by 1-1/2-inch deep, minimum. Furnish with plaster ring and cover plate.
4. Floor boxes for floor outlets shall be cast-metal with threaded conduit entrances, brass flange ring and brass duplex flap cover plate. Boxes shall be watertight and have leveling and adjustment screws for adjusting cover plate to finished floor. Boxes shall be minimum 4 inches diameter and 3-1/2 inches deep with approved gasket or seal between adjusting ring and box.
5. Floor outlets for combination signaling, data, and power outlets shall be constructed of steel base, PVC housing, and steel bracket to allow feed through wiring as well as activation load-bearing support. Box construction shall meet UL 514A requirements.
    a. Entire housing shall be removable for unrestricted access.
    b. Once assembled, PVC housing shall be capable of carrying 6,000 pound load.
    c. Coordinate outlet requirements with communication system requirements.

6. Floor boxes in 2-hour rated floors shall be secured in cored hole and shall be UL classified and listed for 2-hour rated floors.

2.06 PULL AND JUNCTION BOXES

A. Furnish junction boxes and pull boxes where shown on the Drawings, and where necessary to facilitate pulling wires and cables without damage.

B. Above ground boxes shall be formed from sheet steel, with corners folded in and securely welded with inward flange on each of four edges.

C. Drill box for mounting and attachment of cover; galvanize after fabrication.

D. Cover shall be made of one-piece galvanized steel and provided with stainless steel round head machine screws.

E. Box and cover shall be made of code gage steel or heavier if shown on the Drawings.

F. Boxes shall be minimum 4-1/2 inches deep. Size shall be in accordance with NEC. Use next larger standard size when necessary in accordance with manufacturer standard sizes.

G. Pull and junction boxes shall be furnished without knockouts to allow for field drilling.

H. Enclosures shall be as required for areas in which installed and in accordance with requirements specified.

I. Underground boxes shall be specifically designed and constructed for intended installed location and shall be either pre-formed concrete or PVC. Covers shall be capable of withstanding, without failure, type of traffic in installation area.

J. If pull and junction boxes are exposed in and around architecturally finished surfaces, paint box to match finish of nearby surfaces, unless indicated otherwise.

K. Bolt-on junction box covers 3 feet by 0 inches square or larger, or heavier than 25 pounds shall have permanent rigid handles. Covers larger than 3 feet 0 inches by 4 feet 0 inches shall be split.

2.07 EQUIPMENT SAFETY GROUNDING

A. Install raceway electrically continuous. Conduit and tray shall not be considered to be the only ground conductor.

B. Furnish equipment that is part of integral shipping unit or assembly with bare copper ground conductor extending to central ground connection lug. Lug shall be suitable for field connection to local ground. Electrical equipment shall be considered any device that is energized.

C. Single-point ground connections required for proper operation of electronic equipment shall be insulated from equipment safety ground. Such connections shall be extended, using insulated cable, to single insolated termination point suitable for field connection to appropriate ground system.

D. Conduits that contain power circuits shall have ground conductor installed inside conduit. Ground conductor shall be bonded to equipment, tray, or duct ground at both ends.

E. Provide ground bushing on each conduit containing power circuit. Connect ground bushings together inside enclosure and to enclosure ground lug or ground bus.

1. Use No. 8 AWG conductor for ground bushings trade size 1-1/2 inch and smaller.
2. Ground bushings larger than 1-1/2 inch shall be sized in accordance with requirements of NEC, but in no case shall they be smaller than No. 8 AWG.

F. Ground conductor: Uninsulated, Class B standard, round soft drawn uncoated copper as defined in ICEA S-19-81, unless specified otherwise.

G. Hardware: Clamps, bolts, washers, nuts, and other hardware used with grounding conductor shall be copper, copper alloy, high copper alloy, or silicon bronze.

2.08 PIN AND SOCKET CONNECTORS

A. Not allowed unless shown on the Drawings or is part of Manufacturer’s standard equipment package.

2.09 FUSES AND FUSE BLOCKS

A. Modular-type, Class H screw terminal fuse blocks with Bakelite frame and reinforced retaining clips. Blocks shall be similar in construction and by same manufacturer.

B. Slow-blow fuses: Bussmann Type MDL or Gould Shawmut (Ferraz Shawmut/MERSEN) Type GDL with ampere ratings of 1/4A, 1/2A, 1A, or 2A.

C. Fast-acting fuses: Bussmann Type NON or Gould Shawmut Type OT with ampere ratings of 1A, 3A, 6A, 10A, 15A, 20A, or 30A.

D. Extremely fast-acting fuses: Bussmann Type KAB with ampere ratings of 1A, 3A, 6A, 10A, 15A, 20A, or 30A.

2.10 ELECTRICAL METERS

A. Meters for measuring electrical quantities shall be utility grade, multifunction, switchboard-type with accuracy of plus or minus 0.2 percent or better for volts and amperes, and 0.4 percent for power metering functions.

B. Readouts shall have true RMS capability with at least 1/2-inch high intensity LED displays and be capable of surge withstand exceeding IEEE C37.90.1.

C. Instruments checked in field and found to be inaccurate in excess of allowable percent error shall be returned for replacement without cost to Purchaser.

D. Design meters for operation through 5-ampere current transformer secondary and 120V voltage transformer secondary.

E. Electrical meters shall be provided with communications capability.

2.11 CONTROL RELAYS

A. General purpose, industrial grade auxiliary relays rated 600V.

B. Contacts shall be reversible from N.O. to N.C. in field.

C. Timing relays for critical service: Agastat Series 7000.

2.12 CONTROL SWITCHES

A. Multistage, rotary-type rated 120 volts ac or 125 volts dc, 3A minimum, as required.

B. Handles shall be black, fixed, modern, pistol grip type. Provide engraved black plastic escutcheon plates with targets.

C. Provide with colored LED lamps and nameplates as required.

2.13 PUSHBUTTONS

A. Standard pushbuttons shall be heavy duty, industrial-type rated 120 volts ac or 125 volts dc, 3A minimum, as required.

B. Provide with colored LED lamps and nameplates as required.

2.14 INDICATING LIGHTS

A. Status indicating lights shall be high-intensity, cluster, LED-type for panel mounting.

B. Coordinate indicating light colors with indicated conditions as follows. Indicating lights shall be energized when condition exists and shall be de-energized when condition does not exist:

1. Red: Equipment energized: such as motor running, valve open, or breaker closed.
2. Green: Equipment de-energized: such as motor stopped, valve closed, or breaker open.
3. Amber: Equipment abnormality: such as motor trip, breaker trip, or relay trip.
4. White: Monitoring of control power or trip coil: such as lockout relay trip coil monitor or breaker trip coil monitor. Light is on during normal circuit operation and off during loss of power or loss of coil.
5. Blue: Loss of control power.

2.15 ALARM AND TRIP CONTACTS

A. Alarm contacts for remote annunciation shall be suitable for operation at 120V ac and 125V dc. Contacts shall be rated 0.5A make and break, minimum.

B. Alarm contacts shall be normally closed contacts that open to alarm condition.

C. Trip contacts for remote trip shall be suitable for operation at 125 volts dc and shall be rated 5A make or break, minimum.

2.16 SEPARATELY MOUNTED COMBINATION MOTOR STARTERS

A. Enclosed, 3-phase, full-voltage, nonreversing, unless indicated otherwise.

B. Complete combination starter shall have minimum interrupting rating of 65 kA unless shown otherwise on the Drawings.

C. Starter enclosures shall have enclosure NEMA rating specified herein.

D. Provide combination starter with contactor and integral overload protection; minimum size shall be NEMA 1.

E. Each phase shall have a current sensor for motor running overload, phase loss and phase unbalance protection.

1. Provide Class II ground fault protection; set to 20 percent of maximum continuous ampere rating and have delay of 20 seconds and run delay of 1 second to prevent nuisance trip on start.
2. Single-speed starters shall be furnished with three current sensors. Two-speed starters shall be furnished with six current sensors.

F. Starters shall be furnished with motor circuit protectors rated 600V.

1. Each breaker shall be manually operated with quick-make, quick-break, trip-free toggle mechanism.
2. Starters shall have external manual breaker-operating handle with provisions for up to three padlocks.
3. Access door shall be interlocked with motor circuit protector, so door cannot be opened while breaker is closed except by interlock override.
4. Starter contactor shall mechanically operate auxiliary contacts. Each starter shall include auxiliary contacts required for application, plus two spare NO and 1 spare NC contacts.
5. Provide membrane-style pushbutton control module and LED lights, if indicated on schematics, to control starter functions and indication. Pushbuttons and LEDs shall be clearly identified.
6. Verify and match control power transformers, overload protection, and sizes of starters to actual equipment furnished.
7. Size control power transformers (CPT) to supply control circuit and any additional loading simultaneously. Minimum CPT size shall be 100 volts-amperes for Size 1 starters and 150 volts-amperes for Size 2 and larger starters.
8. CPTs shall have primary leads protected, and one secondary lead protected and one secondary lead grounded. Provide DIN rail-mounted, miniature circuit breakers for protection. Fuses not allowed.
9. Starters for systems with system voltage of 120 volts or less shall not require CPT.
10. Two-speed starters and reversing starters shall be mechanically and electrically interlocked so only one set of contacts can be closed at any one time.

2.17 LOCAL SEPARATE MANUAL STARTERS

A. Separately enclosed manual starters, shall be provided with adjustable, bimetallic, Class 10 ambient-compensated, integral overload relay and fixed magnetic short-circuit trip mechanism designed to trip at 12 times maximum current rating.

B. Starters shall use high-conductivity copper for current carrying parts.

C. Size starters for motors served in accordance with NEC and manufacturer's recommendations.

D. Mount manual starters in enclosures with NEMA rating for area as specified herein.

E. If applicable, starters shall be UL-listed for group installations.

F. Accessories shall be available for auxiliary contacts, trip alarm, under-voltage release, and shunt trip for field installation.

G. Starters shall be pad-lockable with three padlocks in "On" and "Off" position.

2.18 LOCAL SEPARATE CIRCUIT BREAKERS

A. Provide 3-pole, molded-case, separately enclosed circuit breakers of not less than interrupting rating shown on the Drawings at rated voltage.

1. Provide with thermal and instantaneous trip elements.
2. Breakers shall use high-conductivity copper for current carrying parts. Breaker enclosures shall have NEMA type enclosure suitable for the required application.

B. Each breaker shall be manually operated with quick-make, quick-break, and trip-free toggle mechanism. Thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.

C. Circuit breakers shall have "On," "Off," and "Tripped" indication and shall be pad-lockable with three padlocks in "On" and "Off" position.

1. Breakers rated over 70A shall be rated 100 percent and have adjustable electronic trip units.
2. Breakers shall be capable of adding alarm, lockout, shunt trip, and under-voltage as options.

2.19 LOCAL SEPARATE DISCONNECT SWITCHES

A. Three-pole, nonfusible, heavy-duty, rated 600V with continuous current rating as shown on the Drawings and as required by load.

1. Type: Either molded-case or blade.
2. Switches shall use high-conductivity copper for current carrying parts.

B. Switches shall be positive, quick-make, and quick-break mechanisms.

1. Switch assembly plus operating handle shall be integral part of enclosure base.

2. Each switch shall have handle whose position is easily recognizable and which can be locked in “On” and “Off” position with three padlocks. “On” and “Off” positions shall be clearly marked.

C. Switches shall be UL-listed and horsepower rated. Where applicable, switches shall have defeatable door interlocks that prevent door from being opened while operating handle is in “On” position.

2.20 DC MOTOR STARTERS

A. Magnetic starters for DC service shall be suitable for starting 125V dc rated motors unless stated otherwise.

B. Starters shall have same features and capabilities, where applicable, as AC combination and manual starters.

C. Size starters for motor served. Coordinate system requirements with equipment manufacturer’s requirements.

D. Manufacturer: General Electric or Eaton Cutler Hammer.

2.21 AUXILIARY POWER TRANSFORMERS

A. Provide separately mounted transformers as shown on the Drawings.

B. Windings shall be copper.

C. Transformers shall be self-air-cooled, dry-type, capable of wall- or floor-mounting, and enclosed for wiring connection by conduit. In areas where dust and dirt may be normally present, use encapsulated-type transformers.

D. Transformers shall meet or exceed the requirements as defined in IEEE C57.12.01.

E. NEMA enclosure type protection shall be as specified herein.

F. Provide at least two full kVA capacity voltage taps above and two full kVA capacity taps below nominal rating. Each tap shall be 2.5 percent step.

G. Transformer shall be capable of at least 150 degrees C rise above rated site maximum ambient without degrading transformer life.

H. Transformers shall be capable of continuous operation at rated kVA with normal life expectancy as defined in ANSI C57.12.01.

I. Sound level shall not exceed NEMA maximum average sound level.

J. Enclosure shall be sheet steel with corrosion-resistant finish and manufacturer's standard color.

2.22 POWER FACTOR CORRECTION CAPACITORS

A. Where capacitors are specified, capacitors shall be rated 3-phase, delta configuration, and rated for voltage of system to which they will be connected. Capacitors shall not contain PCBs.

B. Enclosures shall be as required for areas in which they are installed and in accordance with requirements of this Specification.

C. kVA sizes indicated on the Drawings are approximate. Actual rating shall be verified with manufacturer in order to improve power factor to 95 percent at full load.

D. Capacitors shall be complete with discharge resistors and fuses.

E. Mount as close as physically possible to motors, preferably in main termination enclosure. Coordinate installation of capacitors with Purchaser.

2.23 ENCLOSURES

A. General Enclosure Requirements:

1. Enclosure ratings shall be as shown on the Drawings and Data Sheets.
2. Where required and as shown on the Drawings, control system equipment shall be housed in a non-ventilated, pressurized Z-purge design, to make enclosure suitable for Class I Division 2 environments, floor mounted, double door enclosure with a NEMA 4X rating. The enclosure shall be of stainless steel construction and have a three-point door latch. The Z-purge system shall generate low pressure alarm contact to be wired to the control system I/O module.
3. All alarm, control, and monitoring components to be mounted on the exterior of the enclosure shall be located on the enclosure face or front door.
4. Devices that mount directly to the enclosure face or door front must provide an operator interface function, i.e., switches, indicating lights, annunciators, controllers, gauges, etcetera. Devices that do not provide such functions must be mounted inside the enclosure.
5. All components mounted on the face or door front of an enclosure shall have legend plates/nameplates and shall be organized in a logical manner to simplify operation of the equipment being controlled.
6. All panels with control switches and monitoring lights shall be provided with a single momentary type lamp test pushbutton that, when pressed, illuminates each monitor light and monitoring control switch.

7. The bottom 12 inches of all floor mounted enclosures shall not be used for equipment mounting unless approved by the Owner.
8. The maximum voltages allowed in the control enclosure shall be 120V ac/125V dc.
9. Control panels shall be shop assembled and functionally tested prior to shipment.

B. Enclosure Mounting:

1. Wall mounted enclosures are to be supplied with external mounting ears such that mounting fasteners do not penetrate the enclosure.
2. Floor and skid mounted enclosures shall provide ample clearance between the bottom of the door(s) and the floor. These enclosures may rest on a metal frame base supplied with the enclosure and mounted directly to the floor or on base provided on the equipment skid.

C. Paint Finish:

1. Paint finishes are to be the enclosure manufacturer's standard coating in the colors listed below or as otherwise specified on the Drawings.
   a. Interior of enclosure: White polyurethane "Or-equal," Owner approval.
   b. Exterior of enclosure: Light gray (ANSI 61) polyurethane, epoxy, "Or-equal," Owner approval.
2. All finished Work shall be of uniform color and texture.
3. All finished Work shall be free of runs, sags, drips, and laps.
4. All touchup painting shall be complete prior to factory inspection by Owner. Scratches, scuffs, and chips in the paint must be repaired prior to shipment. Owner reserves the right to make a final inspection just before shipment.
5. All finished Work shall be packaged and handled so as to arrive at the jobsite with no scratches, dents, soil marks, fading or other surface blemish.

D. Internal Component Layout:

1. All internal components are to be mounted on sub-panel assemblies. Mounting of components directly to enclosure back or side walls is not acceptable.
2. 20 percent spare component mounting space shall be provided for future use.
3. All incoming wiring shall be to DIN rail-mounted terminal strips or I/O Interface Modules (IFMs). Terminals shall accept up to 14 AWG wire. Terminals shall be screw type.
4. 20 percent spare terminals shall be provided for future use.

5. Sufficient room shall be provided to accommodate Owner wiring. Provision for supporting and tying incoming Owner cabling shall be made.
6. Cable spreading space is to be located at the top of the enclosure for top entry cables. Likewise, cable spreading space is to be located at the bottom of the enclosure for bottom entry cables.
7. Component layout shall be such that incoming cables do not pass near or over components to reach their termination point. Once a cable enters an enclosure, its termination point shall be within as short a distance as practical.
8. Bundles of wire are to be routed in wire ducts or secured with cable ties. All components, terminal strips, wire duct, cable ties, etc. shall be fastened with screws to the sub-panel. No stick-on or adhesive fasteners are to be attached to the enclosure.

E. Enclosure Features:

1. A ground bus, electrically continuous to the enclosure, is to be provided in enclosures that are greater than two feet in any dimension. For those enclosures that are less than two feet in every dimension, a compression type grounding lug (4/0 AWG size), electrically continuous to the enclosure, is acceptable.
2. Where ground buses are provided, they shall be drilled, tapped and provided with ground screws to accommodate Owner wiring. These buses shall also have one large compression lug (4/0 AWG size) to accommodate a local ground conductor.
3. Lifting rings are to be supplied on enclosures that exceed an installed weight of 150 pounds or more including all internally and externally mounted components.
4. If an enclosure is to be located in a hazardous area, all fixtures, receptacles, and fittings shall be rated to meet the proper NEC hazardous location class.
5. Enclosures larger than 20 cubic feet shall be supplied with an interior light package and NEMA 5R-20 convenience receptacle. In larger multi-sectional enclosures, each section is to be supplied with a light package and convenience receptacle. The light(s) and convenience receptacle(s) may be on the same over-current protected circuit. However, this circuit is to be separate from any incoming power supply circuit used for control functions. Lighting shall be provided in smaller enclosures if necessary due to unusual conditions such as low design area lighting.
6. The width of enclosure access doors is not to exceed 3 feet. Where enclosures larger than 3 feet in width are used, multiple doors shall be provided.
7. Exterior door handles, clamps, etc. shall be stainless steel.

F. Labeling:

1. All enclosures shall have an exterior mounted tag displaying the Owner's cabinet number in a prominent location. Minimum letter size for this tag shall be 3/8-inch. All other tags shall have a letter size of 1/8 inch to 1/4 inch as appropriate.
2. Labels mounted on the interior or exterior of an enclosure shall be mechanically fastened in such a manner as not to degrade the NEMA rating. Labels shall be attached with mechanical fasteners such as screws or rivets. Use of adhesive alone is not acceptable.
3. Each PLC I/O point in the PLC enclosure shall be labeled according to its function. If space does not allow this, a Drawing showing the physical layout of the I/O and its function shall be provided and stored in the enclosure.
4. All interior and exterior components mounted to the enclosure shall be labeled with device numbers in accordance with Owner approved design drawings.
5. In general, all labels shall be phenolic with a white background and black lettering.

2.24 PLATES AND COVERS

A. Provide finish plates and covers of appropriate type and size for wiring and control devices, signal, and communication outlets.

B. Mark each plate and cover to show circuit and panel designation. Unless indicated to be engraved plate, use self-sticking, clear membrane, UV-resistant labels with typed black letters. Handwritten labels not allowed.

C. Coordinate color with adjacent surfaces.

D. Raised cover galvanized steel plates shall be acceptable for use on surface-mounted outlet boxes in unfinished areas where weatherproof plates are not required.

E. For weatherproof installations, cover plates shall be gasketed and rated for NEMA 4 installation.

F. Device plate mounting hardware shall be countersunk and finished to match plate.

2.25 WIRING DEVICES

A. Where more than one flush device is indicated in same location, mount devices in gangs under common plate.

B. Switches for control of AC lighting panel load circuits, single-pole, 3-way, and 4-way, shall be premium, heavy-duty specification-grade, and meet FS W-S-896E. Switches shall be rated for use at 120V or 277V, as required, and 20A, minimum.

C. Device color, if not shown on the Drawings, shall be coordinated to match adjacent finishes.

D. Wall switches requiring pilot light indication shall have red LED pilot light when toggled “On.”

E. Pulse control of lighting contactors shall be 20A, 120V or 277V, momentary, double-throw, and center “Off.”

F. Standard convenience outlets: Premium, heavy-duty, specification-grade, duplex, 3-wire, grounding, 20A, 125V for 120V circuits, and rated 250V for 240V or 208V circuits.

G. Ground fault circuit interrupter (GFI) receptacles: Duplex, 20A, and 125V, feed-through type.

H. Isolated ground (IG) outlets: Duplex, 3-wire, with isolated grounding terminal, 20A, and 125V. Outlets shall be orange in color, unless specified otherwise.

2.26 WELDING

A. If special welding requirements are required for any piece of equipment during installation, requirements shall be stated on manufacturer’s Shop Drawing of affected part.

B. Furnish detailed welding requirements with equipment shipment.

2.27 WELDING RECEPTACLES

A. Provide in appropriate amperage as shown on the Drawings; 600V, 3-phase with grounding conductors connected through 4th pole.

B. Provide one matching plug with appropriate woven grip and plug cap for cable size.

C. Match receptacles to equipment.

D. Provide Hubbell model HBL460MIF7W, 480V, 3 Phase, 4W, 60A welding receptacle.

2.28 PANELBOARDS

A. Fabrication, selection, and installation shall comply with Section 26 24 16, Panelboards, as well as any additional requirements listed in this Specification.

B. Dead-front, circuit breaker type, rated for voltage, phase, with main lugs or main breaker as indicated on panel schedules.

C. Enclosure shall be NEMA-rated for installation location and capable of flush or surface mounting.

D. Enclosure cover and access door shall be hinged with breaker operating handles accessible through latchable and lockable door.

E. Typed panel directory located inside door shall have panel and circuits function clearly identified. Handwritten panel schedules not allowed.

F. Provide main and neutral buses insulated from cabinet with separate ground bus. Bus material shall be copper. Ground bus shall be similar to neutral bus in size and number of conductor terminating positions.

1. Bond ground bus to panelboard enclosure by copper ground strap or copper conductor of appropriate size. Bond neutral bus to ground bus in accordance with requirements of NEC.
2. Grounding bus connection to enclosure by removable screws not allowed.
3. Bus shall be capable of terminating clamp type lugs for neutral cable in each supply conduit, and connections for neutral cable in each load circuit.
4. Neutral bus shall be fully rated, unless specified otherwise.
5. Isolated ground panelboards: As specified above, except isolated ground bus shall be bonded, by insulated ground conductor, back to source of separately derived system. Do not bond isolated ground bus to panelboard enclosure unless this is first point of grounding for separately derived system.

2.29 MOLDED CASE CIRCUIT BREAKERS

A. Molded-case, thermal-magnetic, bolt-in, individually front replaceable, and shall visibly indicate “On,” “Off,” and “Tripped” position.

B. Branch circuit breakers used for lighting circuits shall be switch duty rated, “SWD.”

C. Breakers having multiple poles shall be manufactured as common trip type.

D. Interrupting rating shall be not less than interrupting rating of panelboards, and not series rated to achieve required short circuit interrupting rating.

E. Provide handle clips for 10 percent, or minimum of two whichever is greater, for breakers to prevent casual operation. If no breakers are indicated for installation, then provide on breakers labeled as spare.

F. Breakers, and provisions for future breakers, shall be provided in quantities, poles, and ampere ratings shown on the Drawings.

G. Molded-case circuit breakers used in AC and DC panelboards and AC load centers shall be bolt-on type, G-frame size.

2.30 FINISHES

A. Manufacturer's standard coating systems shall be factory-applied. Coating systems shall provide resistance to corrosion caused by weather and industrial environments.

1. Surfaces inaccessible after factory or field assembly shall be protected for life of equipment.
2. Painted surfaces shall be filled to provide smooth, uniform base for painting.
3. Surfaces requiring field welds shall not be coated within 3 inches of field weld.

B. Coating material and application techniques shall conform to regulations of air quality management agency having jurisdiction.

C. Exterior surfaces of control and electrical equipment, including panels, cabinets, switchgear, transformers, and motors shall be manufacturer's standard colors unless specified otherwise.

D. Apply high-temperature coating systems to uninsulated equipment operating at temperatures at or above 200 degrees F.

2.31 RUST-INHIBITOR COMPOUNDS

A. Uncoated machined and ferrous surfaces subject to corrosion shall be protected with rust-inhibitor compounds.

B. Rust-inhibitor compounds used to protect surfaces of equipment and piping exposed to feedwater or steam shall be completely water-soluble.

C. Surfaces to be field welded shall be coated with consumable rust-inhibitor compounds that will not affect quality of weld.

D. External gasket surfaces, flange faces, couplings, rotating equipment shafts and bearings shall be thoroughly cleaned and coated with rust-inhibitor compounds.

2.32 GALVANIZING

A. Galvanized structural steel members and steel assemblies shall be pickled after fabrication. Remove scale, rust, grease, and other impurities, then hot-dip galvanized in accordance with ASTM.

B. If galvanized member is to be bolted, structural bolts shall be galvanized in accordance with ASTM.

2.33 IDENTIFICATION AND TAGGING

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Conduits inside manholes, hand holes, building entrance pull boxes, and junction boxes shall be provided with 19-gage stainless steel identification tags, with 1/2-inch stamped letters and numbers.

1. Attach conduit Identification tags with stainless steel banding. Tag position shall be readily visible for inspection.
2. Tags shall provide, as minimum:
    a. Circuit origination and destination.
    b. Voltage.
    c. Number of conductors in accordance with phase.
    d. Number of phase conductors.

C. Cables passing through or terminating in manholes, hand holes, and pull boxes shall have 19-gauge stainless steel identification tags with stamped lettering that provides circuit identification information.

D. Provide power, control, and instrumentation cables with permanent type identification markers with typed cable numbers and from/to information at each point of termination. Cable numbers and from/to information will be provided for circuits not associated with low-voltage panelboards.

1. Position cable markers to be readily visible for inspection.
2. Cable numbers shall match those as shown on the Drawings.
3. Provide wire tags at each termination point for each conductor. Tags shall be permanent, wrap around, heat-shrinkable type with typewritten information.

E. Color-code power conductors with electrical tape or provide with colored jacket. This definition is intended to assign phasing to color and not define colors. Cable colors are defined in Low Voltage and Medium Voltage Cable Specifications – Sections 26 05 19 and 26 05 13, respectively.

1. Source voltage of 208Y/120 volts:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Neutral: White.
2. Source voltage of 120/240 volts:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Neutral: White.
3. Source voltage of 480Y/277 volts:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: Gray.
4. Source voltage of 240/120V delta: High-leg systems shall not be used without Engineer approval.
5. Service entrance and equipment ground conductors shall be bare copper or green insulated conductor. Equipment bonding conductors shall be bare copper.
6. Isolated ground conductors shall be insulated; green in color with integral yellow stripe. No substitutions.

2.34 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Laminated white-over-black plastic such that face is white with black letters, with 3/16-inch engraved letters securely fastened with minimum of two self-tapping, stainless steel screws.

C. Motor starters, either separately mounted or contained in motor control centers, shall have nameplates identifying related equipment. Where separate control and indicating lights are used, starters shall have engraved or etched legends (“start”, “stop”, etc.) as shown on the Drawings.

D. Provide control stations with nameplates identifying related equipment. Control and indicating lights shall have engraved or etched legends as shown on the Drawings.

E. Circuit breakers within main switchboards and distribution switchboards shall be provided with nameplates identifying related equipment being served.

F. Fused and nonfused switches shall have two front cover-mounted nameplates.

1. Nameplate containing permanent record indicating switch type, manufacturer's name, catalog number, and appropriate rating for equipment served.
2. Provide additional nameplate to identify associated equipment.

G. Panelboards shall have front cover-mounted nameplates identifying panelboard, matching information shown on the Drawings and associated panel schedule. Nameplate shall have at least four lines of text consisting of:

1. Line 1: Panel equipment identification number.
2. Line 2: IEEE Voltage Designation.
3. Line 3: Appropriate description from which power is derived.
4. Line 4: Location of power source.

H. Lighting and auxiliary power transformers shall have front cover-mounted nameplates identifying transformer, matching information shown on the Drawings. Nameplate shall have at least two lines of text that consist of:

1. Line 1: Transformer equipment identification number.
2. Line 2: Location of derived power source.

I. Nameplates shall meet requirements of NFPA 70E.

J. Warning Signs:

1. OSHA Subpart J – General Environmental Controls, Section 1910.145.
2. Signs provided with equipment are acceptable provided all necessary signs are issued with equipment.
3. Provide identical signs for each application.
4. High voltage warning signs to read “DANGER – HIGH VOLTAGE – KEEP OUT”.

2.35 FASTENING HARDWARE

A. Provide fastening hardware including, but not limited to, anchor bolts, nuts, washers, expansion anchors, wire nuts needed for installation.

B. Fastening hardware smaller than 3/4 inch shall match NEMA standard size bolt holes on motors and electrical equipment.

PART 3 EXECUTION

3.01 EXAMINATION OF SITE

A. Project site conditions shall be investigated to ensure that equipment furnished and installed is capable of withstanding most severe site condition that will be encountered.

3.02 PROTECTION OF WORK

A. Protect installed work and provide temporary and removable protection from installed products. Control activity in immediate work area to prevent damage.

B. Damage occurring to buildings or equipment during installation shall be repaired or replaced to conditions existing prior to damage at no additional cost to Project, Purchaser, or Owner.

3.03 INSTALLATION

A. Install equipment and materials in accordance with manufacturer's recommendations and Drawings.

B. Details for equipment and systems installed in accordance with industry standard techniques will not be furnished.

C. Installation details furnished on the Drawings shall be followed unless found to be unsafe, inappropriate for equipment specified, or unachievable due to site conditions. Where such conditions are found, Contractor shall bring to Owner for resolution.

D. Install equipment indicated on the Drawings as furnished by Others, unless noted as installed by Others.

E. Except as otherwise specified or indicated on the Drawings, equipment shall be installed plumb, square, and level.

F. Sheet metal junction boxes, equipment enclosures, sheet metal raceways, and similar items mounted on earth-bearing walls shall be separated from wall not less than 1/4 inch by corrosion resistant spacers.

G. Equipment located outdoors shall be permanently sealed where not an opening required for access or maintenance. Openings into equipment shall be screened or sealed so as to prevent entrance of insects and animals.

1. Sealing material at base shall be concrete grout.
2. Small cracks and openings shall be sealed from inside with silicone sealant.
3. Large openings shall use galvanized screen mesh.

3.04 CABLE

A. Prior to installation of each cable or cable group into assigned raceway, verify that raceway has been correctly sized.

1. Where raceway is not indicated in Cable Schedule or on the Drawings, size in accordance with requirements of NEC.
2. If raceway size indicated on the Drawings is inadequate, notify Engineer.

B. Replace cables pulled into wrong raceway or cut too short to rack and train at Contractors expense.

C. Do not reinstall cables installed in wrong raceway and removed. Discard cables unless inspected and accepted by Engineer in writing.

D. Carefully lay or pull circuits in cable tray so neither cables nor tray is damaged.

E. Protect cables from dirt, water, oil, damaging chemicals, and from physical injury prior to, and during installation.

F. Cables shall be cut sufficiently long to conform to contour of trays, with particular attention paid to vertical inside bends.

G. Remove excessive slack so cables lie parallel to sides of trays.

H. Multiple single-conductor power cables No. 1/0 AWG or larger installed in cable tray that constitute single power circuit shall be grouped together in triplexed or quadriplexed arrangement. Maintain cable spacing to be 2.15 x O.D. of largest conductor in group or adjacent group.

I. Multiconductor power cables No. 4/0 AWG or larger installed in cable tray shall be installed in single layer with maintained spacing of not less than one cable diameter of largest cable.

J. Fasten cables to cable tray with UV resistant rated nylon ties to hold cables in place.

K. Perform fishing and pulling with flexible round metal tape, CO2 propelled polyethylene cord, nylon rope, or manila rope.

L. For any cable pulls that require use of mechanized cable pulling machine the following additional precautions shall be considered for cable damage caused by improper pulling tension and excessive sidewall pressures.

1. NEC requirements shall be used as guideline. Calculations shall be performed for duct bank runs over 300 feet, and for installations in conduit over 100 feet.
2. Monitor and record pulling tension during installation of cable. Tension shall not exceed maximum recommended by cable manufacturer.
3. To avoid damage from excessive sidewall pressure at bends, pulling tension shall not exceed cable manufacturer’s recommendation.
4. Pulling mechanisms, manual or power type, shall have rated capacity in tons legibly marked on mechanism.
5. During installation, observer shall constantly watch dynamometer and record maximum tension achieved during pull.
6. If excessive strain develops, stop pulling operation at once. Determine difficulty and correct.
7. Provide records of dynamometer readings to Engineer.
8. Inform Purchaser prior to cable pulls requiring the use of a mechanized cable pulling machine.
9. Do not use woven wire cable grips. Use only pulling eyes for pulling cables.
10. As soon as cable is pulled into place, remove pulling eyes and reseal cable.

M. Insert reliable nonfreezing type of swivel or swivel connection between pulling rope and eye to prevent twisting under strain.

N. Only use lubricants as recommended by cable manufacturer. Water-based lubricants not allowed.

O. Outside of each cable reel shall be carefully inspected. Remove protruding nails, fastenings, or other objects that might damage cable.

1. Perform visual inspection for flaws, breaks, or abrasions in cable sheath as cable leaves reel. Pulling speed shall be slow enough to permit inspection.
2. Damage to sheath or finish of cable shall be sufficient cause for rejecting cable.
3. Cable damaged during installation shall be replaced at no expense to Project, Purchaser, or Owner.

P. Permanent radius of each bend after cable installation shall be in accordance with manufacturer's recommendations.

Q. Cable supports and securing devices shall have bearing surfaces located parallel to surfaces of cable sheath. Install to provide adequate support without deformation of cable jackets or insulation.

R. Provide adequate cable end lengths. Properly install in junction boxes and manholes to avoid longitudinal strains and distorting pressures on cable at conduit bushings and duct end bells.

S. Final inspection shall be made after cables are in place. Where supports, bushings, and end bells deform cable jacket, provide additional supports.

T. Splices, joints, and connections shall be made only in accessible junction boxes in accordance with methods specified and instructions of cable manufacturer. Splices not allowed unless shown on the Drawings or specified otherwise herein.

U. Rough-in wiring terminated in junction boxes shall have at least 8 inches of free conductor coiled in box for connection to equipment and receptacles.

V. Circuit information for circuits originating from panelboards may only be indicated on panelboard panel schedules. Other circuits are identified on Cable Schedule.

1. Do not combine receptacle loads with lighting loads.
2. Circuits fed from panelboards shall not be combined with circuits from Cable Schedule.

W. Panelboard circuits are indicated as individual runs. Circuits may be combined into common conduits in accordance with rules of NEC. Perform work associated with combining of circuits at no additional cost to Purchaser.

3.05 WIRING DEVICES, BOXES, AND FITTINGS

A. Install galvanized or cadmium plated, threaded, malleable iron boxes and fittings in:

1. Embedded in concrete walls, ceiling, and floors.
2. Outdoor exposed faces of masonry walls.
3. Locations where weatherproof cover is required by code or this Specification.

B. Install galvanized or cadmium plated sheet steel boxes in:

1. Indoor exposed faces of masonry walls.
2. Interior partition walls.
3. Joist supported ceilings.

C. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

D. Telephone and communication conduit systems shall have separate junction boxes and pull fittings.

E. Install fire system wiring in dedicated conduit system.

F. Finish openings so standard sized cover plates can be used. Oversized plates not allowed.

G. Mount wall switches 3 feet by 6 inches above finished floor or grade unless specified otherwise. After circuits are energized, test wall switches for proper operation.

H. Outlets:

1. Standard mounting height: 18 inches above finished floor, unless specified otherwise.
2. Outlets outdoors, garages, basements, shops, storerooms, and other rooms where equipment may be hosed down: 4 feet by 0 inches above finished floor or grade.
3. Surface-mount welding receptacles 4 feet and 0 inches above finished floor or grade.
4. After circuits are energized, test each receptacle for correct polarity.
5. Test GFCI receptacles for proper operation.
6. Mount wall thermostats 5 feet and 6 inches above finished floor unless noted otherwise. Thermostats mounted shall be suitably insulated from wall temperatures.

I. Communication outlets shall be 18 inches above finished floor unless required otherwise. Outlets outdoors, garages, basements, shops, storerooms, and rooms where equipment may be hosed down shall be 4 feet by 0 inches above floor.

J. Clock outlets shall be located 7 feet by 0 inches above finished floor or grade.

3.06 FIRE PROOFING AND FIRE RATINGS

A. Maintain fire-resistive integrity during construction.

B. Penetrations through fire-resistive structures shall be sealed with fire-resistive material compatible with construction penetration.

C. Where required by codes, local building officials, or fire marshal, furnish UL fire sealing systems and install in accordance with manufacturer’s recommendations.

3.07 CONSTRUCTION TESTING

A. Clean equipment interiors and exteriors prior to construction testing.

B. Unless specified otherwise, tests performed shall be standard tests listed by ANSI/IEEE and NETA for intended equipment.

C. Equipment shall be checked and made ready for operation.

D. Circuits shall be electrically tested after installation. Test power and motor circuits prior to final connection to equipment. Engineer approved splices shall be complete prior to testing.

1. Provide equipment and labor required for construction testing.
2. Circuit failing to test satisfactorily shall be replaced or repaired, and retested at no additional cost to Project, Purchaser, or Owner.
3. Check power and motor circuits, DC power, and control circuits for:
   a. Correct terminations.
   b. Continuity.
   c. Unintentional shorts and grounds.
4. Check power conductors for correct phasing.
5. Motor circuits shall be checked for proper rotation and motors “bumped” to verify correct machine rotation.
6. Control, instrumentation, and thermocouple wire shall be checked for correct termination, continuity, freedom from shorts or grounds, and identification.
7. Current transformer wiring shall be loop checked by injecting current at one end of loop and checking with clip-on ammeter at each field termination point to assure continuity and phase identification.
8. Voltage transformer wiring shall be tested by applying voltage at one point and checking with voltmeter phase rotation meter and phase angle meter at each field termination point to assure continuity, identification and phase shift.

END OF SECTION

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SECTION 26 11 16
DRY TYPE MEDIUM VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. This section shall apply to Dry Type Medium Voltage (MV) transformer(s) detailed on the Data Sheet(s).

B. Supplier's scope of supply includes detailed design and manufacturing of all Dry Type MV transformer-related equipment, delivery to project site, and installation supervision, as well as support, testing, and commissioning of Dry Type MV transformer(s) for the Sewerage and Water Board of New Orleans (SWBNO) as specified herein.

C. Additions / Deletions / Deviations / Exceptions / Substitutions:

1. Supplier will note all exceptions and advise of additions, deletions, deviations, exceptions, substitutions, or other Supplier-recommended changes.
2. Such deviations are permitted, but only with written approval from the Owner or Owner's Engineer, and then, only if the written explanation, with full details, is submitted by Supplier to the Owner or Owner's Engineer. This detailed written explanation must accompany the written deviation request.
3. Written approval from the Owner or Owner's Engineer will constitute acceptance.

D. Compliance:

1. All design, fabrication, assembly, testing, and shipment shall fully comply with this section and is the responsibility of the Manufacturer (or the Supplier).
2. Manufacturer (or the Supplier) shall provide standard product offering where possible, unless otherwise specified or approved.

E. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

6. Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.
7. Section 40 90 00, I&C General Requirements.
8. Section 40 90 10, I&C Summary of Work.
9. Section 40 90 40, Instrumentation and Control for Packaged Mechanical Equipment.
10. Section 40 94 23, PDCS ECS Specification.
11. Section 48 00 10, Mechanical Summary of Work.

F. Field Engineering Services and Training:

1. The work specified in this section includes, but is not limited to, providing Manufacturer's (or the Supplier's) factory authorized field engineering services to support assembly, testing, and commissioning.
2. Furthermore, the work specified in this section also includes Manufacturer's (or the Supplier's) factory authorized training for SWBNO Operation and Maintenance (O&M) personnel.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced and/or applicable to the equipment supplied. The publications are referred to in the text by the basic designation only.

B. The edition/revision of the referenced publications shall be the latest publication date, as of the date of the Contract Documents, unless otherwise specified.

C. Manufacturer (or the Supplier) shall design, fabricate, assemble, test, and install all Dry Type MV transformers and related equipment in accordance with the following industry standards:

1. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   d. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   e. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   f. D709, Standard Specification for Laminated Thermosetting Materials.

g. D1535, Standard Practice for Specifying Color by the Munsell System.

2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 100, The Authoritative Dictionary of IEEE Standards Terms
   b. C2, National Electrical Safety Code.
   c. C37.90.1, Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
   d. C37.121, American National Standard for Switchgear-Unit Substations – Requirements.
   e. C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings.
   f. C57.12.29, (2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments.
   g. C57.12.51, Standard for Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, with High-Voltage 601 to 34,500 Volts, Low-voltage 208Y/120 to 4160 Volts - General Requirement.
   h. C57.12.80, Standard Terminology for Power and Distribution Transformers.
   i. C57.12.91, Standard Test Code for Dry-Type Distribution and Power Transformers.
   j. C57.13, Requirements for Instrument Transformers.
   k. C57.98, Guide for Transformer Impulse Tests.
   l. C57.124, Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.
   m. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).
3. International Electrical Testing Association (NETA):
   a. ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
4. National Electrical Manufactures Association (NEMA):
   a. ICS 6, Industrial Control and Systems: Enclosures.
   b. LI 1, Industrial Laminating Thermosetting Products.
   c. TR 1, Transformers, Step Voltage Regulators and Reactors.
5. National Fire Protection Association (NFPA):
   a. NFPA 70, National Electrical Code.
6. UL:
   a. UL 467, UL Standard for Safety Grounding and Bonding Equipment.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with the Section 01 33 00, Submittal Procedures. In addition to these Documents, supply engineering data, as listed below:

1. Symbols and wiring identification systems shall be in accordance with ANSI Y32.2 and IEEE 315.
2. Certified copies of the factory test reports.
3. Outline Drawings completely dimensioned showing:
   a. Plan and elevations.
   b. High-voltage bushing details.
   c. Low-voltage bushing bus duct flange details.
   d. Location and identification of accessories.
   e. Anchor bolt hole location and hole diameter.
   f. Ground pad locations.
   g. Weight of transformer and center of gravity, with and without insulating liquid and shipping weights.
   h. Total quantity and MSDS of insulating fluid.
   i. Location, mounting, and connection details of surge arresters (if applicable).
   j. Control cabinet dimensional details.
4. Detailed Connection (Wiring) Diagrams:
   a. Interconnecting wiring of components of forced cooling equipment.
   b. Wiring of devices with switches and relays, or electrical connections, including current transformers.
   c. Identification of terminal blocks and connections.
5. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
6. Load List information for all equipment supplied.
7. Motor data sheets.
8. Ratio correction factors and excitation curves for each size and type of current transformer.
9. Nameplate diagram per ANSI standards.
10. Factory Tests: Submit proposed test program prior to time transformer is ready for core and coil inspection; include method and description of each test and test sequence. Submit certified reports of production tests as soon as tests are completed.
11. Installation, Operation, and Maintenance (IOM) instructions: IOM instructions shall cover equipment furnished.
12. Manufacturer catalog cut sheets, as well as collated IOM manuals for all accessories and instruments.

1.04 QUALITY ASSURANCE

A. A Quality Assurance (QA) program is required, summarized in a QA manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment, and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections, and tests.

C. Such inspection or witness of work shall not relieve Manufacturer (or Supplier) from any obligation to perform said work, or to provide equipment in accordance with the plans, drawings, documentation, Specification (and related sections), any verbal or written guidance, or any modification thereof, suitable for the purposes intended. Work not so fabricated, tested, installed, or constructed shall be removed and made good by Manufacturer (or Supplier) at no additional cost to the Owner, Owner's Representative, or Owner's Engineer, including any additional costs for removal, transportation, design, engineering, fabrication, shipment, testing, certifications, installation, construction, or commissioning.

D. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards, Recommended Practices, Guides, and Regulations. Furthermore, Manufacturer (or Supplier) shall guarantee and warrant that all specified equipment tests have been satisfactorily completed per these specified Codes, Standards, Recommended Practices, Guides, and Regulations.

E. Factory Acceptance Testing (FAT) as required per data sheet:

1. Notify the Owner and Engineer 30 days prior to tests.
    a. Furnish a comprehensive test procedure 30 days prior to tests.
    b. Test procedure shall be accompanied with all pre-test reports.
    c. Tests shall simulate site criteria.
    d. Tests shall include emissions testing where applicable.
2. Provide for Owner and Engineer representatives to witness tests.
3. The following information shall be submitted within 30 days following completion of the tests.
    a. A list of equipment used, with calibration certifications.
    b. A copy of all measurements taken.
    c. The dates of testing.
    d. The equipment and values to be verified.
    e. The conditions specified for the test.
    f. The test results signed and dated.
    g. A description of all adjustments made.

F. Regulatory Requirements:

1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner and Engineer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 (National Electrical Code), unless more stringent requirements are specified or indicated.

G. Standard Products:

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.
2. Alternative Qualifications:
   a. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation of not less than 6000 hours, exclusive of the Manufacturer’s factory and laboratory tests, is furnished.
3. Material and Equipment Manufacturing Date:
   a. Products manufactured more than 3 years prior to date of delivery to site shall NOT be used, unless specified otherwise.

1.05 SHIPPING, HANDLING, AND STORAGE

A. Shipping and Packaging:

1. Plug, cap, or cover exposed openings with plywood or other suitable material.
2. Impact detectors/recorders in all three planes shall be provided. Full instructions shall be furnished for interpretation of impact detectors/recorders. If recorder is utilized, the chart must record the entire trip duration to the final destination without retracing. Supplier shall provide maximum shock acceptable criteria prior to shipment.

3. Preparation for shipment shall be in accordance with Supplier's standards.
4. Material Safety Data Sheets (MSDS) shall be included with packing lists.
5. Deliver loose parts in boxed plywood containers and ship as a unit with equipment. Use ink, paint, or other indelible material markings. Securely affix a copy of completed packing list to each separate shipping package. Identify shipping boxes by:
   a. Order Numbers.
   b. Project Name.
   c. Project Location.
   d. Equipment Number.
   e. Description of contents.
6. Provide instructions for proper unpacking.

1.06 WARRANTY AND GUARANTEES

A. Furnish OEM's (or Supplier's) extended guarantee or warranty with Owner named as beneficiary, in writing, as special guarantee.

B. The OEM (or Supplier) shall warrant that the equipment shall be supplied in accordance with this Specification (and related sections) and shall perform as described herein.

C. The OEM (or Supplier) warrants that all equipment to be supplied (or work to be performed) shall accomplish the service anticipated by this Specification and related sections.

D. The OEM (or Supplier) shall warrant that the equipment provided shall operate successfully and be free from defects in materials and workmanship, without objectionable noise or undue vibration while under operation, for a period of 12 months after acceptance by Owner.

E. The Owner shall have the authority to reject any work or material, or any part thereof, which does not conform to the plans, Drawings, documentation, Specification (and related sections), any modifications thereof, suitability for purposes intended, or the contract.

F. The OEM (or Supplier) shall repair or provide a replacement for any defective component under the warranty, provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The OEM (or Supplier) must be able to provide Owner with training and support service during the first year of operation after energization of the equipment and system.

G. Work not so fabricated, tested, installed or constructed in accordance with the plans, Drawings, documentation, Specification (and related sections), any verbal or written guidance, or any modifications thereof, suitable for the purposes intended, shall be removed and made good by OEM (or Supplier) at no additional costs for removal, transportation, design, engineering, fabrication, shipment, testing, certifications, installation, construction, or commissioning.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. ABB.
2. Eaton.
3. Federal Pacific.
4. GE.
5. Hitachi.
6. Schneider Electric.
7. Siemens.
8. Virginia Transformer.
9. WEG.

B. Submit Product Data for each piece of electrical equipment provided.

2.02 SERVICE CONDITIONS

A. Items provided under this section shall be specifically suitable for the site conditions specified in Section 01 61 00, Common Product Requirements.

2.03 PRODUCT COORDINATION

A. Products and materials not considered to be dry type medium voltage transformer and related accessories are specified elsewhere in the Contract Documents.

2.04 DRY TYPE MEDIUM VOLTAGE TRANSFORMER

A. Dry Type Medium Voltage Transformer(s) shall comply with IEEE C37.121 regardless of the kVA rating specified. Dry type transformers shall consist of one incoming section, one transformer section, and one outgoing section.

B. Assemblies shall be sub-assembled and coordinated by one manufacturer and shall be shipped in complete sections ready for connection at the site. Where practicable, assemblies shall be shipped as one unit. External doors, if provided, shall have provisions for padlocking.

C. Incoming Section:

1. The incoming section shall consist of an air-filled terminal chamber for connecting the incoming circuit directly to the transformer. If required for proper connection and alignment, include a transition section with the incoming section.
2. Incoming Section Enclosure:
   a. The incoming section enclosure shall be NEMA ICS 6 Type 1.
   b. Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable.
   c. Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.29.
3. Cable Terminations:
   a. Provide medium voltage (MV) cable terminations as specified on the Data Sheet(s).

D. Outgoing Section:

1. The outgoing section shall consist of a secondary transition section for connecting to outgoing circuit directly to the transformer per the Data Sheet(s).
2. Connections between the transformer secondary bushings and the outgoing section transition bus shall be rigid bus. The secondary transition section shall have a hinged front panel.

E. RLC-Snubber, as required and if specified on the Data Sheet(s):

1. RLC-Snubber Enclosure:
   a. The medium voltage RLC-Snubber shall be housed in an enclosure matching the requirements of the associated transformer.
   b. The enclosure shall be equipped with a hinged door(s) for maintenance and termination. The hinged door shall bolt close with locking provisions. The door shall be removable when in the open position.
   c. High voltage warning signs and a nameplate showing rating information shall be located on the front of the enclosure.
   d. The design shall accept bottom entry or top entry to suit conditions.
2. RLC-Snubber Connections:
   a. The RLC-Snubber shall come fully assembled and ready for interconnection.
   b. Standoff insulators shall be provided for termination of customer phase conductors.

c. Termination points shall accommodate a NEMA 2-hole compression lug.

3. RLC-Snubber Main Incoming Fuses:
   a. The RLC-Snubber shall be equipped with main incoming current limiting fuses. The fuses shall be located on the load side of the main air disconnect switch. The fuses shall be accessible only when the associated transformer is de-energized by the main incoming air disconnect switch and shall be completely isolated from any live parts.
   b. Fuses shall be equipped with blown fuse indication. The blown fuse indication shall be wire to terminal blocks for connection with external indicator and/or plant control system.
4. RLC-Snubber Trouble Alarm:
   a. Current transformers shall be placed in each phase of the RLC-Snubber. The current transformer secondaries shall be connected to an appropriate protection relay to indicate the RLC-Snubber is properly operating (not open, not shorted, and drawing the correction amount of current). Incorrect operation shall trip a relay contact to either alert plant personnel of improper operation of the RLC-Snubber or trip the upstream breaker lockout relay.
5. RLC-Snubber Load Interrupter - Air Disconnect Switch:
   a. The harmonic filter bank shall be supplied with an external chain-operated, load-interrupting switch that accomplishes capacitive current interruption utilizing the dual arc extinguishing system based on the auto-pneumatic air-blast and hard gas nozzle principle.
   b. The Air Disconnect Switch shall be rated as shown on the Data Sheet at 135 percent of the associated transformer nominal current rating and shall have a RMS momentary asymmetrical rating per the Data Sheet.
   c. The Air Disconnect Switch shall be interlocked with the vacuum switches to prevent it from being opened while the filter stage(s) are energized. The switch shall be lockable in either the open or closed position.
   d. The Air Disconnect Switch shall be located in a separate compartment that is isolated from the RLC compartment and the low voltage control compartment by a steel barrier. In addition to the exterior enclosure door, a protective screen (behind the door) shall be provided before access to the switch is allowed.
6. RLC-Snubber Capacitor(s):
   a. A low inductance RLC-Snubber capacitor shall be provided for decreasing the slope of impending voltage surges. The capacitor shall be rated as shown on the Data Sheet(s).
   b. The capacitor shall be equipped with discharge resistors that reduce the capacitor voltage to 50 volts in 5 minutes when disconnected from the source.

c. The surge capacitor shall be capable of operating in the temperature range noted on the Datasheet.

7. RLC-Snubber Resistor:
   a. The medium voltage RLC-Snubber shall be equipped with non-inductive ceramic resistors able to withstand high peak power or high-energy pulses. The resistor shall have a per phase ohm and watt rating noted on the Datasheet.
   b. The resistors shall be clip-mounted with metalized ends for electrical contact to clips.
   c. The resistors shall be rated from minus 55 degrees C to 350 degrees C, with a resistance temperature coefficient of 0.2 degrees C to minus 0.08 degrees C.
8. Surge Protection Device (SPD):
   a. The medium voltage RLC-Snubber shall be equipped with line-to-line and line-to-ground heavy-duty, station class surge arresters (SA) for limiting the crest of impending voltage surges to safe values.
   b. The surge arrester shall be silicone rubber housed and shall utilize Metal-Oxide Varistor (MOV) blocks. The arresters shall comply with IEEE C62.11 standards.
   c. The voltage rating and Maximum Continuous Operating Voltage (MCOV) ratings shall be appropriately rated for the system voltage and grounding as specified above and as shown on the Data Sheet(s).

F. Transformer (Dry-Type) Section:

1. IEEE C57.12.01 and IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger. Transformer base shall include any part of the transformer that is within 3 inches of concrete pad. Paint coating system shall comply with IEEE C57.12.29.
2. Provide a cast coil type transformer with primary and secondary windings individually cast in epoxy or resin-encapsulated windings, as shown on the Data Sheet(s).
3. The transformer electrical insulation class shall be per Data Sheet(s). Transformer design temperature rise shall be based on values listed in the data sheet(s). Solid insulation in the transformer shall consist of inorganic materials as listed in the data sheet(s). The insulation between the high and low voltage coils shall be more than sufficient for the voltage stress without the need of a varnish.
4. Transformer coils shall be constructed of material as shown on the Data Sheet(s), continuously-wound on a non-aging, cold-rolled, grain-oriented, high permeability, silicon metal core of electrical grade steel with insulated laminations.
5. Core and coil assembly shall be mounted on a structural steel base, which shall be isolated from the rest of the structure by vibration pads.

6. The high voltage winding shall be wound over the low voltage winding with sufficient mechanical bracing to prevent movement during fault conditions and sufficient solid insulation to isolate the high voltage winding dielectric potential from the low voltage windings.
7. Sound level may not exceed sound levels listed in NEMA TR 1 (*Transformers, Step Voltage Regulators and Reactors*) standard, without fans operating.
8. The transformer ratings shall be as shown on the Data Sheet(s).
9. Surge protection, where not provided otherwise, shall be provided per the Data Sheet to protect the transformer system from lightning surges. The lightning surge arrester shall be silicone rubber housed and shall utilize Metal-Oxide Varistor (MOV) blocks. The arresters shall comply with IEEE C62.11 standards. The voltage rating and Maximum Continuous Operating Voltage (MCOV) ratings shall be appropriately rated for the system voltage and coordinated with the transformer design.

G. Accessories:

1. Temperature monitoring and cooling control system, as required by the Data Sheet(s), including thermal sensors, control wiring, temperature controller with test switch, power distribution wiring with current limiting fuses, indicating lights, alarm, and alarm silencing relay. The controller shall also have an auxiliary alarm contact for connection to a remote monitoring system.
    a. The temperature monitor shall be mounted flush on the front of the transformer, 54 inches above finished floor (AFF).
    b. The temperature monitor shall be mounted on a hinged front plate of a flush mounted box. The electrical connection shall be accessible, and the monitor shall be removable without de-energizing the transformer.
    c. The wiring for the temperature monitor shall be routed and supported independently of the transformer enclosure so that the enclosure panels can be removed without affecting the wiring. All wiring shall comply with the requirements of the Control Wiring section of this Specification.
    d. The temperature monitoring and cooling control system control power shall be powered by an external 120V ac source.
    e. The cooling fans, as required per the Data Sheet(s), shall be powered by either a locally mounted auxiliary transformer integrated into the overall transformer assembly or, where locally mounted auxiliary transformer not practical, via an external auxiliary power source per the Data Sheets(s).

f. The temperature monitoring and cooling control system shall include an LED or LCD display to allow reading of the hot spot temperature in each phase, and the highest temperature seen on each phase since the last reset. Additional features as listed below:
   1) A reset button shall be provided to reset the maximum readings.
   2) Indication Lights:
      a) Green (G) – Power On.
      b) Amber (A) – Fan On.
      c) Red (R) – High Temperature.
   3) Alarm Silence Pushbutton.
   4) Auto/Manual Fan Control Switch, as required by the Data Sheet(s).
   5) System Test Switch.
   6) Control and monitoring equipment for cooling fans.

2. Ground connection pad.
3. Provision for jacking, lifting, and otherwise moving as required to install or remove.
4. Diagram and rating nameplate.

H. Transformer Electrical Protection Relay:

1. Transformer electrical protection relay shall be installed within the transformer enclosure.
2. Transformer electrical protection relay shall be IEC 61850 (*Communication Networks and Systems in Substations*) standard compatible and interface with the Power Distribution Control System (PDCS) electrical protection system via IEC 61850 Generic Object Oriented Substation Event (GOOSE) messaging protocol.
3. Transformer electrical protection relay design basis is the applicable Schweitzer Engineering Laboratories (SEL) multifunction microprocessor-based electrical protection relay, as further defined on the Data Sheet(s).
4. Transformer electrical protection relay control power shall be supplied by an uninterruptible powersource.
5. Transformer electrical protection relay shall include all transformer related electrical control system input/output.
6. Transformer electrical protection relay shall conform to other electrical protection relay requirements as specified elsewhere in the Specification and as noted on the Data Sheet(s).

I. Digital Meters:

1. Digital Meters:
   a. Digital Meters functionality can either be integral with the Transformer Electrical Protection Relay(s) or stand-alone.

b. Digital meters shall comply with IEEE C37.90.1 for surge withstand.
c. Provide true RMS, with a plus/minus one percent (plus or minus 1 percent) accuracy, programmable, microprocessor-based meters enclosed in sealed cases with a simultaneous three-line display.
d. Meters shall have 0.56-inch high (minimum) Light Emitting Diode (LED) displays.
e. Watt-hour (Wh) meters shall have a single-line display with 0.56-inch high (minimum) LED displays.
f. Meters shall accept input from standard five ampere (5A) secondary-instrument transformers and direct voltage monitoring range to 600 volts, phase-to-phase, line voltage.
g. Programming shall be via a front panel display and a communication interface with a computer.
h. Password secured programming shall be stored in non-volatile Electrically-Erasable / Programmable Read-Only Memory (EEPROM) devices. Digital communications shall be Modbus RTU protocol via an RS485 serial port and an independently addressable RS485 serial port.
i. The meter shall calculate and store average min/max demand values for all readings based on a user selectable sliding window averaging period.
j. The meter shall have programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.
k. Meter shall provide Total Harmonic Distortion (THD) measurement to the thirty-first (31^{st}) order.
l. Multi-Function Meter shall simultaneously display:
    1) selected phase-to-neutral voltage.
    2) phase-to-phase (line) voltage.
    3) percent phase-to-neutral voltage THD.
    4) percent phase-to-phase voltage THD.
    5) selected phase current, neutral current, percent phase current THD, percent neutral current.
    6) selected total PF, kW, kVA, kVAR, FREQ, kVAh, kWh.
    7) Detected alarm conditions include:
        a) Over/under current.
        b) Over/under voltage.
        c) Over/under kVA.
        d) Over/under frequency.
        e) Over/under selected PF/kVAR.
        f) Voltage phase reversal.
        g) Voltage imbalance.
        h) Reverse power.
        i) Over percent THD.
    8) The meter shall have a Form C KYZ pulse output relay.

m. Power Meter shall simultaneously display:
   1) Watts.
   2) VARs.
   3) Selected kVA/PF.
   4) Detected alarm conditions include:
      a) Over/under kVA.
      b) Over/under PF.
      c) Over/under VARs.
      d) Over/under reverse power.

n. Voltmeter shall be selectable between simultaneous display of the three phases of phase-to-neutral voltages and simultaneous display of the three phases of the phase-to-phase (line) voltages.
   1) Detected alarm conditions include:
      a) Over/under voltage.
      b) Over/under voltage imbalance.
      c) Over percent THD.

o. Ammeter shall simultaneously display phase A, B, and C current.
   1) Detected alarm conditions include:
      a) Over/under current.
      b) Over percent THD.

J. Power Distribution Control System (PDCS) Interface(s):

1. All new power distribution equipment will be integrated into the Power Distribution Control System (PDCS).
2. The PDCS design basis architecture utilizes Schweitzer Engineering Laboratories (SEL) Real Time Automation Controllers (RTAC) to manage industrial control and automation.
3. The RTAC will communicate with the following, all generally characterized as intelligent electronic devices (IED):
   a. Multifunction electrical protection relays (PR) over fiber using the IEC 61850 GOOSE messaging protocol. Analog data from the PR will be polled by the RTAC. The RTAC can also send commands to these relays to execute intended functions.
   b. All data from the metering devices shall be brought back to the PDCS HMI via the RTAC. The RTAC will be the data concentrator for these devices.

K. Current Transformers (CT):

1. In accordance with IEEE C57.13.
2. Provide CTs with fully distributed windings in the quantities, ratios, and accuracy classes as specified in the Data Sheets.
3. Connections of current transformers, including taps of multi-ratio current transformers, shall terminate on shorting type terminal blocks located in control equipment compartment. Terminal blocks shall accommodate #8 AWG. All CT secondary wiring shall be yellow.

L. Meter Fusing:

1. Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

M. Insulated Barriers:

1. Where insulated barriers are required by reference standards, provide barriers in accordance with NEMA LI 1, Type GPO-3, 0.25-inch minimum thickness.

N. Terminal Boards:

1. Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers shall be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

O. Wire Marking:

1. Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

P. Transformer Neutral Connection:

1. Neutral Grounding Resistor (NGR) System as required per the Data Sheet(s):
    a. Ground the transformer neutrals with a neutral grounding resistor rated per the Data Sheets.
    b. Monitor the neutral grounding resistor by an NGR monitoring system similar to a Post Glover Pulser Plus “Or-equal.”
    c. Install the NGR monitoring system within the transformer metering compartment.

2. Direct-Connected Neutral Ground Connection as required per the Data Sheet(s).
    a. Where an NGR system is not required per the Data Sheet(s), direct connect the transformer neutral (via insulated conductor) to a dedicated plant ground grid grounding electrode, where a dedicated plant ground grid grounding electrode is not available the transformer neutral connection shall be connected to the closest plant ground grid accessible point.

2.05 MANUFACTURER'S NAMEPLATES

A. Each item of equipment shall have a nameplate bearing, as a minimum, the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. Include additional information as applicable to fully identify the equipment. Nameplates shall be made of noncorrosive metal. As a minimum, provide nameplates for transformers, circuit breakers, meters, switches, and switchgear.

2.06 FIELD FABRICATED NAMEPLATES

A. Provide laminated plastic nameplates, per ASTM D709, for each tagged equipment item, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the Drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be provided in accordance with Section 26 00 00, Electrical General Requirements for Field Fabricated Nameplates.

2.07 WARNING SIGNS

A. Provide warning signs for the enclosures of secondary unit substations having a nominal rating exceeding 600 volts.

B. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.29, such as for secondary unit substations, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 “Or-equal.”

2.08 SOURCE QUALITY CONTROL

A. Equipment Test Schedule:

1. The Owner and Engineer reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Owner and Engineer 30 calendar days before scheduled test date. Notify Owner and Engineer 15 calendar days in advance of changes to scheduled date.

B. Test Instrument Calibration:

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.
4. Dated calibration labels shall be visible on all test equipment.
5. Calibrating standard shall be of higher accuracy than that of the instrument tested.
6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third-party calibration, include the following:
    a. Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
    b. Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

C. Transformer Design Tests (Dry-Type):

1. In accordance with IEEE C57.12.01 and IEEE C57.12.91. Additionally, IEEE C57.12.80 section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports in the same submittal package as the product data, shop drawings, and certificates of transformer losses for each of the specified transformers. Design tests shall have been performed prior to the award of this contract.
2. Tests shall be certified and signed by a registered professional engineer. Engineers stamp and signature shall appear on at least the first page of the factory test reports.

3. Temperature rise:
    a. "Basically the same design" for the temperature rise test means a dry type transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type, the same temperature rise rating, the same insulating class and the same insulating medium as the transformer specified.
    b. Provide temperature rise readings, formulas, calculations of average temperature rise, and description of test method.
4. Lightning impulse:
    a. "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL and the same coil construction (such as wire wound primary and sheet wound secondary).
    b. IEEE C57.12.91 and IEEE C57.98. Provide design lightning impulse tests consisting of a reduced full-wave, two-chopped waves, and one full wave test for each phase of the primary and secondary windings of the same transformer.
    c. State test voltage levels.
    d. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.
    e. Partial Discharge Test per IEEE C57.124. Provide transformer ratings, description and diagram of test method used, test readings and final results.

2.09 SPARE PARTS

A. Spare parts and special tools required for 1 year of operation shall be provided per Supplier’s recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be per Supplier's written recommendations.

B. Field Quality Control: Provide itemized pricing for the following field service items.

1. Provide following field testing:
   a. Insulation resistance of each winding to ground and to other windings.
   b. Power factor testing of bushings before and after installation.
   c. Proper operation of cooling fans and controls.
   d. Proper operation of pressure relief device, sudden pressure relay and auxiliary relay, liquid level indicator, and tap changer.
2. Provide assistance during initial energization, including investigation and remediation of any failures or incorrect and inappropriate operation of equipment or system.
3. Twenty-four hours after initial energization, sample insulating liquid and test for dielectric strength, moisture content, neutralization number, color, content, and complete gas-in-oil analysis.
4. Supplier's service personnel shall be factory trained and shall report to the field Site with all tools, test equipment, and materials as required to perform the service required in paragraphs 1 through 3 above.

3.02 MANUFACTURER'S SERVICES

A. Provide Supplier's services as follows:

1. Assistance to Contractor: One day, one trip.
2. Certificate of Proper Installation: One day, one trip.
3. Training Program: One day, one trip.
4. Functional and Performance Testing: One day, one trip.

3.03 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Data Sheets.

END OF SECTION

DATA SHEETS:
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER

EQUIP NAME: TRANSFORMER
PROJECT: CTG 7
TAG NO. WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419
P.O. NO. BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
SITE CONDITIONS			
24-Hour Ambient DESIGN Temperature (Average)	ºF / ºC	86 /30	
24-Hour Ambient DESIGN Temperature (Maximum)	ºF / ºC	104 / 40	
INDOOR Ambient Temperature (Nominal)	ºF / ºC	See Section 01 61 00	
OUTDOOR Ambient Temperature (Minimum)	ºF / ºC	See Section 01 61 00	
OUTDOOR Ambient Temperature (Maximum)	ºF / ºC	101 / 38	
Site Elevation Above Sea Level	ft	0	
Seismic Class	-	By Contractor	
CHARACTERISTICS			
Operating Frequency	Hz	60	
Transformer Winding Type	-	By Contractor	
Cast Coil Winding Encapsulation Material (Epoxy or Resin)	-	By Contractor	
Cast Coil Transformer Winding Insulation (Porcelain, Glass Fiber, Nomex, Electrical-Grade Glass Polyester)	-	By Contractor	
Insulation Class DESIGN Temperature Rise	ºC	per Class B (Minimum)	
Insulation Class MAXIMUM Temperature Rise	ºC	per Class B (Minimum)	
Cooling Class	-	AN/AF	
Power Capacity @ Design Temp Rise	MVA	By Contractor	
Power Capacity @ Maximum Temp Rise	MVA	By Contractor	
Impedance @ Base MVA Rating	Z%	By Contractor	
Transformer X/R Ratio	-	By Contractor	
Core and Coil Construction Type	-	Circular	
Type of Material Used in Coils	-	Copper (Cu)	
SYSTEM CONFIGURATION			
Utilized as a Unit Auxiliary Power Transformer	Y/N	By Contractor	
Incomming Section Enclosure required?	Y/N	By Contractor	
Outgoing Section Enclosure required?	Y/N	By Contractor	
WINDINGS			
HIGH VOLTAGE (HV):			
Nominal Rated Voltage	kV	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Connection (Delta or Wye)	D or Y	By Contractor	
LOW VOLTAGE (LV):			
Nominal Rated Voltage	kV	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Connection	D or Y	By Contractor	
NEUTRAL:			
Basic Impulse Level (BIL)	kV	By Contractor	
Connection (UN-GRD, SOLID, H-RES, L-RES)	-	By Contractor	
Neutral Insulation (UNIFORM, GRADED)	-	By Contractor	
DISPLACEMENT BETWEEN HV AND LV WINDINGS	degrees	By Contractor	

DATA SHEETS:	
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
BUSHINGS			
High Voltage (HV):	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Location	-	By Contractor	
Segment	-	By Contractor	
Low Voltage (LV):	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Location	-	By Contractor	
Segment		By Contractor	
Neutral:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Location	-	By Contractor	

DATA SHEETS:	
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
CURRENT TRANSFORMERS (CT)			
High Voltage Set 1 (HVCT-S1):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Location	-	Outer	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 2 (HVCT-S2):			
Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Location	-	Middle	
Quantity (Set)	Qty	1 (for Owner's Use)	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 3 (HVCT-S3):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Location	-	Inner	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Thermal Factor	-	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set (LVCT-S1):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set (LVCT-S2):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Quantity (Set)	Qty	1 (for Owner's Use)	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Neutral Bushing (NCT-S):			
Quantity (Set)	Qty	1	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	

DATA SHEETS:	
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
CONNECTIONS			
High Voltage (HV) Side:			
Type:	-	By Contractor	
Location:	-	By Contractor	
Low Voltage (LV) Side:			
Type	-	By Contractor	
Location	-	By Contractor	
RLC-SNUBBER			
Required	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Integrated Disconnect Switch	Y/N	By Contractor	
Disconnect Switch RMS Momentary Asymmetrical Rating	kA	By Contractor	
Capacitor Rating	pF	By Contractor	
Resistor Rating, per phase	Ohm, Watt	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
SURGE PROTECTION DEVICES (SPD) / SURGE ARRESTERS (SA)			
High Voltage (HV) Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
Low Voltage (LV) Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
TAP CHANGER			
Manufacturer	-	By Contractor	
Type: No Load Tap Changer (NLTC) or Load Tap Changer (LTC)	-	NLTC	
Automatic or Manual	-	Manual	
Remote Operation	Y/N	By Contractor	
Tap Location or Regulated Winding	HV or LV	By Contractor	
No. of Steps & Percentage of Voltage (Above Nominal)	Qty x +%	(2) x +2.5% Steps	
No. of Steps & Percentage of Voltage (Below Nominal)	Qty x -%	(2) x –2.5% Steps	
COOLING			
Fan(s) Location – Segment (1, 2, 3, or 4)	-	By Contractor	
Quantity of Fan Motors per Stage	Qty	By Contractor	
Horsepower rating of Each Motor	HP	By Contractor	
Rated Voltage and Phases	V, PH	480V, 3 PH, 3W, 60Hz	
Full Load Current	A	By Contractor	
Guaranteed Power Requirements:			
First-Stage Cooling	kW	By Contractor	
Maximum Sound Level @ Max. MVA Rating and All Fans Operating:			
@ one (1) foot	dBA	By Contractor	
@ six (6) feet	dBA	< 85	

DATA SHEETS:
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER

EQUIP NAME: TRANSFORMER
PROJECT: CTG 7
TAG NO. WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419
P.O. NO. BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
CONTROL CABINET			
Location – Segment (1, 2, 3, or 4)	-	By Contractor	
AC Auxiliary Power Voltage supplied to Control Cabinet	VAC	480	
FREQUENCY OF AC AUXILIARY POWER SUPPLY	Hz	60	
Quantity of AC Auxiliary Power sources Supplied to Control Cabinet	1 or 2	By Contractor	
Power Required for AC Auxiliary Power Source	kVA	By Contractor	
DC Control Power Voltage supplied to Control Cabinet	VDC	125	
DC Rated Power Required	kVA	By Contractor	
TRANSFORMER ELECTRICAL PROTECTION RELAY			
Dedicated transformer electrical protection relay required	Y/N	Y	
Integral to transformer assembly	Y/N	Y	
Design Basis Model	-	SEL 787	
Location	-	Control Cabinet	
IEC 61850 compatible	Y/N	Y	
Control Power Voltage	VDC	125	
DC Rated Power Required	kVA	By Contractor	
ACCESSORIES			
Special Paint	Y/N	N	
Ground Resistor	Y/N	By Contractor	
Ground Resistor Voltage	V	By Contractor	
Ground Resistor Current Rating	A	By Contractor	
Automatic Transfer Switch for Second Power Supply	Y/N	By Contractor	
Winding Hotspot Monitoring System	Y/N	Y	
TESTS			
ANSI Routine Tests	Y/N	Y	
Winding Insulation	Y/N	Y	
Core Insulation	Y/N	Y	
Insulation Power Factor	Y/N	Y	
Auxiliary Cooling Losses	Y/N	Y	
Single Phase Excitation & Rated Voltage	Y/N	Y	
No Load Losses & Excitation Current	Y/N	Y	
Zero Sequence Impedance	Y/N	N	
Temperature Rise	Y/N	Y	
Low Frequency on Auxiliary Devices	Y/N	N	
Lightning Impulse	Y/N	N	
Front of Wave Impulse	Y/N	N	
Switching Impulse	Y/N	N	
Partial Discharge	Y/N	Y	
Audible Noise	Y/N	N	
Factory Acceptance Testing (FAT) Requirements (per specification 26 11 16)	Y/N	Y	

DATA SHEETS:			
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER			
		EQUIP NAME:	TRANSFORMER
PROJECT:	CTG 7	**TAG NO.**	WPCCTG-7-EMV60-XFMR-<TBD>
CP #:	1419	**P.O. NO.**	BY CONTRACTOR
CLIENT:	SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:**	New Orleans, LA

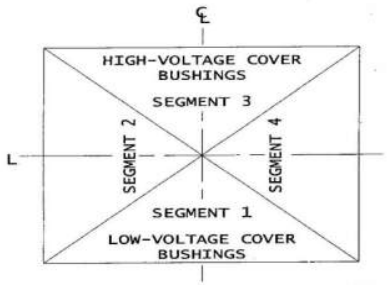
DESCRIPTION	Units	SPEC DATA	SELLER DATA
TECHNICAL DIRECTION			
Time required for field installation, start-up, and commissioning	-	By Contractor	
EFFICIENCY			
@ 100% of Maximum MVA	%	By Contractor	
@ 75% of Maximum MVA	%	By Contractor	
@ 50% of Maximum MVA	%	By Contractor	
VOLTAGE REGULATION (@ 100% of Maximum MVA)			
@ UNITY power factor (PF)	%	By Contractor	
@ 80% LAGGING power factor (PF)	%	By Contractor	
@ 80% LEADING power factor (PF)	%	By Contractor	
Excitation Current @ 100% Rated Voltage & Max. MVA	%	By Contractor	
GUARANTEED LOSSES			
Auxiliary Losses @ Full Load & Max MVA Rating	kW	By Contractor	
No-Load Losses @ 100% Rated Voltage	kW	By Contractor	
Load Losses @ Max MVA Rating	KW	By Contractor	
LOSS EVALUATION			
Auxiliary Losses	$/kW	49,000	
No-Load Losses	$/kW	49,000	
Load Losses	$/kW	49,000	
DIMENSIONS (APPROXIMATE)			
Overall Height	in.	By Contractor	
Overall Width	in.	By Contractor	
Overall Depth	in.	By Contractor	
Minimum Distance Between Surge Arresters	in.	By Contractor	
Recommended Min. Space Between Transformer and Adjacent Structures	in.	By Contractor	

DATA SHEETS: **3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER**		**EQUIP NAME:** TRANSFORMER	
PROJECT: CTG 7		**TAG NO.** WPCCTG-7-EMV60-XFMR-<TBD>	
CP #: 1419		**P.O. NO.** BY CONTRACTOR	
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS		**LOCATION:** New Orleans, LA	
DESCRIPTION	**Units**	**SPEC DATA**	**SELLER DATA**
WEIGHTS (APPROXIMATE)			
Core and Coil	lbs.	By Contractor	
Encolsure and Fittings	lbs.	By Contractor	
Total Transformer with Enclosure and Fittings	lbs.	By Contractor	
Total Shipping Weight	lbs.	By Contractor	
Weight of Largest Piece for Handling	lbs.	By Contractor	
DELIVERY			
Method of Shipment (truck, rail, barge, ship)	-	By Contractor	
OTHER			

FIGURE 1: ANSI/IEEE C57.12.10

REFER TO THIS FIGURE FOR ACCESSORY LOCATIONS, AS SPECIFIED WITHIN THESE DATASHEETS AND SPECIFICATIONS.

ANSI C57.12.10-1997



DATA SHEETS:			
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER			
		EQUIP NAME: TRANSFORMER	
PROJECT: CTG 7		**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>	
CP #: 1419		**P.O. NO.** BY CONTRACTOR	
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS		**LOCATION:** New Orleans, LA	
DESCRIPTION	**Units**	**SPEC DATA**	**SELLER DATA**
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
SITE CONDITIONS			
24-Hour Ambient DESIGN Temperature (Average)	ºF / ºC	86 /30	
24-Hour Ambient DESIGN Temperature (Maximum)	ºF / ºC	104 / 40	
INDOOR Ambient Temperature (Nominal)	ºF / ºC	See Section 01 61 00	
OUTDOOR Ambient Temperature (Minimum)	ºF / ºC	See Section 01 61 00	
OUTDOOR Ambient Temperature (Maximum)	ºF / ºC	101 / 38	
Site Elevation Above Sea Level	ft	0	
Seismic Class	-	By Contractor	
CHARACTERISTICS			
Operating Frequency	Hz	25	
Transformer Winding Type	-	By Contractor	
Cast Coil Winding Encapsulation Material (Epoxy or Resin)	-	By Contractor	
Cast Coil Transformer Winding Insulation (Porcelain, Glass Fiber, Nomex, Electrical-Grade Glass Polyester)	-	By Contractor	
Insulation Class DESIGN Temperature Rise	ºC	per Class B (Minimum)	
Insulation Class MAXIMUM Temperature Rise	ºC	per Class B (Minimum)	
Cooling Class	-	AN/AF	
Power Capacity @ Design Temp Rise	MVA	By Contractor	
Power Capacity @ Maximum Temp Rise	MVA	By Contractor	
Impedance @ Base MVA Rating	Z%	By Contractor	
Transformer X/R Ratio	-	By Contractor	
Core and Coil Construction Type	-	Circular	
Type of Material Used in Coils	-	Copper (Cu)	
SYSTEM CONFIGURATION			
Utilized as a Unit Auxiliary Power Transformer	Y/N	By Contractor	
Incomming Section Enclosure required?	Y/N	By Contractor	
Outgoing Section Enclosure required?	Y/N	By Contractor	
WINDINGS			
HIGH VOLTAGE (HV):			
Nominal Rated Voltage	kV	6.6	
Basic Impulse Level (BIL)	kV	By Contractor	
Connection (Delta or Wye)	D or Y	D	
LOW VOLTAGE (LV):			
Nominal Rated Voltage	kV	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Connection	D or Y	Y	
NEUTRAL:			
Basic Impulse Level (BIL)	kV	By Contractor	
Connection (UN-GRD, SOLID, H-RES, L-RES)	-	L-RES	
Neutral Insulation (UNIFORM, GRADED)	-	GRADED	
DISPLACEMENT BETWEEN HV AND LV WINDINGS	degrees	By Contractor	

DATA SHEETS:
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER

EQUIP NAME: TRANSFORMER
PROJECT: CTG 7
TAG NO. WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419
P.O. NO. BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
BUSHINGS			
High Voltage (HV):	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Location	-	By Contractor	
Segment	-	By Contractor	
Low Voltage (LV):	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Location	-	By Contractor	
Segment		By Contractor	
Neutral:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level (BIL)	kV	By Contractor	
Location	-	By Contractor	

DATA SHEETS:	
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
CURRENT TRANSFORMERS (CT)			
High Voltage Set 1 (HVCT-S1):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Location	-	Outer	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 2 (HVCT-S2):			
Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Location	-	Middle	
Quantity (Set)	Qty	1 (for Owner's Use)	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 3 (HVCT-S3):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Location	-	Inner	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Thermal Factor	-	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set (LVCT-S1):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set (LVCT-S2):			
CT Mounting (B - Bushing or O - Other)	B or O	By Contractor	
Quantity (Set)	Qty	1 (for Owner's Use)	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Neutral Bushing (NCT-S):			
Quantity (Set)	Qty	1	
Ratio of Each CT Set	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	

DATA SHEETS:	
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
CONNECTIONS			
High Voltage (HV) Side:			
Type:	-	By Contractor	
Location:	-	By Contractor	
Low Voltage (LV) Side:			
Type	-	By Contractor	
Location	-	By Contractor	
RLC-SNUBBER			
Required	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Integrated Disconnect Switch	Y/N	By Contractor	
Disconnect Switch RMS Momentary Asymmetrical Rating	kA	By Contractor	
Capacitor Rating	pF	By Contractor	
Resistor Rating, per phase	Ohm, Watt	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
SURGE PROTECTION DEVICES (SPD) / SURGE ARRESTERS (SA)			
High Voltage (HV) Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
Low Voltage (LV) Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
TAP CHANGER			
Manufacturer	-	By Contractor	
Type: No Load Tap Changer (NLTC) or Load Tap Changer (LTC)	-	NLTC	
Automatic or Manual	-	Manual	
Remote Operation	Y/N	N	
Tap Location or Regulated Winding	HV or LV	By Contractor	
No. of Steps & Percentage of Voltage (Above Nominal)	Qty x +%	(2) x +2.5% Steps	
No. of Steps & Percentage of Voltage (Below Nominal)	Qty x -%	(2) x –2.5% Steps	
COOLING			
Fan(s) Location – Segment (1, 2, 3, or 4)	-	By Contractor	
Quantity of Fan Motors per Stage	Qty	By Contractor	
Horsepower rating of Each Motor	HP	By Contractor	
Rated Voltage and Phases	V, PH	480V, 3 PH, 3W, 60Hz	
Full Load Current	A	By Contractor	
Guaranteed Power Requirements:			
First-Stage Cooling	kW	By Contractor	
Maximum Sound Level @ Max. MVA Rating and All Fans Operating:			
@ one (1) foot	dBA	By Contractor	
@ six (6) feet	dBA	< 85	

DATA SHEETS:
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER

EQUIP NAME: TRANSFORMER
PROJECT: CTG 7
TAG NO. WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419
P.O. NO. BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
CONTROL CABINET			
Location – Segment (1, 2, 3, or 4)	-	By Contractor	
AC Auxiliary Power Voltage supplied to Control Cabinet	VAC	480	
FREQUENCY OF AC AUXILIARY POWER SUPPLY	Hz	60	
Quantity of AC Auxiliary Power sources Supplied to Control Cabinet	1 or 2	By Contractor	
Power Required for AC Auxiliary Power Source	kVA	By Contractor	
DC Control Power Voltage supplied to Control Cabinet	VDC	125	
DC Rated Power Required	kVA	By Contractor	
TRANSFORMER ELECTRICAL PROTECTION RELAY			
Dedicated transformer electrical protection relay required	Y/N	Y	
Integral to transformer assembly	Y/N	Y	
Design Basis Model	-	SEL 787	
Location	-	Control Cabinet	
IEC 61850 compatible	Y/N	Y	
Control Power Voltage	VDC	125	
DC Rated Power Required	kVA	By Contractor	
ACCESSORIES			
Special Paint	Y/N	N	
Ground Resistor	Y/N	By Contractor	
Ground Resistor Voltage	V	By Contractor	
Ground Resistor Current Rating	A	By Contractor	
Automatic Transfer Switch for Second Power Supply	Y/N	By Contractor	
Winding Hotspot Monitoring System	Y/N	Y	
TESTS			
ANSI Routine Tests	Y/N	Y	
Winding Insulation	Y/N	Y	
Core Insulation	Y/N	Y	
Insulation Power Factor	Y/N	Y	
Auxiliary Cooling Losses	Y/N	Y	
Single Phase Excitation & Rated Voltage	Y/N	Y	
No Load Losses & Excitation Current	Y/N	Y	
Zero Sequence Impedance	Y/N	N	
Temperature Rise	Y/N	Y	
Low Frequency on Auxiliary Devices	Y/N	N	
Lightning Impulse	Y/N	N	
Front of Wave Impulse	Y/N	N	
Switching Impulse	Y/N	N	
Partial Discharge	Y/N	Y	
Audible Noise	Y/N	N	
Factory Acceptance Testing (FAT) Requirements (per specification 26 11 16)	Y/N	Y	

DATA SHEETS:			
3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER			
		EQUIP NAME:	TRANSFORMER
PROJECT:	CTG 7	**TAG NO.**	WPCCTG-7-EMV25-XFMR-<TBD>
CP #:	1419	**P.O. NO.**	BY CONTRACTOR
CLIENT:	SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:**	New Orleans, LA

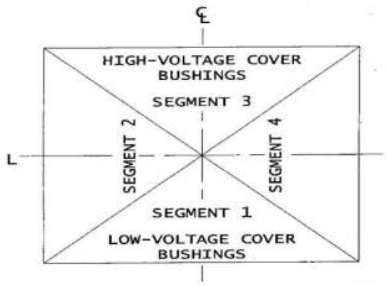
DESCRIPTION	Units	SPEC DATA	SELLER DATA
TECHNICAL DIRECTION			
Time required for field installation, start-up, and commissioning	-	Fac	
EFFICIENCY			
@ 100% of Maximum MVA	%	By Contractor	
@ 75% of Maximum MVA	%	By Contractor	
@ 50% of Maximum MVA	%	By Contractor	
VOLTAGE REGULATION (@ 100% of Maximum MVA)			
@ UNITY power factor (PF)	%	By Contractor	
@ 80% LAGGING power factor (PF)	%	By Contractor	
@ 80% LEADING power factor (PF)	%	By Contractor	
Excitation Current @ 100% Rated Voltage & Max. MVA	%	By Contractor	
GUARANTEED LOSSES			
Auxiliary Losses @ Full Load & Max MVA Rating	kW	By Contractor	
No-Load Losses @ 100% Rated Voltage	kW	By Contractor	
Load Losses @ Max MVA Rating	KW	By Contractor	
LOSS EVALUATION			
Auxiliary Losses	$/kW	49,000	
No-Load Losses	$/kW	49,000	
Load Losses	$/kW	49,000	
DIMENSIONS (APPROXIMATE)			
Overall Height	in.	By Contractor	
Overall Width	in.	By Contractor	
Overall Depth	in.	By Contractor	
Minimum Distance Between Surge Arresters	in.	By Contractor	
Recommended Min. Space Between Transformer and Adjacent Structures	in.	By Contractor	

DATA SHEETS: **3-PHASE 2-WINDING DRY TYPE MEDIUM VOLTAGE TRANSFORMER**		**EQUIP NAME:** TRANSFORMER	
PROJECT: CTG 7		**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>	
CP #: 1419		**P.O. NO.** BY CONTRACTOR	
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS		**LOCATION:** New Orleans, LA	
DESCRIPTION	**Units**	**SPEC DATA**	**SELLER DATA**
WEIGHTS (APPROXIMATE)			
Core and Coil	lbs.	By Contractor	
Encolsure and Fittings	lbs.	By Contractor	
Total Transformer with Enclosure and Fittings	lbs.	By Contractor	
Total Shipping Weight	lbs.	By Contractor	
Weight of Largest Piece for Handling	lbs.	By Contractor	
DELIVERY			
Method of Shipment (truck, rail, barge, ship)	-	By Contractor	
OTHER			

FIGURE 1: ANSI/IEEE C57.12.10

REFER TO THIS FIGURE FOR ACCESSORY LOCATIONS, AS SPECIFIED WITHIN THESE DATASHEETS AND SPECIFICATIONS.

ANSI C57.12.10-1997



SECTION 26 12 13
LIQUID FILLED MEDIUM VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. This Specification together with applicable Data Sheets, covers the technical requirements for the design, manufacture, and testing of liquid filled medium voltage transformers for outdoor installation in a power plant.

1.02 REFERENCES

A. The Supplier's design shall comply with the latest editions, at the date of issuance for bids, of applicable Codes, Standards and Regulations. If there is, or seems to be, a conflict between this specification and a referenced document, the matter shall be submitted to and approved by the Owner or Engineer prior to implementation. Deviations from applicable Codes, Standards and Regulations shall only be implemented with the written approval of the Owner or Engineer.

1. American Society for Testing Materials:
   a. ASTM D117, Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin.
   b. ASTM D3487, Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
2. American Welding Society: AWS D1.1, Structural Welding Code.
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 24, Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.
   b. 32, Standard Requirements, Terminology, and Test Procedure for Neutral Grounding Devices.
   c. 80, IEEE Guide for Safety in AC Substation Grounding.
   d. 112, Test Procedures for Polyphase Induction Motors.
   e. C2, National Electrical Safety Code.
   f. C57.12.00, General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers.
   g. C57.12.70, Terminal Markings and Connections for Distribution and Power Transformers.
   h. C57.12.90, Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers.
   i. C57.13, Requirements for Instrument Transformers.
   j. C57.19.00, General Requirements and Test Procedure for Outdoor Apparatus Bushings.

k. C57.19.01, Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.
l. C57.91, Guide for Loading Mineral Oil Immersed Transformers.
m. C57.104, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
n. C57.109, Guide for Transformer Through Fault Current.
o. C57.110, Recommended Practice for Establishing Transformer Capability When Supplying Non-Sinusoidal Load Currents.
p. C57.113, Trial Use Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors.
q. C62.11, Standard for Metal-Oxide Surge Arresters for AC Power Circuits.
r. C62.22, Guide for the Application of Metal-Oxide Surge Arresters for Alternating Current Systems.

4. International Conference of Building Officials (ICBO): IBC-2015, Uniform Building Code.
5. National Electrical Manufacturers Association (NEMA):
   a. ICS 1, General Standards for Industrial Controls and Systems.
   b. ICS 2, General Standards for Industrial Control Devices, Controllers, and Assemblies.
   c. ICS 6, Enclosures for Industrial Controls and Systems.
   d. LA1, Surge Arresters.
   e. MG1, Motors and Generators.
   f. TR1, Transformers, Regulators and Reactors.
6. National Fire Protection Association: NFPA 70, National Electric Code.
7. Occupational Safety & Health Administration: Part 1 – Regulations (Standards – 29CFR).
8. UL.
9. Factory Mutual Insurance (FM).

B. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with the Section 01 33 00, Submittal Procedures. In addition to these Documents, supply engineering data, as listed below:

1. Symbols and wiring identification systems shall be in accordance with ANSI Y32.2 and IEEE 315.
2. Certified copies of the factory test reports.
3. Outline Drawings completely dimensioned showing:
   a. Plan and elevations.
   b. High-voltage bushing details.
   c. Low-voltage bushing bus duct flange details.
   d. Location and identification of accessories.
   e. Anchor bolt hole location and hole diameter.
   f. Ground pad locations.
   g. Weight of transformer and center of gravity, with and without insulating liquid and shipping weights.
   h. Total quantity and MSDS of insulating fluid.
   i. Location, mounting, and connection details of lightning arresters (if applicable).
   j. Control cabinet dimensional details.
4. Detailed Connection (Wiring) Diagrams:
   a. Interconnecting wiring of components of forced cooling equipment.
   b. Wiring of devices with switches and relays, or electrical connections, including current transformers.
   c. Identification of terminal blocks and connections.
5. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
6. Load List information for all equipment supplied.
7. Motor data sheets.
8. Ratio correction factors and excitation curves for each size and type of current transformer.
9. Nameplate diagram per ANSI standards.
10. Factory Tests: Submit proposed test program prior to time transformer is ready for core and coil inspection; include method and description of each test and test sequence. Submit certified reports of production tests as soon as tests are completed.
11. Installation, Operating, and Maintenance Instructions: Installation, operating, and maintenance instructions shall cover equipment furnished.
12. Mfr. Catalog Cut Sheets & IOMs for all accessories and instruments.

1.04 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.05 SHIPPING, HANDLING, AND STORAGE

A. Shipping and Packaging:

1. Prior to shipment transformer tank shall be hermetically sealed and filled with insulating liquid.
2. Plug, cap, or cover exposed openings with plywood or other suitable material.
3. Impact detectors/recorders in all three planes shall be provided. Full instructions shall be furnished for interpretation of impact detectors/recorders. If recorder is utilized, the chart must record the entire trip duration to the final destination without retracing. Supplier shall provide maximum shock acceptable criteria prior to shipment.
4. A pressure vacuum gauge shall be provided to monitor the tank’s pressure during shipment.
5. Preparation for shipment shall be in accordance with Supplier’s standards.
6. Material Safety Data Sheets (MSDS) shall be included with packing lists.
7. Deliver loose parts in boxed plywood containers and ship as a unit with equipment. Identify shipping boxes by order numbers, Project name, Project location, equipment number, and description of contents. Use ink, paint, or other indelible material markings. Securely affix a copy of completed packing list to each separate shipping package.
8. Provide instructions for proper unpacking.

1.06 WARRANTY AND GUARANTEES

A. Furnish Supplier’s extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Supplier must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. GE Prolec / SPX Transformer Solutions (formerly Waukesha Electric).
2. Hitachi Energy (formerly ABB Power Grids).
3. Niagara Power Transformer.
4. Siemens.
5. Virginia Transformer.
6. WEG.

B. Submit Product Data for each piece of electrical equipment provided.

2.02 DESIGN REQUIREMENTS

A. See Data Sheets for additional information.

B. Furnish transformer insulating liquid in sufficient quantity as required for transformer operation and of type as indicated on Data Sheets.

C. Equipment 600 volts and below shall be UL labeled.

D. Winding Characteristics:

1. Windings and internal connections shall be copper and circular in cross-section.
2. Designed and constructed to withstand short-circuit currents as defined by IEEE C57.12.00 for 2 seconds, resulting from three-phase faults on either side of transformer with sources of short-circuit current as indicated on Data Sheets.

3. Capable of withstanding, without injury, mechanical and thermal stresses caused by through faults on external terminals of windings, with 105 percent rated voltage maintained across terminals of windings intended for connection to sources of energy.
4. Designed to operate above rated voltage or below rated frequency in accordance with IEEE C57.12.00.
5. Transformer shall be rated for continuous operation at 110 percent over excitation and 30 seconds at 125 percent over excitation.

E. Sound Level:

1. Design and construct transformer and auxiliary cooling equipment to minimize audible noise generated with transformer energized at rated voltage and auxiliary cooling equipment in operation.
2. Noise Level: In accordance with NEMA TR1 Table 1. Measurement procedure shall be per ANSI/IEEE standards.

F. Loss Evaluation:

1. Losses will be a maximum as stated on the transformer Data Sheets.
2. At time of shipment, actual losses and increased cooling power requirements resulting in total losses that exceed the maximum permitted losses shall be compensated for by a reduction in contracted purchase price equivalent to the excess losses times the cost per KW listed in the Data Sheets.

2.03 HIGH VOLTAGE BUSHINGS

A. Bushings shall be bulk porcelain and rated for terminating 90 degree C cables.

B. Bushings shall be marked in a permanent manner to identify the phase of each bushing. Marking shall be in accordance with standard nomenclature.

C. Bushings shall be mounted on side of tank and suitable for connection to Supplier’s cables.

D. Terminal box shall include a metal enclosed cable termination compartment sized adequately for the number and size of cables being terminated. Space shall also be sufficient for cable stress cone termination kits (above 600V). Suitable buswork and support shall be provided to suit these incoming cables. Cable support shall be so arranged that the side mounted bushings shall not support any part of the cable weight. Access to the compartment shall be by full height removable, gasketed, covers with handles, which shall be in smaller sections as necessary to allow removal by a single person. The compartment shall be large enough to restrain the cable. All hardware shall be stainless steel. The compartment shall include a space heater with switch and adjustable humidistat. Compartment shall have two 4-inch infrared inspection windows positioned to allow thermal measurement of bushing and connections.

E. Each bushing with a stud-type connection shall be furnished with a removable four-hole spade of sufficient size to accommodate cable connections and be capable of continuously carrying maximum rated current.

2.04 LOW VOLTAGE BUSHINGS

A. Bushings shall be dry-type porcelain.

B. Bushings shall be mounted on side of tank enclosed in NEMA 3R, air-tight terminal chamber, with side entry for cable connection or throat connection for bus duct per Data Sheets.

C. Bushings shall be marked in a permanent manner to identify the phase of each bushing. Marking shall be in accordance with standard nomenclature.

2.05 BUSHING CURRENT TRANSFORMERS

A. In accordance with IEEE C57.13.

B. Provide CTs with fully distributed windings in the quantities, ratios, and accuracy classes as specified in the Data Sheets.

C. Connections of current transformers, including taps of multi-ratio current transformers, shall terminate on shorting type terminal blocks located in control equipment compartment. Terminal blocks shall accommodate #8 AWG. All CT secondary wiring shall be yellow.

2.06 CORE

A. Constructed of high permeability, low loss, grain-oriented, laminated silicon steel. The laminations shall be flat and without burrs and sharp edges. The laminations shall be insulated. Insulation material of laminations shall be resistant to the effects of hot insulating liquid.

B. Clamped and braced to resist distortion caused by short-circuit stresses within rating or transportation handling, and to prevent shifting of core laminations, in accordance with IEEE C57.12.00.

C. The internal core ground shall be connected at one point only through an outside type bushing, so all core ground measurements can be made externally. The bushing shall be mounted within an external enclosure on the transformer cover. The bushing external connection will normally be grounded except for periods of testing. The enclosure cover shall be gasketed and bolted to minimize moisture infiltration. The enclosure cover shall be labeled with a stainless steel nameplate "Core Ground" to permanently identify the connection. The external core ground strap shall be copper bus and connected between the bushing and transformer tank top ground pads using threaded studs or bolted connections with standard NEMA 2-hole spacing.

2.07 DE ENERGIZED TAP CHANGER

A. Provide manually operated de-energized tap changer with tap voltages as indicated on the Data Sheets.

B. Full capacity taps shall be located in high-voltage windings and shall be in accordance with Data Sheets. Tap positions shall not limit the kVA rating of the transformer.

C. Capable of carrying full transformer through-fault current without damage or contact separation.

D. Operator:

1. Gang-operated from a single operating point.
2. Operating handle shall be accessible from transformer base.
3. Operating mechanism shall include provisions for pad locking in each tap position.
4. Tap position indicator shall be provided and shall be easily visible. The tap designation number 1 or the letter A shall be assigned to the highest tap.

2.08 INSULATING LIQUID AND PRESERVATION SYSTEM

A. Unless otherwise noted on Data Sheets, provide Supplier's standard insulating liquid.

B. Insulating liquid shall be certified to contain no detectable PCB at the time of shipment. Certification shall also be provided that transformer or components have not been contaminated with PCBs prior to shipment.

C. Insulating liquid shall meet or exceed requirements of ASTM D3487 standards and shall meet the following requirements, at minimum:

1. Chemically stable.
2. Contain less than 15 ppm water when tested in accordance with ASTM D1533.
3. Possess high dielectric strength.
4. Test at least 30kV upon receipt at final destination when tested in accordance with ASTM D877.

D. In the event that insulating liquid received tests less than 30 kV in dielectric strength, Supplier shall provide labor, material, and equipment required to replace.

E. "Less flammable" insulating liquid shall meet or exceed the requirements of FM 6933 and NEC 450.23, as well as be non-hazardous rated and biodegradable.

2.09 TANK

A. Transformer tank, cover, and manhole cover construction shall be capable of withstanding, without injury, stresses caused by shipment, seismic activity, and operation. Cover and cover-mounted manholes/handholes shall be crowned to prevent accumulation of water.

B. Cooling equipment and components subject to pressures shall be designed to withstand, without permanent deformation, pressures of at least 25 percent greater than maximum operating pressures. The maximum design withstand pressure shall be indicated on nameplate.

C. Design shall include sufficient insulating liquid expansion volume to allow operation under load conditions.

D. Main tank and radiators shall be designed for full vacuum filling in field.

E. Main Cover Seal: Welded construction.

F. Provide one or more manholes in tank cover for access to bushing connections and current transformers. Size shall be sufficient to allow removal of any CTs.

G. Lifting lugs and jack lugs shall be provided for lifting and jacking up the completely assembled transformer. There shall be sufficient clear headroom above each jack lug.

H. Centerline marks shall be clearly and indelibly marked on each side of the transformer to facilitate precise location and alignment during installation.

2.10 GASKETS

A. Unaffected by hot insulating liquid, retain their resiliency during the life of the associated equipment, and be unaffected by weather while maintaining insulating liquid and gas tightness.

B. Metal surfaces to which gaskets are applied shall be smooth and have sufficient rigidity to assure proper compression of gaskets.

C. Compressed Thickness: 1/8-inch minimum.

D. Gasket flanges shall have grooves or stops to prevent overcompression of gaskets. Bolted transformer tank or accessory openings shall be gasketed.

E. Provide a complete set of spares, including those for manholes/handholes.

2.11 RADIATORS OR HEAT EXCHANGERS

A. Rigidly support from tank either through piping or brackets.

B. Valves shall be provided on each removable radiator panel or heat exchanger to allow removal without draining transformer. Oil tight covers shall be provided with each connection to be used when cooling equipment is detached.

C. Provide drain plug in bottom header and vent plug in top header of each radiator.

D. Radiators shall be removable and be equipped with lifting lugs for lifting by a crane.

2.12 COOLING SYSTEM

A. Cooling class stated on Data Sheets. Include necessary supports, control equipment, conduit, and wiring.

B. Powered by low-voltage, three-phase, three-wire, ac power feed as described in Data Sheets.

C. Control Equipment: Include circuit breakers, selector switches, temperature control relays, alarm actuating devices, and associated equipment required to provide complete control of cooling system equipment.

D. Temperature Control Equipment:

1. Readily accessible for adjustment of settings.
2. Provide dial type indicators on temperature relays.

E. Nameplate Information:

1. Recommended temperature setting to start cooling equipment on a rated temperature rise basis.
2. Recommended temperature setting to initiate alarm based on a rated temperature rise basis.

F. Fans:

1. Individually thermally-protected.
2. Motors shall be totally enclosed and weatherproof.
3. Fan guards shall prevent passage of any object greater than 1/2-inch diameter (“OSHA” guards).
4. Power cables shall be hardwired to motor. Plug in connections are not acceptable.
5. Wiring from fans to control cabinet shall be routed in conduit.

2.13 GROUNDING PROVISIONS

A. Ground non-energized metallic components of transformer.

B. Tank grounding provisions shall consist of two silver-plated ground pads, welded on base or on tank wall near base on diagonal corners. Ground pads shall be constructed as per IEEE C57.12.10.

C. Each ground pad shall be provided with NEMA two-hole ground cable crimp type lug with bolts for 4/0 AWG cable termination.

2.14 NEUTRAL GROUNDING RESISTOR

A. Secondary neutral grounding equipment shall be provided. The transformer neutral shall be brought out using a bushing identical to the low voltage phase bushings. Grounding equipment shall be mounted on top of transformer and shall be part of transformer unit.

B. Grounding resistors shall be stainless steel type and insulated with full voltage rated insulators. Lugs shall be provided for neutral and ground connections. Enclosures shall be NEMA 3R galvanized with stainless steel hardware. Ground resistors shall meet the requirements of IEEE 32.

C. Ratings of neutral grounding resistor shall be as indicated on Data Sheets.

2.15 ACCESSORIES

A. Provide standard accessories in accessories in accordance with IEEE C57.12.10.

B. Equip with the following accessories.

1. Liquid level gauge, magnetic type, with low-level alarm contact.
2. Hot spot winding temperature indicating thermal relay and detection equipment with high-temperature alarm contact and high-high alarm and trip contacts provided on each winding.
3. One top insulating liquid temperature gauge with drag hand and with alarm contacts.
4. Fault pressure relay with alarm and trip contacts; with fault alarm visible from grade.
5. Gas accumulation relay with gas level indication and alarm contacts.
6. Pressure relief devices, mechanical automatic resealing type with alarm contact and mechanical target.
7. Common alarm contact.
8. Pressure vacuum gauge to monitor the sealed tank system.
9. All alarm, control, and auxiliary relays shall be approved by the Engineer. Preferred vendor is Qualitrol.

C. Transformer Electrical Protection Relay:

1. Transformer electrical protection relay shall be installed within the transformer enclosure.
2. Transformer electrical protection relay shall be IEC 61850 (*Communication Networks and Systems in Substations*) standard compatible and interface with the Power Distribution Control System (PDCS) electrical protection system via IEC 61850 Generic Object Oriented Substation Event (GOOSE) messaging protocol.
3. Transformer electrical protection relay(s) design basis is the applicable Schweitzer Engineering Laboratories (SEL) multifunction microprocessor-based electrical protection relay, as further defined on the Data Sheet(s).
4. Transformer electrical protection relay control power shall be supplied by an uninterruptible power source.

5. Transformer electrical protection relay shall include all transformer related electrical control system input/output.
6. Transformer electrical protection relay shall conform to other electrical protection relay requirements as specified elsewhere in this Specification and as noted on the Data Sheet(s).

D. Alarm Contacts:

1. Suitable for operation at 125V dc, 120V ac or 24V dc.
2. Rated at least 0.5A make-or-break at 125V dc, 5A at 120V ac, 2A at 24V dc.
3. Form “C”, one normally closed and one normally open, which change state on alarm condition. The convention used at this facility is “open to alarm”.

E. Provide insulating liquid drain globe valve with pipe plug and provisions for a lower filter press connection, with insulating liquid sampling valve and connection.

F. Provide gas (above liquid level) and insulating liquid sampling valves at the top of tank.

G. Mount accessories on low voltage side of transformer whenever possible.

H. Accessories requiring access for servicing, resetting, or recalibration while transformer is energized shall be mounted less than 6 feet above transformer base with the exception of gas detector relay.

I. Each device, valve, gauge, instrument, relay, bushing, and current transformer mounted on transformer shall be permanently labeled to coincide with identification indicated by Owner using stainless steel tags with black imprinted lettering.

J. Control Cabinet:

1. Ventilated NEMA Type 4X outdoor dust and rain-resistant with a rain hood and hinged gasketed door. Ventilation louvers shall be insect resistant.
2. Mount on side of transformer tank with top not more than 6 feet above transformer base.
3. Door shall have provisions for padlocking.
4. Equip with compact fluorescent lighting fixtures with cabinet door-operated switch, 20A specification grade GFI duplex receptacle, and thermostatically controlled cabinet heaters, each on a separate circuit controlled by individual circuit breakers.

5. Contain barrier-type terminal blocks for current transformer leads and alarm leads and control equipment not specifically requiring mounting at other locations on transformer.

K. The following trip functions shall be terminated on a terminal strip for field connections to plant control system (PCS):

1. Thermometer for insulating liquid temperature trip.
2. HV winding temperature trip.
3. LV winding temperature trip.
4. Sudden pressure relay trip.

L. Embedded winding RTD's.

2.16 WIRING

A. Connect control devices and alarms to terminal blocks located in transformer control cabinet.

B. Control panel wiring shall be accomplished in a neat and orderly manner. Where practical, use water-tight wiring trough or gutter with readily removable covers. Two or more wires that run together shall be clamped or tied in a straight lay bundle at approximately 15-inch intervals. Ties or clamps shall be nonmetallic. Wiring shall be arranged so as to be readily accessible for inspection and maintenance, and in no case shall wiring arrangement impede access to panel mounted devices.

C. Electrical Conductors:

1. 600 volts, Class B, stranded, tinned copper with FRXLPE moisture resistant insulation, UL approved.
2. Wire size shall be a minimum of #14 AWG for low-voltage control circuits, #12 AWG for low-voltage power circuits, and #10 AWG YELLOW for current transformer secondary circuits.

D. Hinge wiring shall be fine-stranded, flexible-type, secured on each side of hinge and formed with sufficient slack to minimize strand fatigue and breaking.

E. Terminal Blocks:

1. Industrial duty, barriered, and furnished with white marking strips.
2. Where permitted by safety codes and standards furnish without covers.
3. Furnish a minimum of 20 percent spare terminals.
4. Install shorting type terminal block at accessible location for current transformers supplied with equipment.

5. External control (field) wiring shall be rated 600V minimum and have pan-head screw terminals suitable for #12 AWG and smaller 600 volt insulated conductors.
6. Terminal blocks used for internal wiring shall be rated 600V, 30 A and capable of accepting a minimum of two #10 AWG wires.
7. Current transformer circuits and 120V ac and 125V dc power supply circuits shall be similar to the control wiring terminal blocks, but shall be capable of accepting two #8 AWG maximum wire size.
8. Current transformer circuits and 120V ac and 125V dc power circuits shall be separate from each other and from terminal blocks for control wiring.
9. Model numbers, and arrangement of connections on terminal blocks shall be approved by the Engineer.

F. Current transformer leads shall be brought to shorting type terminal blocks using #10 minimum YELLOW AWG conductor. There shall be no sliding link terminal blocks in current and potential transformer circuits. GE EB27 one-piece shorting type terminal blocks with pan-head screws shall be provided.

G. Permanently label terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary device to coincide with identification indicated on Datasheet. Terminals provided for termination of external circuits shall be identified by inscribing circuit designations on terminal block marking strips with indelible black ink. Wiring terminations shall be identified by printed labels on flame-resistant heat shrink conductor identification sleeves. A conductor identification sleeve shall be provided on each end of each internal conductor. Each sleeve shall be marked with the opposite end designation identification. Wire identification shall correspond with detailed connection (wiring) diagram.

H. Terminate conductors with ring-type non-insulated, seamless, indent-compression lugs. Terminal lugs shall be made of copper and shall be tin-plated. No splice shall be permitted in any wire or cable, and no more than two wires per terminal shall be used.

2.17 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. The main transformer nameplate shall contain connection and rating information in accordance with ANSI and NEMA standards, plus approximate transformer weight with and without insulating liquid, type and quantity of insulating liquid, and date of manufacture. Nameplate shall state transformer contains no detectable PCB. Main transformer nameplate shall include equipment Project tag number assigned by the Data Sheets.

C. Where transformer includes a tap changer, a tap changer nameplate shall be furnished with a stainless steel nameplate, permanently attached with stainless steel hardware next to tap changer operating handle.

D. All external components of transformer shall be labeled, including instructive labels, such as valve and tap changer position.

2.18 PAINTING

A. Supplier's standard.

B. Thoroughly cleaned by particle blasting and painting with at least one corrosion inhibiting primer and one finish coat to give a total dry film thickness of no less than 3 mils.

C. Finish coat shall be Supplier's standard.

D. Furnish two gallons of touchup paint.

2.19 SOURCE QUALITY CONTROL

A. Tests and Calculations:

1. Engineer shall have the right to witness tests. Notify Engineer at least 30 working days in advance of test to allow their representative to be present.
2. The transformer Supplier shall make his plant available to the Owner's personnel and/or his representatives, to inspect the transformer and accessories purchased, at all times from the receipt of the purchase order until shipment, including design, drawing approval, construction, testing, and/or packaging for shipment.
3. If the inspector, through oversight or otherwise, has accepted material or work which does not meet the Specifications or design drawings, and such non-conformance is later uncovered, it will be rejected at the Supplier's cost by the Engineer, regardless of the stage of completion.
4. Each transformer shall be subject to 'routine', 'design', and 'other' tests as required by IEEE to include the following:
    a. Resistance measurements of windings on rated voltage tap and at tap extremes of given rating.

b. Ratio tests on rated voltage connections and tap connections.
c. Polarity and phase displacement and phase sequence tests on rated voltage connections.
d. No-load losses and excitation current at rated voltage and frequency on rated voltage connections.
e. Impedance voltage and load loss at rated current and rated frequency on rated voltage tap and at tap extremes on given rating.
f. Regulation and efficiency calculations at rated load and rated voltage.
g. Insulation resistance tests (high-voltage to ground, each low voltage to ground, each high-voltage to low-voltage).
h. Insulation power factor test.
i. Core ground Megger test.
j. Test transformer in accordance with IEEE C57.12.00 and IEEE C57.12.90.
k. Combustible gas-in-oil analysis before and after factory testing.

5. Comply with all requirements, tests, inspections, reports, documentation, and specified approvals and standards implemented by this section. Upon request make available copies of all quality assurance records. Tests, inspections, reports, and documentation shall be subject to inspection.
6. Maintain records of inspections and tests. Indicate the nature and number of deficiencies found, quantities approved and rejected, and the nature of corrective actions taken. Upon request, supply copies of inspection and test data prior to or at time of shipment.
7. Test control wiring for continuity, grounds, and correct connections.
8. Test transformer for proper operation of controls.
9. Provide certified design test records on a duplicate or similar unit for temperature rise and short circuit capability.
10. Conduct ratio, impedance, and load-loss tests on tap changer per IEEE C57.12.00 Section 8.3.

B. Inspection and Test Plan (ITP): Supplier shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

2.20 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per Supplier’s recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be per Supplier's written recommendations.

B. Field Quality Control: Provide itemized pricing for the following field service items.

1. Provide following field testing:
   a. Insulation resistance of each winding to ground and to other windings.
   b. Power factor testing of bushings before and after installation.
   c. Proper operation of cooling fans and controls.
   d. Proper operation of pressure relief device, sudden pressure relay and auxiliary relay, liquid level indicator, and tap changer.
2. Provide assistance during initial energization including investigation and remediation of any failures or misoperation of equipment or system.
3. Twenty four hours after initial energization, sample insulating liquid and test for dielectric strength, moisture content, neutralization number, color, content, and complete gas-in-oil analysis.
4. Supplier's service personnel shall be factory trained and shall report to the field Site with all tools, test equipment, and materials as required to perform the service required in paragraphs 1 through 3 above.

3.02 MANUFACTURER'S SERVICES

A. Provide Supplier's services as follows:

1. Assistance to Contractor: 1 day, one trip.
2. Certificate of Proper Installation: 1 day, one trip.

3. Training Program: 1 day, one trip.
4. Functional and Performance Testing: 1 day, one trip.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Data Sheets.

END OF SECTION

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DATA SHEETS:
3-PHASE 2-WINDING OIL FILLED TRANSFORMER

PROJECT: CTG 7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: TRANSFORMER
TAG NO. WPCCTG-7-EMV60-XFMR-<TBD>
P.O. NO. BY CONTRACTOR
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
SITE CONDITIONS			
24 Hr. Avg. Ambient Design Temperature	ºF	80	
Maximum Ambient Temperature	ºF	104	
Minimum Ambient Temperature	ºF	50	
Site Elevation Above Sea Level	ft	0 ft.	
Seismic Class		By Contractor	
CHARACTERISTICS			
Operating Frequency	Hz	60	
Design Temperature Rise	ºC	65	
Maximum Temperature Rise	ºC	65	
Cooling Class	-	KNAN/KNAF/KNAF	
Capacity @ Design Temp Rise	MVA	By Contractor	
Capacity @ Maximum Temp Rise	MVA	By Contractor	
Impedance on Base Rating	Z%	By Contractor	
Transformer X/R Ratio	-	By Contractor	
Core and Coil Construction Type	-	Circular	
Type of Material Used in Coils	-	Cu	
SYSTEM CONFIGURATION			
UTILIZED AS A UNIT AUXILIARY POWER TRANSFORMER	Y/N	By Contractor	
WINDINGS			
HIGH VOLTAGE:			
NOMINAL RATED VOLTAGE	kV	By Contractor	
BASIC IMPULSE LEVEL	kVBIL	By Contractor	
CONNECTION	D or Y	By Contractor	
LOW VOLTAGE:			
NOMINAL RATED VOLTAGE	kV	By Contractor	
BASIC IMPULSE LEVEL	kVBIL	By Contractor	
CONNECTION	D or Y	By Contractor	
NEUTRAL:			
BASIC IMPULSE LEVEL	kVBIL	By Contractor	
CONNECTION (UN-GRD, SOLID, H-RES, L-RES)	-	L-RES	
NEUTRAL INSULATION (UNIFORM, GRADED)	-	Graded	
DISPLACEMENT BETWEEN HV AND LV WINDINGS	deg	By Contractor	

DATA SHEETS:
3-PHASE 2-WINDING OIL FILLED TRANSFORMER

EQUIP NAME: TRANSFORMER
PROJECT: CTG 7
TAG NO. WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419
P.O. NO. BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
BUSHINGS			
High Voltage:			
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Location	-	By Contractor	
Segment	-	By Contractor	
Low Voltage:			
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Location	-	By Contractor	
Segment		By Contractor	
Neutral:			
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Location	-	By Contractor	
BUSHING CURRENT TRANSFORMERS			
High Voltage Set 1 (HVCT-S1):			
Location on Bushing	-	Outer	
Quantity on Each Bushing	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 2 (HVCT-S2):			
Location on Bushing	-	Middle	
Quantity on Each Bushing	Qty	1 (for Owners Use)	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 3 (HVCT-S3):			
Location on Bushing	-	Inner	
Quantity on Each Bushing	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Thermal Factor	-	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set 1 (LVCT-S1):			
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set 2 (LVCT-S2):			
Quantity (Set)	Qty	1 (for Owners Use)	
Ratio of Each CT	Pri/Sec	By Contractor	

DATA SHEETS:
3-PHASE 2-WINDING OIL FILLED TRANSFORMER

PROJECT: CTG 7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: TRANSFORMER
TAG NO. WPCCTG-7-EMV60-XFMR-<TBD>
P.O. NO. BY CONTRACTOR
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Neutral Bushing (NCT-S):			
Quantity (Set) on NEUTRAL Bushing	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
CONNECTIONS			
High Voltage:			
Type:	-	By Contractor	
Location:	-	By Contractor	
Low Voltage Side:			
Type	-	By Contractor	
Location	-	By Contractor	
ARRESTERS			
High Voltage Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
Low Voltage Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
TAP CHANGER			
Manufacturer	-	By Contractor	
Type: NLTC or LTC	-	By Contractor	
Automatic or Manual	-	By Contractor	
Remote Operation	Y/N	By Contractor	
Tap Location or Regulated Winding	HV or LV	By Contractor	
No. of Steps Above Nominal	Qty x +%	2 x +2.5%	
No. of Steps Below Nominal	Qty x -%	2 x –2.5%	
INSULATING LIQUID			
Preservation System (Conservator Tank or Inert Gas Pressure System)	-	INERT GAS PRESSURE SYSTEM	
Total Gallons in System	gal	By Contractor	
Quantity shipped Separately	gal	By Contractor	
Weight of Insulating Liquid as Shipped	lbs.	By Contractor	
Type of Insulating Liquid (OEM "Standard" or "Less Flammable" Liquid)	-	Less Flammable	
Proposed Method of Insulating Liquid Shipment	-	By Contractor	

DATA SHEETS: **3-PHASE 2-WINDING OIL FILLED TRANSFORMER**	
PROJECT: CTG 7	**EQUIP NAME:** TRANSFORMER **TAG NO.** WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
COOLING			
Radiator Location – Segment (1, 2, 3, or 4)	-	By Contractor	
Quantity of Fan Motors per Stage	Qty	By Contractor	
Horsepower rating of Each Motor	Hp	By Contractor	
Rated Voltage and Phases	V, ph	480V, 3 ph, 3 W, 60Hz	
Full Load Current	A	By Contractor	
Guaranteed Power Requirements:			
First Stage	kW	By Contractor	
Second Stage	kW	By Contractor	
Maximum Sound Level @ Max. MVA Rating and All Fans Operating:			
@ 1 foot	dBA	By Contractor	
@ 6 feet	dBA	< 85	
CONTROL CABINET			
Location – Segment (1, 2, 3, OR 4)	-	By Contractor	
AC Auxiliary Power Voltage supplied to Control Cabinet	VAC	480	
FREQUENCY OF AC AUXILIARY POWER SUPPLY	Hz	60	
Qty of AC Auxiliary Power sources Supplied to Control Cabinet	1,2	1	
Power Required for AC Auxiliary Power Source	KVA	By Contractor	
DC Control Power Voltage supplied to Control Cabinet	VDC	125	
DC Rated Power Required	KVA	By Contractor	
ACCESSORIES			
Nitrogen Pressurization Tanks	Y/N	If Required	
Special Paint	Y/N	N	
Ground Resistor	Y/N	Y	
Ground Resistor Voltage	V	By Contractor	
Ground Resistor Current Rating	A	By Contractor	
Automatic Transfer Switch for Second Power Supply	Y/N	Y	
Hydran 201R Monitoring System	Y/N	Y	
100% spare gaskets	Y/N	Y	
TESTS			
ANSI Routine Tests	Y/N	Y	
Winding Insulation	Y/N	Y	
Core Insulation	Y/N	Y	
Insulation Power Factor	Y/N	Y	
Auxiliary Cooling Losses	Y/N	Y	
Single Phase Excitation & Rated Voltage	Y/N	Y	
No Load Losses & Excitation Current	Y/N	Y	
Zero Sequence Impedance	Y/N	N	
Temperature Rise	Y/N	Y	
Low Frequency on Auxiliary Devices	Y/N	N	
Lightning Impulse	Y/N	N	
Front of Wave Impulse	Y/N	N	
Switching Impulse	Y/N	N	
Partial Discharge	Y/N	Y	

DATA SHEETS:
3-PHASE 2-WINDING OIL FILLED TRANSFORMER

PROJECT: CTG 7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: TRANSFORMER
TAG NO. WPCCTG-7-EMV60-XFMR-<TBD>
P.O. NO. BY CONTRACTOR
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Audible Noise	Y/N	N	
Dissolved Gases in Oil Analysis	Y/N	Y	
TECHNICAL DIRECTION			
Time required for field installation, start-up, and commissioning	-	By Contractor	
EFFICIENCY			
@ 100% of Maximum MVA	%	By Contractor	
@ 75% of Maximum MVA	%	By Contractor	
@ 50% of Maximum MVA	%	By Contractor	
VOLTAGE REGULATION-			
100% of Maximum MVA:			
@ Unity Power factor	%	By Contractor	
@ 80% lagging power factor	%	By Contractor	
@ 80% leading power factor	%	By Contractor	
Excitation Current @ 100% Rated Voltage & Max. MVA	%	By Contractor	
GUARANTEED LOSSES			
Auxiliary Losses @ full load & Max MVA Rating	kW	By Contractor	
No-Load Losses @ 100% Rated Voltage	kW	By Contractor	
Load Losses @ Max MVA Rating	KW	By Contractor	
LOSS EVALUATION			
Auxiliary Losses	$/kW	49,000	
No-Load Losses	$/kW	49,000	
Load Losses	$/kW	49,000	
DIMENSIONS (APPROXIMATE)			
Overall Height	in.	By Contractor	
Overall Width	in.	By Contractor	
Overall Depth	in.	By Contractor	
Height over Tank	in.	By Contractor	
Height for Untanking	in.	By Contractor	
Minimum Distance Between Surge Arresters	in.	By Contractor	
Recommended Min. Space Between Transformer and Adjacent Structures	in.	By Contractor	

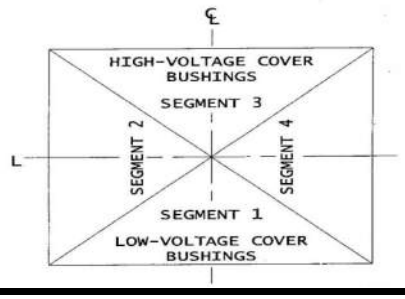
DATA SHEETS: **3-PHASE 2-WINDING OIL FILLED TRANSFORMER**	**EQUIP NAME:** TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV60-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
WEIGHTS (APPROXIMATE)			
Core and Coil	lbs.	By Contractor	
Tank and Fittings	lbs.	By Contractor	
Insulating liquid	lbs.	By Contractor	
Total Transformer With Insulating liquid	lbs.	By Contractor	
Total Shipping Weight	lbs.	By Contractor	
Weight of Largest Piece for Handling	lbs.	By Contractor	
DELIVERY			
Method of Shipment (truck, rail, barge, ship)	-	By Contractor	
OTHER			
Provide bushings with extra creep.		N	

FIGURE 1: ANSI/IEEE C57.12.10

REFER TO THIS FIGURE FOR ACCESSORY LOCATIONS, AS SPECIFIED WITHIN THESE DATASHEETS AND SPECIFICATIONS.

ANSI C57.12.10-1997



DATA SHEETS: **3-PHASE 2-WINDING OIL FILLED TRANSFORMER** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** TRANSFORMER **TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** New Orleans, LA	
DESCRIPTION	**Units**	**SPEC DATA**	**SELLER DATA**
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
SITE CONDITIONS			
24 Hr. Avg. Ambient Design Temperature	ºF	80	
Maximum Ambient Temperature	ºF	104	
Minimum Ambient Temperature	ºF	50	
Site Elevation Above Sea Level	ft	0 ft.	
Seismic Class		By Contractor	
CHARACTERISTICS			
Operating Frequency	Hz	25	
Design Temperature Rise	ºC	65	
Maximum Temperature Rise	ºC	65	
Cooling Class	-	KNAN/KNAF/KNAF	
Capacity @ Design Temp Rise	MVA	By Contractor	
Capacity @ Maximum Temp Rise	MVA	By Contractor	
Impedance on Base Rating	Z%	By Contractor	
Transformer X/R Ratio	-	By Contractor	
Core and Coil Construction Type	-	Circular	
Type of Material Used in Coils	-	Cu	
SYSTEM CONFIGURATION			
Utilized as a Unit Auxiliary Power Transformer	Y/N	By Contractor	
WINDINGS			
High Voltage:			
Nominal Rated Voltage	kV	6.6	
Basic Impulse Level	kVBIL	By Contractor	
Connection	D or Y	By Contractor	
Low Voltage:			
Nominal Rated Voltage	kV	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Connection	D or Y	By Contractor	
Neutral:			
Basic Impulse Level	kVBIL	By Contractor	
Connection (Un-Grd, Solid, H-Res, L-Res)	-	H-RES	
Neutral Insulation (Uniform, Graded)	-	Graded	
DISPLACEMENT BETWEEN HV and LV Windings	deg	By Contractor	

DATA SHEETS:			
3-PHASE 2-WINDING OIL FILLED TRANSFORMER			
		EQUIP NAME: TRANSFORMER	
PROJECT: CTG 7		**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>	
CP #: 1419		**P.O. NO.** BY CONTRACTOR	
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS		**LOCATION:** New Orleans, LA	
DESCRIPTION	**Units**	**SPEC DATA**	**SELLER DATA**
BUSHINGS			
High Voltage:			
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Location	-	By Contractor	
Segment	-	By Contractor	
Low Voltage:			
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Location	-	By Contractor	
Segment		By Contractor	
Neutral:			
Manufacturer	-	By Contractor	
Type	-	By Contractor	
Basic Impulse Level	kVBIL	By Contractor	
Location	-	By Contractor	
BUSHING CURRENT TRANSFORMERS			
High Voltage Set 1 (HVCT-S1):			
Location on Bushing	-	Outer	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 2 (HVCT-S2):			
Location on Bushing	-	Middle	
Quantity (Set)	Qty	1 (for Owners Use)	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
High Voltage Set 3 (HVCT-S3):			
Location on Bushing	-	Inner	
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Thermal Factor	-	By Contractor	
Accuracy Class	-	By Contractor	
Low Voltage Set 1 (LVCT-S1):			
Quantity (Set)	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	

DATA SHEETS:
3-PHASE 2-WINDING OIL FILLED TRANSFORMER

EQUIP NAME: TRANSFORMER
PROJECT: CTG 7
TAG NO. WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419
P.O. NO. BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS
LOCATION: New Orleans, LA

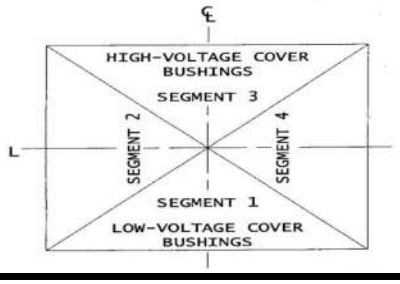
DESCRIPTION	Units	SPEC DATA	SELLER DATA
Low Voltage Set 2 (LVCT-S2):			
Quantity (Set)	Qty	1 (for Owners Use)	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
Neutral Bushing:			
Quantity (Set) on NEUTRAL Bushing	Qty	By Contractor	
Ratio of Each CT	Pri/Sec	By Contractor	
Multi-Ratio	Y/N	By Contractor	
Accuracy Class	-	By Contractor	
CONNECTIONS			
High Voltage:			
Type:	-	By Contractor	
Location:	-	By Contractor	
Low Voltage Side:			
Type	-	By Contractor	
Location	-	By Contractor	
ARRESTERS			
High Voltage Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
Low Voltage Side:	Y/N	By Contractor	
Manufacturer	-	By Contractor	
Type	-	By Contractor	
MCOV Rating	kV	By Contractor	
TAP CHANGER			
Manufacturer	-	By Contractor	
Type: NLTC or LTC	-	By Contractor	
Automatic or Manual	-	By Contractor	
Remote Operation	Y/N	By Contractor	
Tap Location or Regulated Winding	HV or LV	By Contractor	
No. of Steps Above Nominal	Qty x +%	2 x +2.5%	
No. of Steps Below Nominal	Qty x -%	2 x –2.5%	

DATA SHEETS:	
3-PHASE 2-WINDING OIL FILLED TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
INSULATING LIQUID			
Preservation System (Conservator Tank or Inert Gas Pressure System)	-	INERT GAS PRESSURE SYSTEM	
Total Gallons in System	gal	By Contractor	
Quantity shipped Separately	gal	By Contractor	
Weight of Insulating Liquid as Shipped	lbs.	By Contractor	
Type of Insulating Liquid (OEM "Standard" or "Less Flammable" Liquid)	-	Less Flammable	
Proposed Method of Insulating Liquid Shipment	-	By Contractor	
COOLING			
Radiator Location – Segment (1, 2, 3, or 4)	-	By Contractor	
Quantity of Fan Motors per Stage	Qty	By Contractor	
Horsepower rating of Each Motor	Hp	By Contractor	
Rated Voltage and Phases	V, ph	480V, 3 ph, 3 W, 60Hz	
Full Load Current	A	By Contractor	
Guaranteed Power Requirements:			
First Stage	kW	By Contractor	
Second Stage	kW	By Contractor	
Maximum Sound Level @ Max. MVA Rating and All Fans Operating:			
@ 1 foot	dBA	By Contractor	
@ 6 feet	dBA	< 85	
CONTROL CABINET			
Location – Segment (1, 2, 3, OR 4)	-	By Contractor	
AC Auxiliary Power Voltage supplied to Control Cabinet	VAC	480	
FREQUENCY OF AC AUXILIARY POWER SUPPLY	Hz	60	
Qty of AC Auxiliary Power sources Supplied to Control Cabinet	1,2	1	
Power Required for AC Auxiliary Power Source	KVA	By Contractor	
DC Control Power Voltage supplied to Control Cabinet	VDC	125	
DC Rated Power Required	KVA	By Contractor	
ACCESSORIES			
Nitrogen Pressurization Tanks	Y/N	If Required	
Special Paint	Y/N	N	
Ground Resistor	Y/N	Y	
Ground Resistor Voltage	V	By Contractor	
Ground Resistor Current Rating	A	By Contractor	
Automatic Transfer Switch for Second Power Supply	Y/N	Y	
Hydran 201R Monitoring System	Y/N	Y	
100% spare gaskets	Y/N	Y	

DATA SHEETS:	
3-PHASE 2-WINDING OIL FILLED TRANSFORMER	
	EQUIP NAME: TRANSFORMER
PROJECT: CTG 7	**TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD>
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
TESTS			
ANSI Routine Tests	Y/N	Y	
Winding Insulation	Y/N	Y	
Core Insulation	Y/N	Y	
Insulation Power Factor	Y/N	Y	
Auxiliary Cooling Losses	Y/N	Y	
Single Phase Excitation & Rated Voltage	Y/N	Y	
No Load Losses & Excitation Current	Y/N	Y	
Zero Sequence Impedance	Y/N	N	
Temperature Rise	Y/N	Y	
Low Frequency on Auxiliary Devices	Y/N	N	
Lightning Impulse	Y/N	N	
Front of Wave Impulse	Y/N	N	
Switching Impulse	Y/N	N	
Partial Discharge	Y/N	Y	
Audible Noise	Y/N	N	
Dissolved Gases in Oil Analysis	Y/N	Y	
TECHNICAL DIRECTION			
Time required for field installation, start-up, and commissioning	-	By Contractor	
EFFICIENCY			
@ 100% of Maximum MVA	%	By Contractor	
@ 75% of Maximum MVA	%	By Contractor	
@ 50% of Maximum MVA	%	By Contractor	
VOLTAGE REGULATION-			
100% of Maximum MVA:			
@ Unity Power factor	%	By Contractor	
@ 80% lagging power factor	%	By Contractor	
@ 80% leading power factor	%	By Contractor	
Excitation Current @ 100% Rated Voltage & Max. MVA	%	By Contractor	
GUARANTEED LOSSES			
Auxiliary Losses @ full load & Max MVA Rating	kW	By Contractor	
No-Load Losses @ 100% Rated Voltage	kW	By Contractor	
Load Losses @ Max MVA Rating	KW	By Contractor	
LOSS EVALUATION			
Auxiliary Losses	$/kW	49,000	
No-Load Losses	$/kW	49,000	
Load Losses	$/kW	49,000	

DATA SHEETS: **3-PHASE 2-WINDING OIL FILLED TRANSFORMER** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** TRANSFORMER **TAG NO.** WPCCTG-7-EMV25-XFMR-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** New Orleans, LA	
DESCRIPTION	**Units**	**SPEC DATA**	**SELLER DATA**
DIMENSIONS (APPROXIMATE)			
Overall Height	in.	By Contractor	
Overall Width	in.	By Contractor	
Overall Depth	in.	By Contractor	
Height over Tank	in.	By Contractor	
Height for Untanking	in.	By Contractor	
Minimum Distance Between Surge Arresters	in.	By Contractor	
Recommended Min. Space Between Transformer and Adjacent Structures	in.	By Contractor	
WEIGHTS (APPROXIMATE)			
Core and Coil	lbs.	By Contractor	
Tank and Fittings	lbs.	By Contractor	
Insulating liquid	lbs.	By Contractor	
Total Transformer With Insulating liquid	lbs.	By Contractor	
Total Shipping Weight	lbs.	By Contractor	
Weight of Largest Piece for Handling	lbs.	By Contractor	
DELIVERY			
Method of Shipment (truck, rail, barge, ship)	-	By Contractor	
OTHER			
Provide bushings with extra creep.		N	
FIGURE 1: ANSI/IEEE C57.12.10 REFER TO THIS FIGURE FOR ACCESSORY LOCATIONS, AS SPECIFIED WITHIN THESE DATASHEETS AND SPECIFICATIONS .		ANSI C57.12.10-1997  	

SECTION 26 13 00
MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Design, manufacture, testing, and delivery of a complete lineup of medium voltage metal-clad switchgear and motor controllers.

B. Switchgear and motor controllers to comply with requirements of this section and Project Drawings.

C. Substitutions/Exceptions:

1. Note exceptions and advise of deviations, additions, deletions, or other changes recommended to meet specified requirements.
2. Deviations are permitted only if outlined in full detail. Written approval of those deviations, and reasons for them, will constitute acceptance.

D. Compliance:

1. Design in compliance with this section is responsibility of Supplier.
2. Provide manufacturer’s standard products unless otherwise specified or approved.

E. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work.

1.02 REFERENCES

A. Standards: Design, assemble and test the equipment in accordance with following industry standards:

1. National Electrical Manufacturers Association (NEMA):
   a. CS, Industrial Controls and Systems.
   b. C37.54, Indoor A C High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear - Conformance Test Procedures.
   c. C37.55, Switchgear - Medium Voltage Metal-Clad Assemblies - Conformance Test Procedure.

d. C37.58, Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear Conformance Test Procedures.
e. SG4, Alternating-Current High-Voltage Circuit Breakers.

2. National Electrical Code (NEC): NFPA 70.
3. Institute of Electrical and Electronics Engineers (IEEE): C37.04, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers.

B. Conflicting Requirements: If section requires compliance with two or more industry standards which establish different or conflicting requirements, obtain approval before proceeding with affected operations.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Provide Shop Drawings.
2. Test reports.
3. Maintenance and service instructions.

B. The following Drawing type shall be submitted for approval as a minimum:

1. Plan and elevation Drawings including minimum access dimensions.
2. Single-line diagrams.
3. Three-line diagrams.
4. Schematics for each circuit breaker including terminal block numbers and all control circuits.
5. Device list with part number.
6. Nameplate schedules.
7. Connection diagrams.
8. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.

1.04 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.05 WARRANTY AND GUARANTEES

A. Furnish Supplier's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Supplier must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. ABB.
2. Eaton.
3. GE.
4. Point Eight.
5. Powell Industries.
6. Schneider Electric.
7. Siemens.

B. Submit Product Data for each piece of electrical equipment provided.

C. Provide metal clad switchgear and motor controllers with removable element vacuum circuit breakers and contactors, capable of both bottom and top cable entry.

D. Surge Arresters: Provide polymer distribution class arresters on outgoing terminals of main breakers.

E. Auxiliary apparatus equipment compartment to consist of the following and as shown on the Drawings:

1. Auxiliary compartments.
2. 3 phase bus.
3. Potential transformers as required with primary current limiting fuses.
4. Ground bus.
5. ABB FT-1 test switches as shown on the Drawings.
6. Microprocessor based multi-function high-impedance bus differential relay as shown on the Drawings.
7. Lockout relay (device 86) Electroswitch Series 24 LOR with coil monitor and lighted target nameplate and a minimum 4 NO and 4 NC spare contacts.

F. Main incoming line metal-clad equipment each to consist of:

1. Metal-clad stationary unit.
2. Draw-out power circuit breaker as shown on the Drawings.
3. Current transformers (CTs) and type ‘C-C’ test switches on all CT inputs to protective relays as shown on the Drawings.
4. ABB FT-1 potential test switches to fully isolate shutdown contacts for testing purposes as shown on the Drawings. Blades of test switches shall not be energized when in open position.
5. Microprocessor based multi-function protection relay as shown on the Drawings.
6. Close/Open Control switch with indicating lights.
7. Provisions for remote close and trip.
8. 3-phase bus.
9. Copper ground bus.
10. Local-Remote control switch.
11. Lockout relays (device 86) Electroswitch Series 24 LOR with coil monitor and lighted target nameplate and a minimum 4 NO and 4 NC spare contacts.
12. Provide sufficient space for training and terminating the cable or other incoming circuit configuration as required by the CTG Supplier. Provide termination pads for terminating cables sized for a minimum of 200 percent nominal rated current; these termination provision shall be approved by the Engineer.

G. Feeder metal-clad equipment as shown on the Drawings and each consisting of:

1. Metal-clad stationary unit.
2. Draw-out power circuit breaker as shown on the Drawings.

3. Current transformers (CTs) and type ‘C-C’ test switches on all CT inputs to protective relays as shown on the Drawings.
4. ABB FT-1 potential test switches to fully isolate shutdown contacts for testing purposes as shown on the Drawings. Blades of test switches shall not be energized when in open position.
5. Microprocessor based multi-function feeder protection relay as shown on the Drawings.
6. Close/Open Control switch with indicating lights.
7. Provisions for remote close and trip.
8. 3-phase bus.
9. Copper ground bus.
10. Local-Remote control switch.
11. Lockout relay (device 86) Electroswitch Series 24 LOR with coil monitor and lighted target nameplate and a minimum 4 NO and 4 NC spare contacts.
12. Provide sufficient space for training and terminating the cable. Provide termination pads for terminating cables sized for a minimum of 200 percent nominal rated current; these termination provision shall be approved by the Engineer.

H. Tie breaker metal-clad equipment to consist of:

1. Metal-clad stationary unit.
2. Draw-out power circuit breaker as shown on the Drawings.
3. Current transformers (CTs) and type ‘C-C’ test switches on all CT inputs to protective relays as shown on the Drawings.
4. ABB FT-1 potential test switches to fully isolate shutdown contacts for testing purposes as shown on the Drawings. Blades of test switches shall not be energized when in open position.
5. Microprocessor based multi-function protective relays as shown on the Drawings.
6. Close/Open Control switch with indicating lights.
7. 3-phase bus.
8. Copper ground bus.
9. Local-Remote control switch.
10. Lockout relay (device 86) Electroswitch Series 24 LOR with coil monitor and lighted target nameplate and a minimum 4 NO and 4 NC spare contacts.

I. Power quality meter shall be provided on all main incoming breakers as shown on the Drawings.

J. Switchgear logical controller, SEL RTAC “Or-equal,” with auxiliary input/output module sized as required and SEL 2740S “Or-equal,” software defined network switch for interface with PDCS/ECS.

K. Transition sections shall be supplied as required. Provide all copper bus, linkage, and hardware for a continuous phase and ground bus.

2.02 RATINGS

A. Bus: as indicated on the Drawings and/or Data Sheet.

B. Circuit Breakers:

1. Interrupting Rating: as indicated on the Drawings and/or Data Sheet.
2. Continuous Current Rating: as indicated on the Drawings and/or Data Sheet.

2.03 BUSES

A. Main Bus:

1. Copper.
2. Non-tapered.
3. Tin or Silver-plated at joints.
4. Current rating in accordance with ANSI standards of temperature rise.

B. Ground Bus: Copper and include provisions for connection to station grounding system at each end of switchgear with minimum 4/0AWG cable.

C. Main bus compartment totally enclosed by metal plates and arranged to permit future extension. Arrange barriers to isolate compartment of each unit. Each bar of main 3 phase bus of each unit shall be fully insulated, completely encased with molded or sleeve insulation, except where provision is made for splicing adjacent units together, or making connections to disconnecting devices, special insulating material and hardware shall be installed.

D. Mount insulated bus on insulated supports with coordinated dielectric properties and strength to withstand magnetic stresses developed by current equal to power circuit breaker momentary and interrupting ratings. Insulated connections and insulated supports to be made from insulation possessing excellent flame-retardant and self-extinguishing, tracking-resistant, dielectric and anti-hygroscopic properties.

2.04 CIRCUIT BREAKERS

A. Draw out type vacuum break circuit breaker.

B. All breakers shall be electrically operated, stored energy, trip free type with 125V dc control.

C. Each breaker to have minimum of twelve electrically separate auxiliary contacts (6-52/a and 6-52/b) available for interlocks. These contacts are to be in addition to those required for breaker operation and indication. Each breaker to have minimum of four position indicating contacts (2-52H/a and 2-52H/b). Contacts shall be rated for minimum 5A at 120V ac, 2A at 125V dc. All circuit breakers to be wired for both local and remote operation via switchgear mounted local / remote control switch.

D. Removable type with self-coupling primary and secondary disconnecting devices (contacts). Automatic safety shutters close entrance to stationary primary disconnecting devices when removable power circuit breaker is in test or withdrawn position.

E. Breaker shall be pad-lockable in the withdrawn position.

F. All breakers shall be capable of being racked with a remote racking device.

G. Breakers of same type and ratings to be interchangeable with each other. Breakers of a higher-ampere rating should be allowed in a lower-ampere rated cubicle. Conversely, breakers of a lower-ampere rating should not be allowed in a higher-ampere rated cubicle.

H. Six primary disconnecting devices in breaker unit consisting of aligned socket and stud having silver-to-silver pressure line contact.

I. Provide secondary disconnecting devices for bringing control leads to removable power circuit breaker operating mechanism and auxiliary switches. Spring mount self-aligning receptacles spring mounted on stationary framework and mount plugs on removable power circuit breaker. Interlocks to prevent inserting or removing breaker unless it is in the open position. Removable power circuit breaker self- aligning and held rigidly in connected operating position without necessity of locking bars or bolts.

J. When specified on the Data Sheets or Drawings, a selectable (enabled/disabled), including remote selection, temporary paralleling scheme (10 seconds maximum) of the main circuit breakers with the tie circuit breaker closed shall be provided when initiated by having both mains and the tie circuit breakers closed. Tie circuit breaker shall be tripped when the set paralleling time expired. An adjustable timer with high accuracy shall be used for this function (0 to 10 seconds).

K. When specified on the Data Sheets or Drawings, the main-tie-main or main-tie-tie-main breakers shall have automatic transfer to alternate source and automatic re-transfer to normal source. The transfer scheme should be furnished as follows:

1. The normal system configuration is with both incoming main breakers closed and the bus tie breaker open. The transfer scheme implemented in the Specification should be Open Transfer, with an “Open before Close” operation sequence.
2. After the lost source has been reestablished, the scheme should provide three methods to restore the system to normal configuration.
    a. Manual Method 1, when the sources cannot be synchronized: The bus tie breaker must be manually opened before the open incomer main breaker can be manually closed.
    b. Manual Method 2, when the sources are synchronized with synchrocheck supervision: There should be allowed to manually close the open incomer main breaker to parallel all three breakers. The scheme will then automatically open a breaker that had been previously selected to trip if all three breakers become closed. If the bus tie breaker is ‘Selected to Trip’, it will be tripped by the system and will open.
    c. Automatic Method: The automatic method of returning the system to normal configuration is a derivation of Manual Method 2 where the actions are allowed to proceed automatically.
3. In addition to the relay required for each of the three circuit breakers, the system should require a manual operated control switch or equivalent device.
    a. Auto-Off Control Switch. One contact must be connected to each relay. This switch should select either the transfer scheme in Off position or the transfer scheme in Automatic position. The contacts are either normally-open or normally-closed, depending on the asserted logic of the corresponding logic input used for this purpose. When the Auto-Off switch is in the “Off” position, the contact connected to the relay should place the corresponding logic input in the “Asserted Position”, blocking the operation of the Auto Transfer Scheme.
4. Because a relay is required on the bus tie breaker, it should allow bus-splitting operation.
5. The scheme should be used in conjunction with drawout switchgear. Drawout switchgear designs can make use of an auxiliary switch that confirms that the monitored breaker is racked in and in the “Connected” position, and therefore ready for operation.
6. The Auto Transfer Scheme should be applied to any one of the following systems:
    a. Substations with no signaling from upstream equipment.

b. Substations with an upstream circuit breaker equipped with a trip signal (Device 94).
c. Substations with a source transformer and transformer fault detection signal (Device 86T).
d. Both paragraphs b and c above.

7. Because the setpoints and logic are incorporated into the transfer scheme, the relays should make use of:
   a. Some or all of the logic inputs,
   b. Phase instantaneous overcurrent (Device 50P-1 or 2),
   c. Neutral overcurrent (Device 50N-1 or 2),
   d. Both line undervoltage elements (Devices 27-3 and 27-4),
   e. The synchrocheck (Device 25).

2.05 INSTRUMENTATION

A. Instruments and Relays as shown on the Drawings:

1. Hinged control panels to be made from specifically smooth and leveled steel. Semi-flush instruments, meters and relays, mounted on these panels to have enclosing cases with dull black finish. Meters and relays of draw-out type.
2. Protective relays shall be draw-out microprocessor based relays as specified.

B. Control Switches:

1. Furnish pistol grip handles on for momentary control functions round knurled handles for maintained control functions.
2. Indicating lights shall be provided that indicate the current status of the controlled function.
   a. Red indicates breaker is in the closed position.
   b. Green indicates breaker has been opened manually.
   c. Amber indicates protective relay tripped.
   d. Additional function colors shall be submitted to Engineer for approval.

C. Potential Transformers: Supply metal compartments with draw-out or lift-out carriages for potential transformers and control power transformers with associated primary current limiting fuses shown on the Drawings. Ground primary terminals when transformers are in withdrawn position.

D. Current Transformers: Provide compartment enclosed by metal plates to house current transformers in each unit. Current transformers shown on the Drawings to have sufficient thermal and mechanical ratings to withstand currents equal to maximum interrupting and momentary current ratings of power circuit breaker. Basic insulation levels to be compatible with that of BIL of switchgear. Current transformers provided shall have relay accuracy classification matching the application.Control Power Transformers: Supply CPT, one for each Bus. Size as required.

F. When specified on the Data Sheets or Drawings, Plant Control System and/or Power Distribution Control System Interface: The following monitoring and control functions shall be made available for the Plant Control System (PCS) and/or Power Distribution Control System (PDCS) via hardwire connections and Modbus communications with protection relays. Note: PCS and/or PDCS interface may be via intelligent remote terminal unit interfaced with PCS and/or PDCS via digital bus connectivity. Additional hardware including transducers shall be provided as required:

1. Bus A and Bus B Main Circuit Breakers and Tie Breaker:
    a. PCS/PDCS Open (trip) command: Contact from PCS/PDCS.
    b. PCS/PDCS Close command: Contact from PCS/PDCS.
    c. Breaker Status: Contact closed when breaker is racked in and closed.
    d. Breaker Ready Indication for PCS/PDCS operation – Remote enable. Racked in, power available, and permissive interlocks satisfied: Contact.
    e. Breaker local / remote switch position indication to PCS/PDCS: Contact from device 43L/R.
    f. Breaker tripped by protective device indication to PCS/PDCS: Contact from device 86.
    g. Bus Voltage, Average: Communication Modbus or Modbus TCP/IP.
    h. Current: Communication Modbus or Modbus TCP/IP or 4-20 mA.
    i. Instantaneous KW: Communication Modbus or Modbus TCP/IP.
    j. Instantaneous KVAR: Communication Modbus or Modbus TCP/IP.
    k. KW-HRS: Pulse. And Modbus or Modbus TCP/IP.
    l. KVAR-HRS: Communication Modbus or Modbus TCP/IP.
2. All Feeder Circuit Breakers:
    a. PCS/PDCS Open (trip) command: Contact from PCS/PDCS.
    b. PCS/PDCS Close command: Contact from PCS/PDCS.
    c. Breaker Status: Contact closed when breaker is racked in and closed.

d. Breaker Ready Indication for PCS/PDCS operation – Remote enable. Racked in, power available, and permissive interlocks satisfied: Contact.
e. Breaker local / remote switch position indication to PCS/PDCS: Contact from device 43L/R.
f. Breaker tripped by protective device indication to PCS/PDCS: Contact.
g. Current: Communication Modbus or Modbus TCP/IP or 4-20 mA.

3. Circuit breaker alarm contacts (one for each breaker) Alarm contact shall be normally closed (open on alarm).
4. Circuit breaker status contact opens when circuit breaker is closed (52b).
5. Contacts shall be rated for minimum 5A at 120V ac, 2A at 125V dc.
6. Analog signals shall be 4-20 mA dc.

2.06 ACCESSORIES

A. Furnish one set of metal-clad switchgear accessories consisting of:

1. One manual charging handle.
2. One circuit breaker racking handle.
3. One remote racking device with 15-foot controller umbilical cord.
4. One test cabinet with test coupler.
5. One interlock override.
6. One dolly for lifting breakers.

B. Humidistatically Controlled Space Heaters: Provide for prevention of condensation of moisture within the equipment. Provide in each circuit breaker compartment, auxiliary compartment, and cable compartment sufficiently sized space heaters. Space heater power shall be provided from switchgear control power transformer and panelboard. Furnish and install wiring from panelboard to space heaters.

2.07 WIRING

A. Furnish and install small wiring, potential buses fuses, and terminal blocks within each unit. Provide control wiring trough for interconnecting wires between units and common potential and control buses. Make all connections with ring-tongue terminals.

B. Wire stranded. Power wires to have 90 degrees C thermosetting insulation; control wire may have thermosetting or thermoplastic insulation. Wire rated for operation with conductor temperature of 90 degrees C. Switchgear wiring 14AWG minimum, Type SIS, tinned-copper wire. All CT secondary wiring shall be YELLOW, 10AWG minimum.

C. Provide terminal blocks suitable for ring-tongue wire terminals with numbers for termination of external connections. Provide at least 20 percent spare terminals for connection of external wiring.

D. Provide 90 degrees C rated power terminals and connectors for all outgoing and incoming feeder cable connections.

2.08 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per Supplier's recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning, and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing part item number, part name or description, Drawing reference, and equipment tag cross-reference for equipment with which the spare part and/or tool is intended for.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 SOURCE QUALITY CONTROL

A. Testing/Inspections:

1. Comply with requirements, tests, inspections, reports, documentation, and specified approvals and standards in this section. Make available on request copy of any part of quality assurance records. Tests, inspections, reports, and documentation subject to inspection by Owner or representative.
2. Provide notification not less than 10 working days prior to start of fabrication.
3. Maintain records of inspections and tests. Indicate nature and number of deficiencies found, quantities approved and rejected, and nature of corrective actions taken. On request, supply copies of inspection and test data prior to or at time of shipment.

4. Provide notification not less than 2 weeks prior to conducting inspection or testing required by this section.

B. Inspection and Test Plan (ITP): Supplier shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

3.02 FACTORY TESTS

A. Tests:

1. Notify Owner at least 30 days in advance of starting date of factory testing to permit Owner's representative(s) to be present.
2. Switchgear shall be subjected to Supplier's standard tests including but not limited to the following:
   a. Control and secondary wiring continuity check.
   b. Mechanical operation tests.
   c. Clearance and mechanical adjustment check.
   d. Dielectric Tests between live parts and ground on both power and control circuits.
   e. Electrical Tests including insulation resistance and overpotential tests on a completely assembled unit bus system.
   f. Protective relays, meters, and transducers shall be inspected and tested in accordance with Supplier's standards.
   g. Main-Tie-Main breakers transfer scheme testing.
   h. A complete functional check of equipment shall be performed after all component parts have been inspected and tested. Simulation of remote signals to be used for testing of each designed function. Functional checks shall verify all controls and interlocks shown on the Drawings.
   i. Verify communications between switchgear PDCS/ECS logical controller and switchgear intelligent electronic devices.

B. Test Reports: Provide certified test reports on equipment prior to shipment.

3.03 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. 1-1/2-inch white nameplates with 1/2-inch black letters on each section and cubicle. As a minimum and per the Drawings, name plates shall include:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

3.04 MANUFACTURER'S SERVICES

A. Provide manufacturer's services as follows:

1. Assistance to Contractor: 1 day, one trip.
2. Certificate of Proper Installation: 1 day, one trip.
3. Training Program: 1 day, one trip.
4. Functional and Performance Testing: 3 days, one trip.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Data Sheets.

END OF SECTION

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV25-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
MANUFACTURER	-	By Contractor	
CATALOG/SERIAL NO.	-	By Contractor	
CIRCUIT BREAKER MANUFACTURER	-	By Contractor	
MOTOR CONTROLLER MANUFACTURER	-	By Contractor	
QUANTITY			
TOTAL NUMBER REQUIRED	Qty.	per Drawings	
SYSTEM			
VOLTAGE	-	By Contractor	
OPERATING FREQUENCY	Hz	25	
GROUNDING	-	Low Resistance	
MAXIMUM AMBIENT TEMPERATURE	ºF	104	
MINIMUM AMBIENT TEMPERATURE	ºF	50	
SITE ELEVATION ABOVE SEA LEVEL	ft	0	
BASIC DESIGN			
ENCLOSURE	-	By Contractor	
ARC RESISTANT	(Y/N)	Y	
COLOR	ANSI	Manufacturer's Standard	
CABLE ENTRY	-	Top & Bottom	
LIGHTNING ARRESTORS	-	Polymer Distribution Class	
BUSES			
MAIN BUS	-	Copper, Non-tapered, Tin-plated	
MAIN BUS CONTINUOUS AMPS	-	per Drawings	
FAULT CURRENT WITHSTAND CAPABILITY	-	100 kAIC	
GROUND BUS TYPE	-	Copper	
GROUND BUS SIZE	-	By Contractor	
CIRCUIT BREAKERS			
TYPE	-	Drawout, vacuum break	
RATING	kV	By Contractor	
CONTINUOUS CURRENT RATING	-	By Contractor	
CONTROL VOLTAGE	VDC	125V DC	
SHORT CIRCUIT INTERRUPTING RATING	-	By Contractor	
BREAKER OPERATION	-	Electrically	
SPARE TYPE "52/A" AUX CONTACTS	Qty	6	
SPARE TYPE "52/B" AUX CONTACTS	Qty	6	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV25-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
SPARE "52H/A" POSITION INDICATING CONTACTS	Qty	2	
SPARE "52H/B" POSITION INDICATING CONTACTS	Qty	2	
BREAKER CONTROL	-	Remote & Local	
MAIN METAL-CLAD SECTION			
3 PHASE BUS	Cu/Al	Cu	
COPPER GROUND BUS	(Y/N)	Y	
CONTROL SWITCH WITH INDICATING LIGHTS	(Y/N)	Y	
CURRENT TRANSFORMERS	-	per Drawings	
LOCKOUT RELAY	-	Electroswitch Series 24	
LOCKOUT RELAY SPARE CONTACTS	Qty	4 NO & 4 NC	
MULTI-FUNCTION PROTECTIVE RELAYS	-	per Drawings	
REVENUE METER	-	per Drawings	
TIE METAL-CLAD SECTION			
3 PHASE BUS	Cu/Al	Cu	
COPPER GROUND BUS	(Y/N)	Y	
CONTROL SWITCH WITH INDICATING LIGHTS	(Y/N)	Y	
CURRENT TRANSFORMERS	-	per Drawings	
LOCKOUT RELAY	-	Electroswitch Series 24	
LOCKOUT RELAY SPARE CONTACTS	Qty	4 NO & 4 NC	
MULTI-FUNCTION PROTECTIVE RELAYS	-	per Drawings	
FEEDER METAL-CLAD SECTION			
3 PHASE BUS	Cu/Al	Cu	
COPPER GROUND BUS	(Y/N)	Y	
CONTROL SWITCH WITH INDICATING LIGHTS	(Y/N)	Y	
ARRANGEMENT	-	By Contractor	
CABLE LUGS FOR TERMINATION	-	90°C	
CURRENT TRANSFORMERS	-	per Drawings	
LOCKOUT RELAY	-	Electroswitch Series 24	
LOCKOUT RELAY SPARE CONTACTS	Qty	4 NO & 4 NC	
MULTI-FUNCTION PROTECTIVE RELAYS	-	per Drawings	
INSTRUMENTATION			
CONTROL POWER TRANSFORMER AT EACH BUS	-	Min. 1500 VA, <By Contractor>kV-120V	
POTENTIAL TRANSFORMER	-	per Drawings	
CURRENT TRANSFORMER	-	per Drawings	
CONTACTS RATING	-	120V AC at 5A 125V DC at 2A	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV25-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
ANALOG SIGNALS	-	4-20 mA DC	
COMMUNICATION			
MODBUS TCP INTERFACE	(Y/N)	Y	
EQUIPMENT TO IMPLEMENT INTERFACE	(Y/N)	Y	
MAINS & TIE BREAKERS MONITOR & CONTROL			
CONTACTS FROM PCS/PDCS			
Close OPEN	(Y/N)	By Contractor By Contractor	
CONTACTS FOR PCS/PDCS			
Breaker Status Breaker Ready BREAKER TRIPPED	(Y/N)	Y Y Y	
ANALOG SIGNALS			
Bus Voltage Current Instantaneous kW/kVAR kW-HRS KVAR-HRS	MODBUS / 4-20MA	By Contractor By Contractor By Contractor By Contractor By Contractor	
FEEDER BREAKERS MONITOR & CONTROL			
CONTACTS FROM PCS/PDCS			
Close OPEN	(Y/N)	By Contractor By Contractor	
CONTACTS FOR PCS/PDCS			
Breaker Status Breaker Ready BREAKER TRIPPED	(Y/N)	Y Y Y	
ANALOG SIGNALS	-	Current	
Bus Voltage Current Instantaneous kW/kVAR kW-HRS KVAR-HRS	MODBUS / 4-20MA	By Contractor By Contractor By Contractor By Contractor By Contractor	
TRANSFER SCHEME (MAIN-TIE-MAIN)			
AUTOMATIC/MANUAL	-	MANUAL	
CLOSED/OPEN TRANSITION	-	OPEN	
TEMPORARY PARALLEING SCHEME TIMER	-	NONE	
ACCESSORIES/OPTIONS			
MANUAL CHARGING HANDLE	(Y/N)	Y	
CIRCUIT BREAKER RACKING HANDLE	(Y/N)	Y	
REMOTE RACKING DEVICE	(Y/N)	Y	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV25-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
TEST CABINET WITH TEST COUPLER	(Y/N)	Y	
INTERLOCK OVERRIDE	(Y/N)	Y	
DOLLY FOR LIFTING BREAKERS	(Y/N)	Y	
HUMIDISTATICALLY CONTROLLED SPACE HEATERS IN EACH SECTION	(Y/N)	Y	
BOOTS FOR INSULATING TERMINATED CABLES	(Y/N)	Y	
WIRING			
TYPE	-	SIS, Tinned Copper	
RATED	°C	90	
SWITCHGEAR WIRING	-	#14 AWG Min.	
TERMINALS TYPE	-	Ring-Tongue	
SPARE TERMINALS IN TERMINAL BLOCKS	-	20%	
POWER WIRES INSULATION	-	90°C Thermosetting	
CONTROL WIRES INSULATION	-	Thermosetting or Thermoplastic	
CONTROL WIRING TROUGH BETWEEN UNITS	(Y/N)	Y	
OUTGOING/INCOMING FEEDER CABLE TERMINALS & CONNECTORS RATING	°C	90	
BUS A DIMENSIONS			
SWITCHGEAR SECTIONS HxWxD(in.)/WEIGHT(lb)	-	By Contractor	
CONTROLLER SECTIONS HxWxD(in.)/WEIGHT(lb)	-	By Contractor	
BUS B DIMENSIONS			
SWITCHGEAR SECTIONS HxWxD(in.)/WEIGHT(lb)	-	By Contractor	
CONTROLLER SECTIONS HxWxD(in.)/WEIGHT(lb)	-	By Contractor	
SPECIAL REQUIREMENTS			
SPECIAL REQUIREMENTS:	---	By Contractor	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV60-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
MANUFACTURER	-	By Contractor	
CATALOG/SERIAL NO.	-	By Contractor	
CIRCUIT BREAKER MANUFACTURER	-	By Contractor	
MOTOR CONTROLLER MANUFACTURER	-	By Contractor	
QUANTITY			
TOTAL NUMBER REQUIRED	Qty.	By Contractor	
SYSTEM			
VOLTAGE	-	By Contractor	
OPERATING FREQUENCY	Hz	60	
GROUNDING	-	Low Resistance	
MAXIMUM AMBIENT TEMPERATURE	ºF	104	
MINIMUM AMBIENT TEMPERATURE	ºF	50	
SITE ELEVATION ABOVE SEA LEVEL	ft	0	
BASIC DESIGN			
ENCLOSURE	-	By Contractor	
ARC RESISTANT	(Y/N)	Y	
COLOR	ANSI	Manufacturer's Standard	
CABLE ENTRY	-	Top & Bottom	
LIGHTNING ARRESTORS	-	Polymer Distribution Class	
BUSES			
MAIN BUS	-	Copper, Non-tapered, Tin-plated	
MAIN BUS CONTINUOUS AMPS	-	per Drawings	
FAULT CURRENT WITHSTAND CAPABILITY	-	100 kAIC	
GROUND BUS TYPE	-	Copper	
GROUND BUS SIZE	-	By Contractor	
CIRCUIT BREAKERS			
TYPE	-	Drawout, vacuum break	
RATING	kV	By Contractor	
CONTINUOUS CURRENT RATING	-	By Contractor	
CONTROL VOLTAGE	VDC	125VDC	
SHORT CIRCUIT INTERRUPTING RATING	-	By Contractor (match existing)	
BREAKER OPERATION	-	Electrically	
SPARE TYPE "52/A" AUX CONTACTS	Qty	6	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV60-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
SPARE TYPE "52/B" AUX CONTACTS	Qty	6	
SPARE "52H/A" POSITION INDICATING CONTACTS	Qty	2	
SPARE "52H/B" POSITION INDICATING CONTACTS	Qty	2	
BREAKER CONTROL	-	Remote & Local	
MAIN METAL-CLAD SECTION			
3 PHASE BUS	Cu/Al	Cu	
COPPER GROUND BUS	(Y/N)	Y	
CONTROL SWITCH WITH INDICATING LIGHTS	(Y/N)	Y	
CURRENT TRANSFORMERS	-	per Drawings	
LOCKOUT RELAY	-	Electroswitch Series 24	
LOCKOUT RELAY SPARE CONTACTS	Qty	4 NO & 4 NC	
MULTI-FUNCTION PROTECTIVE RELAYS	-	per Drawings	
REVENUE METER	-	per Drawings	
TIE METAL-CLAD SECTION			
3 PHASE BUS	Cu/Al	Cu	
COPPER GROUND BUS	(Y/N)	Y	
CONTROL SWITCH WITH INDICATING LIGHTS	(Y/N)	Y	
CURRENT TRANSFORMERS	-	per Drawings	
LOCKOUT RELAY	-	Electroswitch Series 24	
LOCKOUT RELAY SPARE CONTACTS	Qty	4 NO & 4 NC	
MULTI-FUNCTION PROTECTIVE RELAYS	-	per Drawings	
FEEDER METAL-CLAD SECTION			
3 PHASE BUS	Cu/Al	Cu	
COPPER GROUND BUS	(Y/N)	Y	
CONTROL SWITCH WITH INDICATING LIGHTS	(Y/N)	Y	
ARRANGEMENT	-	By Contractor	
CABLE LUGS FOR TERMINATION	-	90°C	
CURRENT TRANSFORMERS	-	per Drawings	
LOCKOUT RELAY	-	Electroswitch Series 24	
LOCKOUT RELAY SPARE CONTACTS	Qty	4 NO & 4 NC	
MULTI-FUNCTION PROTECTIVE RELAYS	-	per Drawings	
INSTRUMENTATION			
CONTROL POWER TRANSFORMER AT EACH BUS	-	Min. 1500 VA, <By Contractor>kV-120V	
POTENTIAL TRANSFORMER	-	per Drawings	
CURRENT TRANSFORMER	-	per Drawings	
CONTACTS RATING	-	120VAC at 5A	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV60-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
		125VDC at 2A	
ANALOG SIGNALS	-	4-20 mA DC	
COMMUNICATION			
MODBUS TCP INTERFACE	(Y/N)	Y	
EQUIPMENT TO IMPLEMENT INTERFACE	(Y/N)	Y	
MAINS & TIE BREAKERS MONITOR & CONTROL			
CONTACTS FROM PCS/PDCS			
Close OPEN	(Y/N)	By Contractor By Contractor	
CONTACTS FOR PCS/PDCS			
Breaker Status Breaker Ready BREAKER TRIPPED	(Y/N)	Y Y Y	
ANALOG SIGNALS			
Bus Voltage Current Instantaneous kW/kVAR kW-HRS KVAR-HRS	MODBUS / 4-20MA	By Contractor By Contractor By Contractor By Contractor By Contractor	
FEEDER BREAKERS MONITOR & CONTROL			
CONTACTS FROM PCS/PDCS			
Close OPEN	(Y/N)	By Contractor By Contractor	
CONTACTS FOR PCS/PDCS			
Breaker Status Breaker Ready BREAKER TRIPPED	(Y/N)	Y Y Y	
ANALOG SIGNALS	-	Current	
Bus Voltage Current Instantaneous kW/kVAR kW-HRS KVAR-HRS	MODBUS / 4-20MA	By Contractor By Contractor By Contractor By Contractor By Contractor	
TRANSFER SCHEME (MAIN-TIE-MAIN)			
AUTOMATIC/MANUAL	-	By Contractor	
CLOSED/OPEN TRANSITION	-	By Contractor	
TEMPORARY PARALLEING SCHEME TIMER	-	By Contractor	
ACCESSORIES/OPTIONS			
MANUAL CHARGING HANDLE	(Y/N)	Y	
CIRCUIT BREAKER RACKING HANDLE	(Y/N)	Y	

DATA SHEETS: **MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR** **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** MEDIUM VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-EMV60-SG-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
REMOTE RACKING DEVICE	(Y/N)	Y	
TEST CABINET WITH TEST COUPLER	(Y/N)	Y	
INTERLOCK OVERRIDE	(Y/N)	Y	
DOLLY FOR LIFTING BREAKERS	(Y/N)	Y	
HUMIDISTATICALLY CONTROLLED SPACE HEATERS IN EACH SECTION	(Y/N)	Y	
BOOTS FOR INSULATING TERMINATED CABLES	(Y/N)	Y	
WIRING			
TYPE	-	SIS, Tinned Copper	
RATED	°C	90	
SWITCHGEAR WIRING	-	#14 AWG Min.	
TERMINALS TYPE	-	Ring-Tongue	
SPARE TERMINALS IN TERMINAL BLOCKS	-	20%	
POWER WIRES INSULATION	-	90°C Thermosetting	
CONTROL WIRES INSULATION	-	Thermosetting or Thermoplastic	
CONTROL WIRING TROUGH BETWEEN UNITS	(Y/N)	Y	
OUTGOING/INCOMING FEEDER CABLE TERMINALS & CONNECTORS RATING	°C	90	
BUS DIMENSIONS			
SWITCHGEAR SECTIONS HxWxD(in.)/WEIGHT(lb)	-	By Contractor	
CONTROLLER SECTIONS HxWxD(in.)/WEIGHT(lb)	-	By Contractor	
SPECIAL REQUIREMENTS			
SPECIAL REQUIREMENTS:	---	By Contractor	

SECTION 26 19 13
MEDIUM VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 SUMMARY

A. This section applies to motors specified within a motor-driven equipment specification package. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this Specification will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

B. Compliance with this Specification does not relieve Supplier of the responsibility for furnishing motors of proper design and mechanically suited to meet operating guarantees at the specified service conditions.

C. Proposed design features having less than two years operating experience in similar service shall be specifically listed, and details provided for Purchaser review.

D. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification
3. Section 01 61 00, Common Product Requirements
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Bearing Manufacturers Association (ABMA).
2. American Petroleum Institute (API):
   a. 541, Form-Wound Squirrel-Cage Induction Motors—500 Horsepower and Larger.
   b. 670, Vibration, Axial Position, and Bearing Temperature Monitoring Systems.
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.

4. National Electronics Manufacturers Association (NEMA): MG 1, Motors and Generators.

1.03 DEFINITIONS

A. CT: Current Transformer.

B. IPS RMS: Inches Per Second, Root Mean Squared.

C. PIV: Peak Inverse Voltage.

D. RTD: Resistance temperature detector.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed in this article.

B. Action Submittals:

1. Complete motor data sheet with driven equipment Shop Drawings.
2. Induction motor name and specification number of driven equipment.
3. Rated motor horsepower.
4. Voltage, phase and frequency ratings.
5. Design full load current at rated horsepower for utilization (motor) voltage.
6. Number of poles and full-load speed.
7. Service factor.
8. Power factor at full, 3/4-load and 1/2-load.
9. Locked rotor, pull-up, breakdown, and full-load torque.
10. Guaranteed minimum full-load efficiency, include nominal efficiencies at 1/2-load and 3/4-load.
11. Maximum number of successive cold and hot starts.
12. Code letter for locked-rotor kVA/HP.
13. Locked-rotor inrush in percent of full-load current.
14. Motor Thermal Performance: Hot and cold start curves.
15. Winding insulation class and temperature rise class.
16. Frame size.
17. Enclosure.
18. Motor type/model and dimension drawing. Include motor component weights.
19. As applicable, complete manufacturers date for current transformers, surge arrestors, and surge capacitors.

20. Motor terminal box, resistance temperature detectors (RTDs) box, vibration detector box, and space heater box dimensions, location on motor, and wiring.
21. Motor lead termination support insulators.
22. Schematic wiring diagram for motor and for devices such as RTDs, vibration sensors, zero speed switches, leak detectors, space heaters, differential pressure switches, current transformers, and any other motor mounted auxiliary device requiring wiring into the motor control circuit as applicable.
23. Bearing Data:
    a. Identify type and manufacturer of bearings to be installed, such as radial journal type, antifriction type, and thrust bearing type, as applicable**.**
    b. Specify proposed bearing insulation materials and methods and recommended bearing lubricant(s).
    c. Bearing protection data including: shaft sensing proximity vibration probes, bearing housing vibration sensors, and for vertical motors, axial position probes, and RTDs, as applicable.
24. Where required, complete lube oil system requirements.
25. Anticipated maximum maintenance weights for rotors and removable housing elements.
26. Assembly clearances; this requirement includes, but is not limited to, diametrical bearing clearances, air gap, coupling interference fit to shaft, and bearing housing interference fit.
27. Shaft radial and axial runout tolerances at various lateral locations.
28. Shaft mass elastic diagram.
29. Motor rotor wk^2, added flywheel wk2 where applicable, and load wk^2, as obtained from driven machinery manufacturer.
30. Motor shaft grounding pickup method shall be via readily accessible, spring-loaded contact brush, as applicable.
31. Instrumentation, including but not limited to, vibration transducers, vibration monitoring system (if provided with motor), RTDs, motor protection relay (if provided with motor), leak detectors, differential pressure switches, and zero speed switches. as applicable. Provide detailed catalog information indicating complete model number derivation and wiring diagrams.
32. Water or oil cooling, if required, for motor thrust bearings.
33. Anchorage and bracing drawings and cut sheets, as required by Division 01, General Requirements.

C. Informational Submittals:

1. Lateral and torsional analysis report.
2. Driven equipment and motor manufacturers’ detailed mass elastic data.

3. Anchorage and bracing calculations as required by Division 01, General Requirements.
4. Name, address, telephone number, and contact name for factory-trained and authorized service organization representing motor manufacturer.
5. Written installation, connection, and commissioning instructions for specific motor(s) to be furnished.
6. Factory test results.
7. Component and attachment testing seismic certificate of compliance as required by Division 01, General Requirements.
8. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Production Facility: Motor manufacturer shall produce the medium voltage, induction motors at a facility manufacturer owns or operates under its own supervision.

B. Service Organizations: Motor manufacturer shall have a factory-owned or authorized service organization.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this section found defective during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Provide materials, equipment, and accessories specified in this section manufactured by, "Or-equal":

1. ABB Motors, Inc.
2. Ideal Electric.
3. GE Industrial Systems.
4. Siemens Electric Motors.
5. TECO-Westinghouse Motor Company.
6. Toshiba International Corporation.
7. WEG Electric Motors Corp.

2.02 GENERAL

A. Provisions of this section apply to induction motors larger than 250 hp and rated 2,300 volts through 13,200 volts.

B. Electric motors driving identical machines shall be identical.

C. Maximum motor loading at any point on driven load operating curve shall not exceed 85 percent of motor nameplate horsepower rating in lieu of service factor unless otherwise indicated on Data Sheet, and as verified with approved submittal data of driven machinery. Motor shall be required to conform to NEMA standard ratings.

D. Lateral and Torsional Analysis:

1. Driven equipment supplier with system responsibility shall perform a complete lateral and torsional analysis of each distinct equipment-coupling motor system provided on Project.
2. Identify lateral critical(s) plus torsional critical(s) speeds; typically including driven system process status, such as ‘dry’ or ‘wet’.
3. Produce critical speed maps; no active critical speed shall be allowed within 20 percent of operating speed range.
4. Analysis shall be performed, submitted, reviewed, and approved by Engineer prior to fabrication of machinery.
5. Mass Elastic Data: Used for independent evaluation of lateral and torsional natural frequency analysis. Encroachment by plus or minus 20 percent of any active critical speeds upon operating speed range must be eliminated to satisfaction of Engineer.

E. Motors driven by Variable Frequency Motor Controller (VFC or VFD), as shown on Data Sheet, shall be rated and labeled as suitable for inverter duty, and rated for continuous operation at 40 degrees C ambient temperature running on VFD output at any frequency as shown on Data Sheet.

F. Vertical motor dimensions shall conform to the following:

1. Installed space requirements per the Drawings or/and as listed on the Data Sheets.
2. Regardless of the limits on motor dimensions specified herein, all vertical motors and appurtenances shall be configured such that a minimum of 6 feet of horizontal clearance is provided to any adjacent motor or motor appurtenance.

G. Horizontal motor dimensions shall conform to the following:

1. Installed space requirements per the Drawings or/and as listed on the Data Sheets.
2. Regardless of the limits on motor dimensions specified herein, all horizontal motors and appurtenances shall be configured such that a minimum of 6 feet of horizontal clearance is provided to any adjacent motor or motor appurtenance.

H. Provide flywheel(s), keyed to motor shaft, of required geometry and mass or provide suitably oversized rotor diameter design to provide additional rotational moment of inertia as specified in driven equipment specification.

2.03 DESIGN REQUIREMENTS

A. Electric motors shall be in accordance with NEMA MG 1, except as indicated in equipment specifications for motors controlled for variable speed operation and other special motors, constant speed induction motors having starting torque and starting current sufficient to ramp up to speed of driven equipment. In no case shall locked rotor, pull-up or breakdown torque be less than value specified in NEMA MG 1.

B. Motor Voltage Ratings: voltage, phase, and frequency per the Data Sheet.

C. Service Factor: per the Data Sheet, but generally 1.0 as described elsewhere herein, particularly the maximum motor loading requirements.

D. Insulation: Furnish motors with Class F insulation minimum, rated to operate at the Project Conditions specified in Section 01 61 00, Common Product Requirements, without exceeding Class B temperature rise limits stated in NEMA MG 1-20.8 at driven equipment rated full load and 1.0 service factor.

E. Provide corona protection for motors operating at or above 6,000 volts.

F. Motor Leads and Terminations:

1. Provide main leads fitted with solderless lug terminals with two holes minimum each.
2. Hole spacing and size shall meet NEMA standards.
3. Leads shall be brought out to main terminal box for all motors.
4. Motor leads shall be arranged in main terminal box for use with three, self-balancing CTs for differential protection.

G. Rotor Bars:

1. Copper or copper alloy; designed to meet starting and accelerating torque characteristics of NEMA MG 1-20.4.2 for Constant Torque applications, NEMA MG 1-20.4.3.1 for Variable Torque Linear applications, or NEMA MG 1-20.4.3.2 for Variable Torque Square applications.
2. Select materials and processes used for fabricated rotor bars to minimize hydrogen embrittlement.
3. Size to assure tight bar construction to eliminate bar vibration.
4. Replaceable without damage to air passages or laminations.

H. Stator:

1. Iron laminations shall utilize C5 core-plate minimum, on both sides, capable of withstanding 1,400 degrees F without deterioration.
2. Brace and support to eliminate any detrimental winding movement.

I. Additional Insulated Stator Coils: Provide two additional, loose, insulated and cured, stator coils, identical to those form-wound for insertion into stator core, for each unique machine design provided. The additional, insulated stator coils shall be used for destructive surge testing as specified in paragraph Factory Testing.

J. Additional Bare Stator Coils: Provide two additional, loose, bare copper, stator coils, identical to those form-wound for insertion into stator core, for each unique machine design provided. Coils shall be completely sealed in a permanent steel box for long-term storage.

K. Shafts:

1. Material: Hot-rolled C1045, minimum.
2. Stiff-shaft design.
3. Shaft Dimensions: Manufacturer’s standard.
4. Provide extended shaft, tapered shaft, double shaft, or short shaft as required.
5. Permanently mark shaft on drive end and indicate magnetic center with a pointed indicator mounted off drive-end bearing cap.
6. Include reference measurement to locate magnetic center in the event of a broken pointer on motor outline drawing.
7. Provide drive shaft extension with open-ended keyway and key.

L. Torque:

1. Motor manufacturer shall review start-up load curve for driven equipment to determine minimum motor capabilities for locked-rotor torque, pull-up torque, and breakdown torque.
2. Motor speed-torque curve shall exceed driven equipment speed-torque curve by a minimum margin of 10 percent at all points from zero speed to pull-up speed.
3. Motor shall also be able to start and accelerate, to rated-speed of driven equipment during a 20 percent under-voltage or reduced voltage start condition.

M. wk^2:

1. Motors shall be capable of accelerating driven equipment and, if required, flywheel without excessive temperature rises.
2. Motor acceleration time at specified reduced voltage should not exceed locked rotor safe stall time.

N. Number of Starts: Each motor shall be capable of two successive cold starts or one hot start according to NEMA MG 1.

O. Minimum Power Factor: As specified on the Data Sheet.

P. Motor Efficiency:

1. Guaranteed Minimum Efficiency: As specified on the Data Sheet.
2. Stamp nameplate with tested efficiency.
3. In accordance with IEEE 112.

Q. Capable of operating at 120 percent of full-speed in reverse rotation direction, with no power applied to motor.

R. Starting: Motors shall be suitable for starting method indicated on Data Sheet.

S. Enclosures:

1. Mechanical protection and method of ventilation or cooling as listed below and as defined in NEMA MG 1-25 for Open Machines and NEMA MG 1-26 for Totally Enclosed Machines.
2. Open Drip-Proof, Guarded (ODPG):
   a. Check spaces, dimensions, and arrangement to ensure heat exhaust of one motor is not fed as air intake to an adjacent motor.
   b. Provide removable, antirodent type, screens fabricated from stainless steel expanded metal or SST wire mesh.

3. Weather Protected, Type II (WPII):
    a. Check spaces, dimensions, and arrangement to ensure heat exhaust of one motor is not fed as air intake to an adjacent motor.
    b. Provide reusable, washable, stainless steel inlet air filters and stainless steel screens.
    c. Provide differential pressure switches for indication of dirty inlet air filters.
4. Totally Enclosed, Air-to-Air Cooled (TEAAC):
    a. Design for outdoor use.
    b. Cooling Tubes: Fabricate from aluminum tubes with less than 0.2 percent copper.
    c. Average Wall Thickness: 0.035 inch, minimum.
5. Totally Enclosed, Water-to-Air Cooled (TEWAC):
    a. NEMA cooling designation IC7A1W7.
    b. Heat Exchanger:
        1) Provide on top of or on one side only of motor.
        2) Design for 30 degrees C inlet water at 50 psi and 0.001 fouling factor with a maximum flow velocity of 7 feet per second.
        3) Construction: 90/10 Cu-Ni tubes with copper or aluminum fins, 5/8-inch tube OD, 0.049-inch minimum tube wall thickness, and Cu-Ni headers or water boxes with flanged pipe connections.
            a) Construct headers or water boxes with removable cover plates to permit access to tubes for inspection and cleaning without disconnecting piping.
        4) Provide condensation/drip plan with external drain connection and leak detector.
        5) Provide a stainless steel automatic air vent valve at highest point with external drain connection.
        6) Include water spray baffles to minimize water spray entering motor and emergency dampers to enable ambient air ventilation at full rated HP in event of cooler failure.
6. Cooling Air:
    a. Internal cooling air shall circulate from end(s) of motor towards center of rotor and stator lamination stacks, then through vents in rotor and stator laminations (symmetrical cooling) to exhaust openings or heat exchanger.
    b. Internal air shall circulate through rotor and stator in a symmetrical manner to minimize hotspots.
7. Hardware: Stainless steel hardware for screens and associated fasteners.
8. Provide openings in stator endplates with access covers for checking motor air gap.

2.04 ACCESSORIES

A. Connection Box:

1. Cast or fabricated steel connection box.
2. Fabricated steel connection boxes shall have hinged covers secured by knurled screws.
3. Gasketed and provisions for grounding.

B. Main Terminal Boxes:

1. Size:
   a. For six main leads and neutral, incoming cable glands, and accessories.
   b. To accommodate components and accept power supply conductors, all per NEMA requirements.
   c. Minimum of one size greater than standard requires.
2. Construction comparable with rating of enclosure indicated for motor itself.
3. Allot space for mounting of auxiliary devices such as surge arrestors, surge capacitors, current transformers for differential protection, stress cones, and neutral bar, as required.

C. Equipment Grounding Lugs: Provide within main terminal box, suitable to terminate equipment ground wire, sized as indicated. Ground path shall be direct to stator frame.

D. Auxiliary Terminal Boxes:

1. Provide separate boxes for termination of space heaters, stator and bearing RTD or thermocouple leads, vibration probe leads, and other factory-mounted instrumentation.
2. Space heater terminations shall be in a terminal box that is separate from control signal terminations.
3. Wire devices to auxiliary terminal boxes and terminate on suitable terminal blocks.

E. Surge Protection:

1. Provide suitably sized station-class surge capacitors and lightning arrestors on each medium voltage motor terminal, mounted on insulated block.
2. Design to protect motor insulation from voltage surges caused by lightning strikes or switching.

3. Conductors:
    a. Between arrestor and point of attachment on stator frame shall be at least 4/0 AWG stranded copper conductor or larger.
    b. Keep as short and straight as possible.
    c. Lead length of connecting conductors shall be less than 36 inches.
4. Surge capacitors and lightning arrestors shall have a single-point quick disconnect connection to ground bus.

F. Current Transformers:

1. Provide three 50/5A zero-sequence current transformers in main terminal box. These current transformers shall be used for motor balanced flux differential protection.
2. Provide and channel six leads through appropriate current transformer. Current transformer leads shall be prewired to shorting-type blocks inside connection box positioned outside motor power terminal box and shall have YELLOW jacket color.
3. CT connections shall be shorted during factory testing and transportation to Site with a suitable warning label.

G. Zero Speed Switch:

1. To prevent startup, unless motor has been at zero speed for 5 seconds.
2. Provide with dry contact output that closes on shaft rotation in either direction, and opens on zero speed.
3. Operates on 120V ac power.
4. Manufacturer: Airpax, “Or-equal.”

H. Leak Detector:

1. Provide 120V ac operated conductance type level switch for detection of stator cooling water heat exchanger leaks.
2. Level switch shall have single-pole double-throw contacts and provided for TEWAC motors.

I. Space Heaters:

1. Provide to keep motor windings at least 5 degrees C to 10 degrees C above dew point during de-energized conditions.
2. Grid type in base of stator with easy access for maintenance.
3. Rated for 240V ac, single-phase power, but suitable for use on 120V ac, single-phase power.
4. Prewired to terminal junction box mounted on motor.
5. Provide warning label on space heater junction box and motor indicating space heater wiring is energized when motor is not running.

J. Where driven equipment requires, provide manufacturer's standard antireverse rotation ratchet.

K. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved or die-stamped block type black enamel filled equipment identification number and letters indicated on the Drawings and Data Sheet and as also compliant with Section 01 58 53, Project Equipment Identification.

L. Frame Grounding Pads: Provide two stainless steel faced grounding pads and locate on opposite sides of motor frame diagonally apart. Grounding pads shall feature a tapped 1/2-inch national coarse (NC) thread drilling into motor frame.

M. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

2.05 MOTOR BEARINGS

A. Bearings shall conform to provisions of driven equipment specification, except as supplemented or modified by requirements of this Specification. Unless otherwise specified, hydrodynamic radial bearings shall be provided on horizontal machines and antifriction bearings shall be used for vertical machines provided the following conditions are met:

1. dN factor is less than 300,000.
2. Antifriction bearings meet ABMA L10 rating life of 100,000 hours with continuous operation at rated conditions or 50,000 hours at maximum axial and radial loads and rated speed.
3. Antifriction thrust bearings for vertical machines shall be rated for ABMA L10 life of 5,000 hours.

B. Horizontal Motor Sleeve Bearings:

1. Use oil ring lubricated, spherically-seated, self-aligning, cylindrical split sleeve bearings.
2. Provide floating labyrinth inboard and outboard seals which are vented to atmosphere to equalize pressure.
3. Each bearing shall be lubricated by oil ring for oil lubrication during shutdown.
4. Bearings shall be designed for a minimum end float of 1/2 inch per NEMA MG 1 and API 546.
5. Housing: Cast iron; containing oil ring inspection port, oil level sight glass, threaded oil fill and drain plugs, and provisions for oil inlet and outlet piping.

6. Provide one RTD to monitor bearing temperature for each sleeve bearing.

C. Vertical Motor Thrust Bearings:

1. Provide plate type, load-equalizing, thrust bearings located in oil reservoir at top of motor frame. Bearings shall be Kingsbury, Renk, or Waukesha.
2. Bearing Capacity: Rated for weight of pump motor rotating assembly plus maximum hydraulic down-thrust developed by pump. Capable of operating at this rating in either direction of rotation up to runaway speed.
3. Up-thrust Capacity: As required for any operating condition.
4. Oil Lubrication System:
    a. Self-contained and self-circulating.
    b. Oil Reservoir:
        1) Cooling Coils:
            a) Sized to maintain a 40 degrees C, maximum, oil temperature rise.
            b) 90/10 Cu-Ni tube.
            c) Design for 30 degrees C, inlet water at 50 psig, and 0.001 fouling factor.
            d) 90/10 Cu-Ni threaded pipe connections.
        2) Contain an RTD to sense oil temperature.
        3) Water-cooling shall only be used with approval of Engineer.
5. Provide oil level sight glass, and threaded oil fill and drain plugs.
6. High Pressure Lift System:
    a. Provide where required to pressurize thrust bearing at startup and shutdown to reduce starting torque and minimize bearing wear.
    b. Mount oil pump, circulating piping and associated components on motor.
    c. Energize prior to motor start and stop end run for an adjustable time period.
    d. Operation of pumping unit without lift system shall not damage thrust bearing.
    e. Oil Pump: Three-phase, 460-volt, 60Hz, no greater than 3 hp.
7. Thrust Bearing Temperature Elements:
    a. Provide each bearing with two 100-ohm platinum RTD each which shall be prewired to a terminal junction box mounted on motor.
    b. Elements shall be installed in two opposite thrust shoes of thrust bearing.
    c. Metal of bearings and mountings shall be drilled, milled, and tapped to place element at hottest points of bearings and within 1/16 inch of bearing metal.

D. Vertical Motor Guide Bearings:

1. Upper Guide Bearing: Sleeve type lubricated by oil in reservoir for thrust bearing or antifriction type meeting performance criteria listed above.
2. Lower Guide Bearing: Split sleeve type with oil reservoir, oil level sight glass, and threaded oil fill and drain plugs or antifriction type meeting performance criteria listed above. If provided, lubrication system shall be self-contained and self-circulating.
3. Upper and lower bearings shall have spring-loaded RTDs to sense bearing metal temperature.

E. Hydrodynamic Radial Bearing Temperature: 93 degrees C, maximum.

F. Bearing Insulation: Electrically insulated in a manner to prevent circulating currents from passing through bearing surfaces. Provide grounding device in bearing housing on drive end.

2.06 VIBRATION MONITORING

A. General: Provide for each medium voltage induction motor, for integration into each medium voltage motor controller. Configure, program, test, calibrate, and place each system into operation. System shall include the following features:

1. Microprocessor based system with programmable firmware options.
2. Programmable operating range.
3. Programmable alarm range.
4. Dual channel modules.
5. Danger voting logic for alarm/trip outputs.
6. Timed OK/channel defeat.
7. Ethernet communications interface.

B. Hardware:

1. One multi-position (slot) rack sufficient to support all Project requirements containing quantities and types of plug-in modules listed below. Rack shall be Bently Nevada (B/N) type 3300/05.
2. One power supply module (position 1); B/N type 3300/12.
3. One system monitor module (position 2); B/N type 3300/03.
4. Dual channel radial shaft vibration monitoring modules, B/N type 3300/16, per the Drawings, Data Sheet, and Project requirements.
5. Dual channel velocity monitoring module(s), B/N type 3300/55, per the Drawings, Data Sheet, and Project requirements. Channels shall indicate velocity in inches per second, root mean squared (IPS RMS).

6. Dual channel (axial) thrust position monitoring module(s), B/N type 3300/20, per the Drawings, Data Sheet, and Project requirements.
7. Appurtenances: Provide transducers, probes, software, accessories, rack, interconnecting cables, power supply module, and monitoring modules; Bently Nevada Corporation, 3300 Series or latest Bently Nevada Corporation model compatible with 3300 Series system.
8. Cables requiring special calibration for optimum performance shall be calibrated by vibration monitoring system manufacturer or authorized representative thereof.
9. Alarm Contacts: Configured to be normally closed, open in alarm condition, and open on loss of power.

C. Vibration Transducers:

1. Timing Transducer:
   a. Consisting of a Bently Nevada Corporation Proximity Probe, calibrated extension cable, and Proximitor Sensor.
   b. Provide Keyphasor timing probe for motors; Bently Nevada Corporation Series 3300 XL 8 mm radial Proximity Probe similar to radial vibration transducers permanently installed by motor manufacturer. Probe shall contain a minimum 8-millimeter tip diameter mounted in a 0.375-inch by 24 threads per inch stainless body.
   c. Proximitor Sensor: Bently Nevada Corporation Series 3300 XL Proximitor Sensor, linear range from 10 mils to 90 mils, plus or minus 6.5 percent accuracy.
   d. Cable: Bently Nevada Corporation Series 3300 XL Extension Cable, 75 Ω, 69.9 pF/m shielded, triaxial.
   e. Elements shall be fully protected in sealed weatherproof conduit and housings.
2. Radial Shaft Vibration Transducers:
   a. Each transducer shall consist of a Bently Nevada Corporation Series 3300 XL 8mm Proximity Probe, calibrated extension cable, and Proximitor Sensor.
   b. Provide permanently installed radial shaft displacement proximity probes on motors with sleeve bearings.
   c. Use Orthogonal X-Y Bently Nevada Corporation Series 3300 XL Proximity Probes at each radial bearing housing.
   d. Mount probes at plus or minus 45 degrees from true vertical centerline.
   e. Probes to contain a minimum 8-millimeter tip diameter mounted in a 0.375-inch by 24 threads per inch stainless steel body.
   f. Proximitor Sensor: Bently Nevada Corporation Series 3300 XL Proximitor Sensor, linear range from 10 mils to 90 mils, plus or minus 6.5 percent accuracy.

g. Cable: Bently Nevada Corporation Series 3300 XL Extension Cable, 75 Ω, 69.9 pF/m shielded, triaxial.
h. Elements shall be fully protected in sealed weatherproof conduit and housings.

3. Bearing Housing Velocity Transducers:
   a. Use antifriction bearings and bearing housing velocity transducers permanently installed by motor manufacturer.
   b. Locate transducers at each bearing, measuring in axial, horizontal direction.
   c. Minimum rated operating frequency shall be less than minimum motor operating speed.
   d. Vibration element shall include shielded signal cable and enclosed in a NEMA 4X housing.
   e. Manufacturer and Product: Bently Nevada Corporation; Velomitor, piezo-velocity sensor.
4. Thrust Position Transducer:
   a. Each transducer shall consist of a Bently Nevada Corporation Series 3300 XL 8mm Proximity Probe, calibrated extension cable, and Proximitor Sensor.
   b. Use vertical synchronous motors, permanently installed axial shaft displacement proximity probes.
   c. Probes shall observe thrust collar or top end of shaft.
   d. Probes shall contain a minimum 8-millimeter tip diameter mounted in a 0.375-inch by 24 threads per inch stainless steel body.
   e. Proximitor Sensor: Bently Nevada Corporation Series 3300 XL Proximitor Sensor, linear range from 10 mils to 90 mils, plus or minus 6.5 percent accuracy.
   f. Cable: Bently Nevada Corporation Series 3300 XL Extension Cable, 75 Ω, 69.9 pF/m shielded, triaxial.
   g. Elements external to motor enclosure shall be fully protected in sealed weatherproof conduit and housings.
   h. Manufacturer and Product: Bently Nevada Corporation; Series 3300 series probes or latest model at each thrust bearing.
5. Motor Casing Velocity Transducers:
   a. For vertical motors over 250 horsepower, permanently installed velocity transducers.
   b. Each element shall be a velocity transducer with a velocity output in IPS RMS.
   c. Minimum rated operating frequency shall be less than minimum pump operating speed.
   d. Vibration element shall include shielded signal cable and enclosed in NEMA 4X housing.
6. Vibration transducer and timing transducer shall be prewired to terminal junction box mounted on motor.

2.07 MOTOR PROTECTION RELAY

A. Microprocessor based IEC 61850 compatible capable of supervision, management, and protection of large AC motors. Use motor thermal model consisting of the following elements, minimum:

1. Overload curves.
2. Negative sequence unbalance/single phase biasing.
3. RTD biasing (hot/cold motor compensation).
4. Motor cooling time constants.

B. Functions:

1. Protection of rotor during stall and acceleration, stall/acceleration curve shall be voltage compensated.
2. Stator protective thermal model shall combine inputs from positive and negative sequence currents and RTD winding feedback.
3. Relay shall provide one speed switch input.

C. Protective Features:

1. Stall.
2. Mechanical jam.
3. Overtemperature based on 12 independent RTD inputs.
4. Ground overcurrent.
5. Short circuit.
6. Differential protection using CT inputs from both sides of machine winding (such as, zero sequence, self-balancing differential protection).
7. Voltage transformer inputs which shall be used to provide overvoltage, undervoltage, voltage phase reversal, overfrequency, and underfrequency functions.

D. Metering:

1. Include complete power metering, including amperes, volts, watts, vars, volt-amperes, power factor, Hertz, watt-hours, varh, and demand.
2. Relay shall provide events record containing at least last 40 events and store 16 cycles of waveform data each time a trip occurs.

E. User Interface:

1. 40-character illuminated display.
2. Integral keypad to provide access to monitored values and setpoints.
3. RS232 serial port for setpoint programming.
4. Two RJ45 ethernet ports for network integration.

F. Software: Provide interface software in MS Windows format. Relay shall support simulation mode for testing relay.

G. Construction: Relay shall have a drawout construction to facilitate testing, maintenance and interchange flexibility.

2.08 MOTOR TEMPERATURE DETECTION

A. RTDs:

1. 100 ohm, three-wire, platinum, and prewired to terminal junction box mounted on motor base.
2. Provide two bearing RTDs (one per bearing) and six stator winding RTDs (two per phase).
3. For motors with thrust bearings, provide two RTDs per thrust bearing.
4. For water-cooled motors, provide one air circuit RTD.

2.09 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Engraved nameplates shall be furnished as indicated on the Drawings or equipment list. Nameplates shall be fastened to motor using screws. As a minimum and per the Drawings, name plates shall include:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. General:

1. Factory test motors in conformance with IEEE 112, IEEE 43, and NEMA MG 1.
2. Notify Engineer a minimum of 5 weeks prior to test.
3. No equipment shall be shipped until Engineer has approved test data.
4. Witnessed by Engineer.
5. Acceptance:
   a. In the event motor fails to meet above requirements or efficiencies make necessary modifications, repairs, or replace entire motor.

b. Retest motor until found satisfactory.

6. Test Reports:
   a. Include documentation and results.
   b. Indicate test procedure and instrumentation used to measure and record data.
   c. Certified, signed, and dated by motor manufacturer's test personnel and responsible engineers.

B. Tests:

1. Routine:
   a. Measurement of winding resistance.
   b. No-load motoring readings of current, power, and speed at rated voltage and frequency.
   c. Measure and record air gap during assembly.
   d. Visually inspect bearing and bearing insulation.
   e. High potential test in accordance with NEMA MG 1-20.17.
2. Surge: Test stator coils individually after insertion into stator core, but prior to coil-to-coil connection, to ensure no turn-to-turn shorts. Repeat surge test after coil-to-coil connections are complete.
3. High Potential: High pot stator coils individually after insertion into stator core, but prior to coil-to-coil connection, to ensure no turn-to-turn shorts. Repeat high potential test after all coil-to-coil connections are complete.
4. Perform two, destructive surge tests on the two spare loose (uninserted) stator coils. Fit coils into a dummy slot, VPI treated, and cured prior to testing. Test as follows:
   a. Test ground wall insulation with three successive applications of a 1.2x50-microsecond impulse voltage with a crest value of 5 p.u. Apply impulse voltage to both terminals of coil conductor while conducting surfaces of simulated slot portions of coil are connected to ground.
   b. Test turn-to-turn insulation with successive applications within 1-minute intervals of voltage impulses having a rise time of 0.1 to 0.2 microsecond applied between coil terminations. Gradually increase crest value of voltage impulse until point of insulation failure is reached.
   c. Test voltages shall include values of 2.0, 3.5, and 5.0 p.u.
5. Efficiency and Loss: Use any IEEE 112 Method B only. Included the following in determining efficiency per NEMA MG 1–20.21.
   a. Stator I^2R.
   b. Rotor I^2R.
   c. Core loss.
   d. Stray load losses.
   e. Friction and windage loss.

6. Phase Rotation:
    a. Apply phase sequence as called for on the outline drawing and check for correct direction of rotation.
    b. Record direction of rotation and phase sequence.
7. Temperature:
    a. Perform heat run tests on motors via embedded detector, using either of the IEEE 112 8.2.3 methods of loading.
    b. Record stator and bearing temperatures every 30 minutes until machine reaches constant temperature.
    c. Determine temperature rise for service factor loading.
8. Blocked Rotor Test: With rotor blocked, take the following readings at highest voltage possible: line voltage, current, kW, torque, and induced field current.
9. Noise:
    a. In accordance with NEMA MG 1, Part 9.
    b. Mean A-weighted sound pressure level measured at one meter from major machine surface shall not exceed 85 dB (A) with motor operating at no-load, and rated frequency and voltage applied.
10. Vibration:
    a. Radial Shaft at Full Operating Speed: 2.0 mils peak-to-peak, maximum.
    b. Take vibration data at cold and hot operating conditions, at no-load during factory testing.
    c. Transient Shaft Vibration: 3.5 mils peak-to-peak, maximum, throughout normal startup and shutdown speed range.
    d. Values shall include shaft surface runout sensed by probes.
    e. Shaft Runout: At slow roll speeds of less than 100 rpm shall be less than 0.25 mils peak-to-peak, maximum. For areas to be observed by axial-position probes, combined total electrical and mechanical runout shall not exceed 0.5 mil.
    f. Bearing Housing Vibration:
        1) At full operating speed shall be 0.15 inches per second (RMS), maximum.
        2) Take vibration data at cold and hot conditions, at no-load.
        3) Transient Vibration: 0.5 IPS RMS, maximum, throughout normal startup and shutdown speed range.
    g. Vibration Frequency:
        1) Record during vibration testing at cold and hot conditions.
        2) Record frequencies up to seven times line frequency.
        3) When operated uncoupled at rated speed, machinery shall not exhibit unusual or abnormal frequency components on either shaft or casing vibration measurements.

4) Normal frequency components are defined as excitations such as rotational speed, synchronous and multiples of synchronous frequency, or blade passing frequency that are inherent with mechanical construction of machinery.
5) Unusual or abnormal frequency components are excitations that are nonsynchronous or not related to known geometry of machinery.

11. Starting Characteristics: Determine speed-torque characteristics using any of the four IEEE 112-7.3.2 recommended methods.
12. Final Factory AC High Potential Test:
    a. Perform after above tests are completed to assure no damage to insulation during setup and testing.
    b. Apply 1,000 volts plus twice rated machine voltage across stator insulation and 2,500 volts across rotor insulation for one minute, per NEMA MG 1, Part 3.
13. Final Insulation Resistance: Take reading of armature insulation with mega-ohmmeter for one minute after high potential test has been completed.

3.02 INSTALLATION

A. Install in accordance with motor manufacturer's written recommendations and written requirements of manufacturer of driven equipment.

B. Perform electrical work involving connections, controls, and switches in accordance with the applicable sections of Division 26.

3.03 FIELD TESTING

A. Functional Tests: Perform the following prior to connection to driven equipment:

1. Check electrical supply at motor feeder cable terminations for any deviation from rated voltage, phase, or frequency.
2. Visually inspect motor mounting and coupling to driven equipment.
3. Visually check for proper phase and ground connections. Verify multi-voltage motors are connected for proper voltage.
4. Test insulation of all winding and bearing temperature detectors and space heaters.
5. Bump motor to test for proper rotation.
6. Test motor insulation in accordance with NEMA MG 1.
7. Test insulation after motor has arrived at Site via an AC high potential test performed for same duration as final factory high potential test, but at 75 percent of specified voltage.
8. Take vibration data at no-load and maximum available load.

9. Test motors for proper noise, temperature, and vibratory behavior following no less than 4 hours at maximum available load and full operating speed. Noise and vibration limits used for factory testing with temporary machinery support shall also be applicable to field testing condition with proper rigid support structure below machinery.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Medium Voltage Induction Motors Data Sheet**.**

END OF SECTION

Medium Voltage Induction Motors Data Sheet

Project Name: Sewerage & Water Board of New Orleans CTG-7 at West Power Complex

Equipment Tag Number: _____

Item Name: _____

GENERAL

1. Volts _____
2. Phase _____
3. Hertz _____
4. Duty ☐ Continuous
5. ☐ Other _____
6. Nameplate HP, kW _____
7. Service Factor _____
8. Synchronous RPM _____
9. Rated PF _____
10. Insul. Class ☐ Class F ☐ Other _____
11. Voltage and Freq. Variations _____
12. Stator Temp. Rise _____ °C Above _____°C by _____
13. Rotor Temp. Rise _____ °C Above _____°C by Resistance
14.
15. Site Data:
16. Area Classification Class _____ Group _____
17. Division _____ ☐ Nonclassified
18.
19. Zone _____ Class _____
20. Group _____ Temp. Code _____
21. Ignition Temp., if less than 250°C _____
22. Site Elevation (ft/m) _____
23. Ambient Temp. Max. _____ Min. _____
24. Relative Humidity Max. _____ Min. _____
25. Motor Location ☐ Indoor ☐ Outdoor
26. ☐ Roof Over Motor ☐ No Roof Over Motor
27. Building Temp. ☐ Controlled ☐ Not Controlled
28. Unusual Conditions: _____
29. Dust _____
30. Chemicals _____
31. Seismic Loading _____
32. Corrosive Agents _____
33. Other _____
34. Enclosure: ☐ Explosion Proof ☐ TEFC
35. ☐ Open-Drip-Proof
36. ☐ Weathered Protected: ☐ Type I ☐ Type II
37. ☐ TEPV ☐ TEWAC ☐ Other _____
38. ☐ TEAAC, Tubes:
39. ☐ Copper ☐ Aluminum ☐ Stainless Steel
40. ☐ Stainless Steel Fasteners
41. ☐ Provision for Purging _____
42. ☐ Degree of Protection IP _____
43. ☐ Cooling System _____
44.
45.
46.
47.
48.
49.
50.

51. Mounting: ☐ Horizontal ☐ Vertical
52. ☐ Shaft Down ☐ Shaft Up
53. ☐ Flange Mounted ☐ Pedestal ☐ Foot Mounted
54. ☐ Engine Type: _____
55. Motor Starting: ☐ Full Voltage ☐ Reduced Voltage _____
56. Type _____
57. ☐ Other Starting Method _____
58. ☐ Volt. Dip @ Locked Rotor-Max % ___ at KVA Inrush
59. ☐ Loaded ☐ Unloaded ☐ Partially Loaded _____

BEARING DATA

60. Bearings:
61. Type Required ☐ Hydrodynamic
62. ☐ Oil Rings Required
63. ☐ Antifriction
64. Thrust Bearings Max. _____
Connected Equipment _____
Thrust _____

LUBRICATION SYSTEM

65. Lubrication: ☐ Pressure of Flood Lube:
66. System Supplied By _____
67. ☐ Common With Drive Equipment
68. ☐ Per API 614
69. ☐ Manufacturer's Standard
70. ☐ Self-Lube:
71. ☐ Bearing Housing Headers Required
72. ☐ Bearing Constant-Level Sight Feed Oilers Required
73. ☐ Oil Mist for Antifriction Bearings

CONTROLS

74. Motor Vendor to Furnish:
75.
76.
77. ☐ Separate Monitoring and Control Devices, as
78. Listed Below, for Mounting In:
79. ☐ Purchaser's Switchgear
80. ☐ Vendor Furnished Control Panel
81. _____
82. _____
83. _____
84. _____
85. _____
86. _____
87. _____
88. _____
89. _____
90. _____
91. _____
92. _____
93. _____
94. _____

Medium Voltage Induction Motors Data Sheet

Project Name: Sewerage & Water Board of New Orleans CTG-7 at West Power Complex

Equipment Tag Number: _____

Item Name: _____

ACCESSORY EQUIPMENT

Main Conduit Box

Sized For:

- ☐ Feeder Cable:
  - Conductor Size _____
  - Type _____
  - Insulation _____
  - Quantity Per Phase _____
  - Entering From:
    - ☐ Top ☐ Bottom ☐ Side
- ☐ Both Ends of Stator Winding Brought Out to Terminal Box
  - Terminations and Interior Jumpers:
    - ☐ Insulated ☐ Uninsulated
- ☐ Current Transformers for Differential Protection:
  - Type: ☐ Core Balance ☐ Full Differential
  - Accuracy Class _____
  - Quantity _____ Ratio _____
  - Supplied by _____ Mounted by _____
- ☐ Surge Capacitors: _____ Microfarads
  - Supplied by _____ Mounted by _____
- ☐ Surge Arresters: _____ kV Rated
  - Supplied by _____ Mounted by _____
- ☐ Current Transformers for Ammeter
  - Quantity _____ Ratio _____
  - Accuracy Class _____
  - Supplied by _____ Mounted by _____
- ☐ Potential Transformers for Voltmeter
  - Quantity _____ Ratio _____
  - Accuracy Class _____
  - Fuses Required _____
  - Supplied by _____ Mounted by _____
- ☐ Bushing Studs or Receptacles _____
- ☐ Space for Stress Cones _____
- ☐ Thermal Insulation _____
- ☐ Maximum Sheath Temperature, °C or Temperature Code _____
- ☐ Breathers
- ☐ Drain Holes
- ☐ Provision for Purging
- ☐ Ground Bus _____
- ☐ Other Terminal Box Requirements _____

Stator Space Heaters: _____ Volts _____ Phase

Bearing Heaters: _____ Volts _____ Phase

Vibration Detectors: ☐ Noncontacting Probes

- ☐ Installed ☐ Provisions Only
- Qty/Bearing: ☐ Two ☐ Four
- Probe Type _____
- Model _____
- Probe Furnished By _____

☐ Bearing Housing Seismic Sensors

- ☐ Installed ☐ Provisions Only
- Qty/Bearing _____
- Location (H,V,A) _____
- Sensor Type _____
- Model _____
- Sensor Furnished By _____

☐ Motor Casing Seismic Sensors

- Qty/Motor _____
- Location (H,V,A) _____
- Sensor Type _____
- Model _____
- Sensor Furnished By _____

☐ Vibration Switch:

- ☐ Manual Reset ☐ Electric Reset
- Switch Type _____
- Model _____
- Terminal Head or Box _____

TEWAC Heat Exchanger:

Exchanger Location _____

Redundant Coolers Req. ☐ Yes ☐ No

☐ Air Temperature Sensor Required

- Description _____

☐ Flow Sensor Local Indicator Required

☐ Lead Detection Required

Air Filters: ☐ Provision Only ☐ Required

☐ Differential Pressure Switch:

- ☐ Provisions Only ☐ Differential Pressure Gauge

Hydrodynamic & Thrust Bearing Temp. Devices: ☐ Provision Only ☐ Manufacturer's Standard

☐ RTD: Detector Material _____

_____ ohms @ _____ °C

Type: ☐ 3-Wire ☐ 2-Wire

☐ Thermocouple: Type _____

☐ Dial Type Thermometers: ☐ Alarm Contacts

Winding Temperature Detectors: ☐ RTD: Qty/Phase _____ Material _____

_____ ohms @ _____ °C

Type: ☐ 3-Wire ☐ 2-Wire

Ground One Lead ☐ Yes ☐ No

☐ Thermocouples: Type _____

Qty/Phase _____

NOTES:

SECTION 26 23 00
LOW VOLTAGE METAL ENCLOSED SWITCHGEAR

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Design, manufacture, testing, and delivery of low voltage, metal enclosed, draw-out type switchgear, Switchgear, with high-resistance grounding system.

B. The Switchgear is applied in an electrical system as defined on the Data Sheets or Drawings.

C. Where the Drawings show part of an assembly that includes low voltage motor control, reference Section 26 24 19, Low Voltage Motor Control Centers, for the requirements of the low voltage motor control. Coordination between these two elements shall be the responsibility of the Supplier such that a complete functional assembly is provided.

D. Switchgear, unless otherwise defined on the Data Sheet or Drawings, will be installed indoors in a 50 to 104 degrees F controlled environment.

E. Switchgear shall comply with all requirements of this section and supplements.

F. Substitutions/Exceptions:

1. Note exceptions and advise of deviations, additions, deletions, or other changes recommended to meet specified requirements.
2. Deviations are permitted only if outlined in full detail. Written approval of those deviations, and reasons for them, will constitute acceptance.

G. Compliance:

1. Design in compliance with this section is responsibility of Supplier.
2. Provide manufacturer’s standard products unless otherwise approved.

H. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section. Design, assemble, and test switchgear in accordance with these standards:

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors Preferred Ratings, Related Requirements, and Application Recommendations.
   c. C37.20.1, Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
2. National Electrical Manufacturers Association (NEMA):
   a. C37.50, Switchgear Low Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures.
   b. C37.51, Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies - Conformance Test Procedure.
3. UL Labeling or Listing: Furnish switchgear bearing UL label:
   a. 1066, Standard for Safety Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
   b. 1558, Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
4. National Electrical Code (NEC): NFPA 70.

B. All design, equipment, installation, testing, materials, and devices shall meet all state and local codes and standards.

C. In cases where the specified codes and standards include differing requirements, the more stringent requirements shall apply.

D. Standards of foreign organizations shall not be used.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Provide Shop Drawings.
2. Test reports.
3. Maintenance and service instructions.

B. The following Drawing type shall be submitted for approval as a minimum:

1. Plan and elevation Drawings including minimum access dimensions.
2. Single-line diagrams.

3. Three-line diagrams.
4. Schematics for each circuit breaker including terminal block numbers and all control circuits.
5. Device list with part number.
6. Nameplate schedules.
7. Connection diagrams.
8. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.

1.04 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.05 WARRANTY AND GUARANTEES

A. Furnish Supplier’s extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner’s representative. The Supplier must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 LOW VOLTAGE METAL ENCLOSED SWITCHGEAR

A. Acceptable Suppliers listed below (or Approved Alternates):

1. Eaton.
2. Powell.
3. Schneider Electric.
4. Siemens.

B. Submit Product Data for each piece of electrical equipment provided.

C. Housing:

1. Bolted steel framework rigidly braced and covered with sheet steel in accordance with ANSI/IEEE C37.20.1, self-supporting, for indoor service. Provide stiffeners and cross bracing as required to ensure alignment of compartments after rolling and levering the line-up into position and setting level. Transition sections, if required, to facilitate interconnection with close-coupled motor control center (MCC) section(s) as shown on the Drawings and specified in this Specification.
2. Compartments: Separate compartment for each circuit breaker with insulating or grounded metal barriers to segregate circuit breaker and auxiliary compartments, main bus, incoming line buses, and rear cable compartment of each vertical frame or section.
3. Doors: Formed steel, mounted on concealed hinges, with latches.
4. Ventilation: Openings for natural ventilation designed to prevent entry of rodents and to guard against accidental contact with energized parts.
5. Switchgear shall be installed indoors. All external power and control cables enter the switchgear from the top and bottom.
6. Provide all control wiring and auxiliary contacts for breaker operation, interlocking and protective device tripping. Additionally, provide three type “a” and 3 type “b” auxiliary contacts on all breakers for owner’s use. Also provide three normally open and three normally closed contacts indicating breaker is in “test” and “full draw-out” position. All wires intended for external connection shall be brought out to terminal blocks.
7. Provide sufficient space for terminating the cable. Provide termination pads sufficient for termination of conductor’s 200 percent of rated current. Note: installation may require larger conductor size than normally required due to power cable derating.
8. Secondary control and communications connections shall be accessible from the front of the switchgear without opening the breaker compartment or exposing any power cables or bus.

9. Provision for padlocking breaker in “connected”,” test” and “draw-out” positions. Provision for locking breaker in “open” position.

D. Buses:

1. All bus work shall be high conductivity, electrical grade copper bars with tin plated connections at all contact surfaces. Use split type washers on bolted connections fabricated of non-magnetic, corrosion resistant steel.
2. Provide an un-insulated ground bus through the entire length of switchgear assembly.
3. Insulate or provide barriers for load side runbacks to feeder cable connection terminals where they pass through main bus compartment.

E. Power Circuit Breakers:

1. Ratings shall be as noted on Data Sheets and/or Drawings.
2. Provide solid-state trip devices with current sensors as required. Provide adjustable long-time, short-time, and instantaneous (LSI) functions as designated on Data Sheets and/or Drawings.
3. Contacts for breaker status and draw-out position.

F. Instrument Transformers: Provide current transformers with accuracy classes suitable for applications and burdens imposed and with thermal and mechanical characteristics adequate to withstand stresses caused by maximum possible short circuit conditions. All CT secondary wiring shall be yellow.

G. Provide potential transformers with accuracy class as noted on data sheets.

H. Operating Handle Height: Position power circuit breaker units so that center of operating handle grip does not exceed 6 feet 6 inches above finished floor or working platform.

I. Main & Tie Circuit Breaker Control: Circuit breakers shall be monitored and controlled through the Owner’s Plant Control System (PCS) or Power Distribution Control System (PDCS), as shown on the Drawings. Local closing shall be allowed only when the breaker remote/local selector switch is in the ‘local’ position; local opening of the breaker shall be permitted at any time. Remote opening through the PCS or PDCS shall be permitted only when the breaker is in the connected position and remote/local selector switch is in the ‘remote’ position.

1. Trip Command: Contact from PCS or PDCS.
2. Close Command: Contact from PCS or PDCS.
3. Breaker Status: Contact closed when breaker is racked in and closed.
4. Breaker Ready: Contact.
5. Breaker Tripped: Contact.

6. Breaker in Drawout Position: Contact.

J. When required per the Data Sheet, Main-Tie-Main shall have automatic transfer to alternate source and automatic re-transfer to normal source with close transition.

1. Two sources shall be electrically interlocked.
2. No time delay on transfer and only re-transfer shall a have 10 second delay with close transition.
3. Source stabilization before retransfer shall be set at 10 seconds.
4. Provide Auto/Manual switch with removable key interlock and light indication. Note: Manual mode operation shall allow operator to parallel both synchronized sources for routine maintenance.
5. Provide sync check relay (Device 25).

K. Feeder Circuit Breaker Control: Feeder Circuit breakers shall be manually operated locally (MO) unless electrically operated (EO) is indicated on the Data Sheets and/or Drawings and their status monitored through the Owner's Plant Control System (PCS) or Power Distribution Control System (PDCS), as shown on the Drawings.

1. Trip Command: Contact from PCS or PDCS.
2. Close Command: Contact from PCS or PDCs.
3. Breaker Status: Contact closed when breaker is racked in and closed.
4. Breaker Ready: Contact.
5. Breaker Status: Contact.
6. Breaker Tripped: Contact.

L. Switchgear control voltage supplied from external 125V dc source.

M. Accessories:

1. Hoist: rail mounted, manually operated hoisting device for removal of breakers.
2. Test Set: Portable test set, operating on 125V dc, capable of verifying circuit breaker operation within band-width of trip device characteristic curves at desired settings.

N. Space Heater: Humidistatically controlled space heaters shall be provided in each switchgear section for condensation control. Space heaters shall be rated for 240V and operated at 120V.

O. High Resistance Grounding System: Provide a high resistance grounding system in the switchgear assembly for use on a 480V wye source. The system shall limit ground fault current by a high resistance assembly with multiple taps; a meter relay shall be connected across the resistor to provide indication of a ground fault and a current pulsing system shall be utilized to locate the ground fault. The system shall include, but not be limited to, the following components.

1. Meter relay (MR).
2. Three indicating lights: white for “Normal”; red for “Ground Fault” and green for “Pulsing”.
3. “Reset” push button.
4. “Test” pushbutton.
5. On-Off switches for system and pulse.
6. Repeat cycle timer, set to produce approximately 30 current pulses per minute.
7. Neutral grounding resistor assembly.
8. Pulse resistor assembly.
9. Test resistor assembly.
10. Relay for repeat cycle timer.
11. Single pole double throw (SPDT) alarm relay with extra interlocks for remote alarm (59G) to PCS or PDCS.
12. Control power transformer.
13. Neutral current transformer and ammeter.
14. Portable clamp on ammeter.
15. Neutral Grounding control circuit shall operate at 120V ac.

2.02 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per Supplier’s recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 SOURCE QUALITY CONTROL

A. Testing/Inspections:

1. Comply with requirements, tests, inspections, reports, documentation, and specified approvals and standards required by this section. Make available on request copy of any part of quality assurance records, tests, inspections, reports, and documentation subject to inspection by Engineer, Owner or representative.
2. Provide notification not less than 10 working days prior to start of fabrication.
3. Maintain records of inspections and tests. Indicate nature and number of deficiencies found, quantities approved and rejected, and nature of corrective actions taken. On request, supply copies of inspection and test data prior to or at time of shipment.
4. Provide notification not less than 2 weeks prior to conducting inspection or testing required by this section.

B. Inspection and Test Plan (ITP): Supplier shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner 3 weeks (or as otherwise specified) prior to testing.

3.02 CLEANING AND PAINTING

A. Apply finish to steel surfaces.

B. Before painting, apply necessary filler and clean surfaces with phosphatizing process, “Or-equal.”

C. Apply non-chromate sealer.

D. Apply Supplier’s standard final finish of light gray, ANSI No. 61.

3.03 FACTORY TESTS

A. Tests:

1. Notify Engineer at least 5 days in advance of starting date of factory testing to permit Engineer's representative(s) to be present.
2. Switchgear to be subjected to tests in accordance with ANSI/IEEE C37.20.1. Tests to include:
   a. Control and secondary wiring check tests.
   b. Mechanical operation tests.
   c. Clearance and mechanical adjustment check tests.
   d. Dielectric Tests between live parts and ground on both power and control circuits.
   e. Electrical Tests including insulation resistance and over potential tests on a completely assembled unit bus system.
   f. Protective relays, meters, and transducers shall be inspected and tested in accordance with manufacturer's standards.
   g. Main-Tie-Main breakers transfer scheme testing.
   h. A complete functional check of equipment shall be performed after all component parts have been inspected and tested. Simulation of remote signals to be used for testing of each designed function. Functional checks shall verify all controls and interlocks shown on the Drawings.

B. Test Reports: Provide certified test reports on equipment prior to shipment.

3.04 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. White engraved nameplates with black letters on all sections and cubicles. As a minimum and per the Drawings, name plates shall indicate:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's services as follows in coordination with the close-coupled low voltage motor control center specified under Section 26 24 19, Low Voltage Motor Control Centers:

1. Assistance to Contractor: 1 day, one trip.
2. Certificate of Proper Installation: 1 day, one trip.
3. Training Program: 1 day, one trip.
4. Functional and Performance Testing: 2 days, one trip.

3.06 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Data Sheets.

END OF SECTION

DATA SHEETS: **LOW VOLTAGE METAL ENCLOSED SWITCHGEAR** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIPMENT NAME:** LOW VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-0-ELV25-<TBD> **P.O. NO.** TBD **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
MANUFACTURER	-	By Contractor	
CATALOG/SERIAL NO.	-	By Contractor	
QUANTITY			
TOTAL NUMBER REQUIRED	Qty.	0	
SYSTEM			
VOLTAGE	-	480V, 3PH, 3W	
OPERATING FREQUENCY	Hz	25	
GROUNDING	-	High Resistance	
MAXIMUM AMBIENT TEMPERATURE	ºF	104	
MINIMUM AMBIENT TEMPERATURE	ºF	50	
SITE ELEVATION ABOVE SEA LEVEL	ft	0	
BASIC DESIGN			
ENCLOSURE	ANSI	NEMA Type 2B AR MEF	
COLOR	ANSI	Manufacturer's Std	
BUSES			
TYPE	-	Tin Plated Copper	
MAIN BUS CONTINUOUS AMPS	-	800A MINIMUM	
SHORT CIRCUIT BRACING AMPS	-	65 KAIC	
GROUND BUS	-	Uninsulated through length of switchgear	
GROUND BUS CONTINUOUS AMPS	A	Not less than 25% of incoming bus	
POWER CIRCUIT BREAKERS			
TYPE	-	Drawout, 3 pole, air-circuit	
RATED	-	600V	
FRAME SIZE	-	1200 A	
SENSOR AMP RATING	-	Per the Drawings	
CONTROL VOLTAGE (EXTERNAL OF GEAR)	[VDC]/[VAC]	125 VDC	
SHORT CIRCUIT INTERRUPTING RATING	kA	65 kAIC	
OPERATION – FEEDER BREAKER	-	Electrically	
OPERATION – MAIN, TIE	-	3	
SPARE TYPE "A" AUX CONTACTS (ALL BRKS)	Qty	3	
SPARE TYPE "B" AUX CONTACTS (ALL BRKS)	Qty	3	
SPARE "NO" CONTACTS INDICATING BREAKER IN TEST OR DRAWOUT POSITION (MAINS & TIE)	Qty	3	

DATA SHEETS: **LOW VOLTAGE METAL ENCLOSED SWITCHGEAR** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIPMENT NAME:** LOW VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-0-ELV25-<TBD> **P.O. NO.** TBD **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
SPARE "NC" CONTACTS INDICATING BREAKER IN TEST OR DRAWOUT POSITION (MAINS & TIE)	Qty	3	
TRIP DEVICE TYPE	-	Solid-State	
TRIP CHARACTERISTICS (L/S/I/G)	-	L/S/I	
TRIP UNIT METERING (MAINS & TIE BREAKER)			
AC VOLTS EACH PHASE	(Y/N)	Y	
AC AMPS EACH PHASE	(Y/N)	Y	
REAL AND REACTIVE POWER	(Y/N)	Y	
FREQUENCY	(Y/N)	Y	
KWHRS FOR ADJUSTABLE INTERVALS	(Y/N)	Y	
REMOTE COMMUNICATION CAPABILITY	(Y/N)	Y	
INSTRUMENT TRANSFORMERS			
CT, ACCURACY CLASS	-	MIN. C400	
PT, ACCURACY CLASS	-	0.6 W, X, Y	
COMMUNICATION			
MODBUS TCP INTERFACE	(Y/N)	N	
EQUIPMENT TO IMPLEMENT INTERFACE	(Y/N)	N	
TRANSFER SCHEME (MAIN-TIE-MAIN)			
AUTOMATIC/MANUAL	-	Manual	
CLOSED/OPEN TRANSITION	-	OPEN	
ACCESSORIES			
BREAKER HOIST (RAIL MOUNTED)	(Y/N)	Y	
PORTABLE 115VAC TEST SET	(Y/N)	Y	
OPTIONS			
THERMOSTATICALLY CONTROLLED SPACE HEATERS IN EACH SECTION	(Y/N)	Y	
CONTROL POWER TRANSFORMER	(Y/N)	N	
COMPRESSION LUGS FOR TERMINATING POWER CABLES	(Y/N)	Y	
SWITCHGEAR DIMENSIONS			
HEIGHT	In.	By Contractor	
LENGTH	In.	By Contractor	
WIDTH	In.	By Contractor	
WEIGHT	Lb.	By Contractor	

DATA SHEETS: **LOW VOLTAGE METAL ENCLOSED SWITCHGEAR** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIPMENT NAME:** LOW VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-0-ELV25-<TBD> **P.O. NO.** TBD **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
SPECIAL REQUIREMENTS			
SPECIAL REQUIREMENTS:	---	By Contractor	

DATA SHEETS: **LOW VOLTAGE METAL ENCLOSED SWITCHGEAR** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS		**EQUIPMENT NAME:** LOW VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-0-ELV60-<TBD> **P.O. NO.** TBD **LOCATION:** NEW ORLEANS, LA	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
MANUFACTURER	-	By Contractor	
CATALOG/SERIAL NO.	-	By Contractor	
QUANTITY			
TOTAL NUMBER REQUIRED	Qty.	0	
SYSTEM			
VOLTAGE	-	480V, 3PH, 3W	
OPERATING FREQUENCY	Hz	60	
GROUNDING	-	High Resistance	
MAXIMUM AMBIENT TEMPERATURE	ºF	104	
MINIMUM AMBIENT TEMPERATURE	ºF	50	
SITE ELEVATION ABOVE SEA LEVEL	ft	0	
BASIC DESIGN			
ENCLOSURE	ANSI	NEMA Type 2B AR MEF	
COLOR	ANSI	Manufacturer's Std	
BUSES			
TYPE	-	Tin Plated Copper	
MAIN BUS CONTINUOUS AMPS	-	800A MINIMUM	
SHORT CIRCUIT BRACING AMPS	-	65 KAIC	
GROUND BUS	-	Uninsulated through length of switchgear	
GROUND BUS CONTINUOUS AMPS	A	Not less than 25% of incoming bus	
POWER CIRCUIT BREAKERS			
TYPE	-	Drawout, 3 pole, air-circuit	
RATED	-	600V	
FRAME SIZE	-	1200 A	
SENSOR AMP RATING	-	Per the Drawings	
CONTROL VOLTAGE (EXTERNAL OF GEAR)	[VDC]/[VAC]	125 VDC	
SHORT CIRCUIT INTERRUPTING RATING	kA	65 kAIC	
OPERATION – FEEDER BREAKER	-	Electrically	
OPERATION – MAIN, TIE	-	3	
SPARE TYPE "A" AUX CONTACTS (ALL BRKS)	Qty	3	
SPARE TYPE "B" AUX CONTACTS (ALL BRKS)	Qty	3	
SPARE "NO" CONTACTS INDICATING BREAKER IN TEST OR DRAWOUT POSITION (MAINS & TIE)	Qty	3	

DATA SHEETS: **LOW VOLTAGE METAL ENCLOSED SWITCHGEAR** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIPMENT NAME:** LOW VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-0-ELV60-<TBD> **P.O. NO.** TBD **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
SPARE "NC" CONTACTS INDICATING BREAKER IN TEST OR DRAWOUT POSITION (MAINS & TIE)	Qty	3	
TRIP DEVICE TYPE	-	Solid-State	
TRIP CHARACTERISTICS (L/S/I/G)	-	L/S/I	
TRIP UNIT METERING (MAINS & TIE BREAKER)			
AC VOLTS EACH PHASE	(Y/N)	Y	
AC AMPS EACH PHASE	(Y/N)	Y	
REAL AND REACTIVE POWER	(Y/N)	Y	
FREQUENCY	(Y/N)	Y	
KWHRS FOR ADJUSTABLE INTERVALS	(Y/N)	Y	
REMOTE COMMUNICATION CAPABILITY	(Y/N)	Y	
INSTRUMENT TRANSFORMERS			
CT, ACCURACY CLASS	-	MIN. C400	
PT, ACCURACY CLASS	-	0.6 W, X, Y	
COMMUNICATION			
MODBUS TCP INTERFACE	(Y/N)	N	
EQUIPMENT TO IMPLEMENT INTERFACE	(Y/N)	N	
TRANSFER SCHEME (MAIN-TIE-MAIN)			
AUTOMATIC/MANUAL	-	Manual	
CLOSED/OPEN TRANSITION	-	OPEN	
ACCESSORIES			
BREAKER HOIST (RAIL MOUNTED)	(Y/N)	Y	
PORTABLE 115VAC TEST SET	(Y/N)	Y	
OPTIONS			
THERMOSTATICALLY CONTROLLED SPACE HEATERS IN EACH SECTION	(Y/N)	Y	
CONTROL POWER TRANSFORMER	(Y/N)	N	
COMPRESSION LUGS FOR TERMINATING POWER CABLES	(Y/N)	Y	
SWITCHGEAR DIMENSIONS			
HEIGHT	In.	By Contractor	
LENGTH	In.	By Contractor	
WIDTH	In.	By Contractor	
WEIGHT	Lb.	By Contractor	

DATA SHEETS: **LOW VOLTAGE METAL ENCLOSED SWITCHGEAR** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIPMENT NAME:** LOW VOLTAGE SWITCHGEAR **TAG NO.:** CWPCTG-7-0-ELV60-<TBD> **P.O. NO.** TBD **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
SPECIAL REQUIREMENTS			
SPECIAL REQUIREMENTS:	---	By Contractor	

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. C62.1, Surge Arresters for Alternating Current Power Circuits.
   b. C62.11, Standards for Metal-Oxide Surge Arrestors for AC Power Circuits.
2. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. 289, Application Guide for Ground Fault Circuit Interrupters.
   c. AB 1, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   d. KS 1, Enclosed Switches.
   e. LA 1, Surge Arrestors.
   f. PB 1, Panelboards.
   g. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
   g. 943, Standard for Ground-Fault Circuit-Interrupters.

B. Related Sections, as applicable, and not limited to the following:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.

3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.
6. Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.
7. Section 26 05 75, Basic Electrical Materials and Methods.

NOTE: Where a more restrictive or stringent requirement is specified in a Related Section, the more restrictive or stringent requirement shall apply.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's Shop Drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.
   d. Voltage, frequency, and phase ratings.
   e. Enclosure type.
   f. Bus and terminal bar configurations and current ratings.
   g. Provisions for circuit terminations with wire range.
   h. Short circuit current rating of assembled panelboard at system voltage.
   i. Features, characteristics, ratings, and factory settings of auxiliary components.

B. Informational Submittals: Manufacturer's recommended installation instructions.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton/Cutler-Hammer.
2. General Electric Co.
3. Square D Co.

B. Panelboards shall be of the same manufacturer as equipment furnished under Section 26 23 00, Low Voltage Metal Enclosed Switchgear.

2.02 GENERAL

A. This Project utilizes power at 25Hz and 60Hz. Panelboard exterior shall have engraved nameplate that identifies connected system frequency. Design panelboards for appropriate frequency.

B. Provide low voltage panelboards for application at 600V or less in accordance with this section.

C. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.

D. Wire Terminations:

1. Panelboard assemblies, including protective devices, shall be suitable for use with 75 degrees C or greater wire insulation systems at NEC 75 degrees C conductor ampacity.
2. In accordance with UL 486E.

E. Load Current Ratings:

1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
2. Where indicated “continuous”, “100 percent”, selected components and protective devices shall be rated for continuous load current at value shown.

F. Short Circuit Current Rating (SCCR):

1. Integrated equipment short circuit rating for each panelboard assembly shall be no less than the following:
2. Minimum SCCR at 208Y/120 or 120/240 volts shall be 22,000 amperes rms symmetrical (minimum) or greater, for 60Hz power and 12,000 amperes (minimum) or greater for 25Hz power.
3. Minimum SCCR at 480Y/277 volts shall be 65,000 amperes rms symmetrical (minimum) or greater, for 60Hz power supply and 42,000 amperes (minimum) or greater for 25Hz power supply.

G. Overcurrent Protective Devices:

1. In accordance with NEMA AB 1, NEMA KS 1, UL 98, and UL 489.
2. Protective devices shall be adapted to panelboard installation.
   a. Capable of device replacement without disturbing adjacent devices and without removing main bus.
   b. Spaces: Cover openings with easily removable cover.
3. Series-Connected Short Circuit Ratings: Devices shall be fully rated; series-connected ratings unacceptable.

H. Circuit Breakers:

1. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
2. Noninterchangeable: In accordance with NEC.
3. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and plug-in circuit breakers in 208Y/120 and 240/120-volt branch circuit panelboards.
4. Trip Mechanism:
   a. Individual permanent thermal and magnetic trip elements in each pole.
   b. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
   c. Two and three pole, common trip.
   d. Automatically opens all poles when overcurrent occurs on one pole.
   e. Test button on cover.
   f. Calibrated for 40 degrees C ambient, unless shown otherwise.
5. Unacceptable Substitution:
   a. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
   b. Do not use tandem or dual circuit breakers in normal single-pole spaces.

6. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).
   a. Ground fault sensor shall be rated same as circuit breaker.
   b. Push-to-test button.
   c. Reset button.
7. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

I. Enclosures:

1. Provide as specified in Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.
2. Material: Type 1, Type 3R, and Type 3S shall be code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Finish: Rust inhibitor prime followed by manufacturer's standard gray baked enamel or lacquer.

J. Bus:

1. Material: Tin-plated copper, full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

K. Feeder Lugs: Main, feed-through, and neutral shall be replaceable, bolted mechanical or crimp compression type.

L. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.

M. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.

3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.

N. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

2.03 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Protective Device Locking: Furnish provisions for handle padlocking for main and subfeed devices; also provide for branch devices where indicated.

B. Multi-Section Panelboards: Where more than 42 poles are required or more than one section is otherwise indicated, provide multiple panelboards with separate fronts.

1. Panelboard sections shall be individually installed and field interconnected to form a single electrical unit.
2. Unless otherwise indicated, provide feed-through lugs on each section but last.
3. Surface-mount panels shall be individually mounted and may be different sizes.
4. Recessed-mount panels shall be individually mounted and the same size tub and flush cover.
5. Surface-mount multi-section panelboards may be comprised of sections of unequal heights.
6. Provide feed-through and main lugs in individual sections as required for field assembly of a complete multi-section panelboard.
7. Provide neutral and ground terminal bars in each section.

C. NEMA 250 Type 1 Branch Panelboard Enclosure:

1. Front trim shall be secured to box with concealed trim clamps.
2. Surface-mount panelboard front trim shall have same dimensions as box.
3. Flush panelboards front trims shall overlap box nominal 3/4 inch on all sides.
4. Door in panelboard front trim, with concealed hinges, shall provide access to protective device operating handles.
5. Doors over 30 inches in height shall have multi-point latching.
6. Door lock shall be secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
7. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.

2.04 POWER DISTRIBUTION PANELBOARDS

A. Branch Protective Devices:

1. Locking: Furnish devices with provisions for handle padlocking.
2. Load Connections: Wire lugs shall be mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
3. Provide a nameplate for each circuit, blanks for spares.

2.05 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Engraved nameplates shall be furnished on the outside of each panelboard to identify the service as indicated on the Drawings or equipment/load list. Nameplates shall be white with minimum 3/16-inch black lettering. Nameplates shall be fastened to panelboard using screws. As a minimum and per the Drawings, name plates shall include:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1 and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle, and wrap with nylon wire ties.

3.02 BRANCH CIRCUIT PANELBOARD

A. Mount flush panels uniformly flush with wall finish.

B. Provide typewritten circuit directory for each panelboard.

3.03 POWER DISTRIBUTION PANELBOARD

A. Provide engraved identification for each protective device.

END OF SECTION

SECTION 26 24 19
LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. This Specification includes the design, fabrication, and delivery of Low Voltage Motor Control Centers (MCC).

B. The MCC may be part of an assembly that include low voltage switchgear as shown on the Drawings and specified under Specification 26 23 00, Low Voltage Metal Enclosed Switchgear. Coordination between these two elements shall be the responsibility of the Supplier such that a complete functional assembly is provided.

C. Equipment furnished shall be of standard design and quality meeting or exceeding the requirements of this Specification and referenced industry Standards.

D. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification
3. Section 01 61 00, Common Product Requirements
4. Section 26 00 00, Electrical General Requirements
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

1.02 REFERENCES

A. Design, assemble, and test each motor control center in accordance with the latest edition of the following industry standards:

1. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment.
   b. ICS 1, Industrial Controls and System General Requirements.
   c. ICS 2, Industrial Control and Systems Controllers: Contactors and Overload Relays Rated 600 Volts.
   d. ICS 2.3, Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers.
   e. ICS 4, Terminal Blocks.
   f. ICS 6, Industrial Control and systems: Enclosures.
   g. ICS 18, Motor Control Centers.
   h. KS 1, Enclosed and Miscellaneous Distribution equipment Switches (600 Volts Maximum).
   i. ST 1, Specialty Transformers (Except General Purpose Type).

2. International Electrical Testing Association, Inc. (NETA): Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
3. National Fire Protection Association (NFPA): 70, National Electrical Code.
4. UL:
   a. 98, Standard for Safety Enclosed and Dead-Front Switches.
   b. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   c. 508, Standard for Safety Industrial Control Equipment.
   d. 845, Standard for Safety Motor Control Centers.

B. UL Compliance: Products manufactured within scope of UL shall conform to UL Standards and have an applied UL listing mark.

C. In the event that two or more industry standards establish different or conflicting requirements, the more stringent standard shall be used.

1.03 DEFINITIONS

A. Drawings: Drawings includes all Technical Drawings and Documents used to define the system(s) and equipment specified herein.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Completed Data Sheets for each different drive provided. Identify any special accessories required to match with driven load.
2. Electrical Drawings including electrical schematics, wiring diagrams, one-line diagrams, and three-line diagrams. Terminal block numbers shall be indicated on the Drawings.
3. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
4. General Arrangement Drawings: Outline Drawings, showing location, dimension, and size of structure and equipment including location of related accessories.
5. Detailed Drawings: Details of components required for installation.
6. Sectional Elevation Drawings: Showing dimensions for the locations and size of each major piece of equipment.

7. Material test reports and Certifications where required by governing codes or standards.
8. Description of standard factory tests.
9. Electrical test results.

1.05 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.06 WARRANTY AND GUARANTEES

A. Furnish Manufacturer’s extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner’s representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Motor control centers (MCC’s) shall be 600V class suitable for operation on a three-phase system, as further defined on the Data Sheets.

B. MCC's shall meet the seismic requirements as listed in the Data Sheets. MCC's shall be designed such that there will be no damage or loss of function, and remain operational, during and following the specified seismic loading in the Data Sheets.

C. MCC's shall be designed to continuously operate at full load ratings during maximum ambient temperature and site elevation as specified in the Data Sheets.

D. Unless specified otherwise, all controllers, main and branch circuit breakers, wire connections, and other devices shall be front mounted and accessible.

E. MCC's shall be designed and constructed in accordance with applicable NEMA, NETA, NFPA, and UL Codes and Standards.

2.02 STRUCTURE AND ENCLOSURE

A. Motor control centers shall be designed and constructed as free standing, totally enclosed metal structures with grouped motor control and circuit breaker compartments.

B. The construction of each motor control center shall consist of 12 gauge sheet steel that is reinforced with channel or angle irons. Each motor control center shall be butted together flush, end-to-end, with no bolts, nuts, or cover plates that cause interferences. Metal work shall be free from burrs and sharp edges.

C. Enclosures shall be rated as NEMA 1 gasketed, unless specified otherwise in the Data Sheets.

D. MCC's shall be 90 inches tall with manufacturer's standard for depth and manufacturer's standard for width.

E. Each motor control compartment shall be supplied with a hinged door. Each door shall be mechanically interlocked with its starter or feeder breaker such that the door cannot be opened with the compartment unit energized. Each compartment door shall be provided with a defeat mechanism to allow intentional access at any time, including when the compartment unit is energized.

F. Each motor control and feeder breaker compartment shall have an automatic shutter mechanism that provides isolation from the vertical bus. The shutter shall move to cover the stab openings when a unit is removed. As the unit is reinserted, the shutter shall move to uncover the stab openings.

G. All external disconnect switch handles shall indicate tripping by its operating handle position and shall be padlockable in the OFF or OPEN position.

H. Each vertical section shall have a front vertical wire way, as indicated on the Data Sheets, with hinged covers and equipped with cable support hardware for all field-connected power and control wiring.

I. When indicated on the Data Sheets, provisions shall be made for top and bottom horizontal wire ways with covers for interconnecting wiring between structures. Provisions shall be made for easy removal of any module without disturbing wiring to adjacent modules.

J. Provide a solid isolation barrier between each section and / or compartment.

K. MCC’s shall be designed such that each compartment within the enclosure can be wired via top or bottom entry.

L. Incoming feeder compartment cable access plate shall be made of non-ferrous material to prevent circulating currents.

M. Compartments shall not contain more than two feeder breakers or one single motor starter, except where two-speed or reversing starters are required.

N. Compartments for mounting motor control units shall not be smaller than 2X space.

O. Equipment and devices weighing in excess of 100 pounds shall have lifting lugs.

2.03 BUS

A. All busses shall be copper and plated as indicated in the Data Sheets. Ratings of all bus shall be based on a 65 degrees C temperature rise. All busses shall be braced to withstand the specified short circuit current as indicated on the Data Sheets. The vertical bus shall be adequately supported for the "plug-in" line connection of each module.

B. The incoming feeder cable section for each motor control center shall be designed to accommodate top-entry feeder cable or non-segregated bus duct, as indicated on the Data Sheets.

C. Provisions shall be made for future extension of the horizontal bus and the addition of structures.

D. Motor control centers shall be equipped with a copper ground bus along the full length of each lineup. Minimum size of ground bus shall be 1/4 inch by 2 inches. Ground bus shall provide connections to each vertical section structure.

E. MCC's shall have provisions to connect the internal ground bus to the plant's ground grid system. Provisions shall include lugs for ground cable connections of 4/0 AWG or greater.

F. All bus ratings shall be as indicated in the Data Sheets and the Drawings. Vertical bus shall be rated 600A, minimum, and shall be securely bolted to the main horizontal bus. Connection points shall be front accessible.

2.04 WIRING

A. All wiring shall be NEMA Class 1, Type B. control wiring shall be SIS type wire and shall be not smaller than #14 AWG.

B. All conductors shall be terminated with spade-type pre-insulated indent-compression lugs with locking tabs. The terminal lugs shall be constructed of copper and shall be tin plated. No splice shall be permitted in any wire or cable, and no more than two wires per terminal shall be used.

C. All current transformer wiring shall be #10 AWG, minimum, terminated with ring lugs on shorting-type terminal blocks and YELLOW insulation coloring.

D. Terminal blocks shall be pull-apart type conforming to NEMA ICS 4, rated 600V, and suitable for Type B wiring in each individual compartment. Motor control centers are to be provided with a minimum of 20 percent spare terminals in each starter.

E. Provide oversized terminals/lugs for power cable termination; two sizes larger than standard starter size to allow for oversized load power cables.

F. All interior wiring shall be neatly and carefully installed in wiring gutters or conduit and secured with plastic tie-wraps. All wiring shall be protected from contact with sharp edges with grommets if necessary. Extra wire shall be furnished at hinge point to allow opening of the doors.

G. All wiring between devices in the same MCC lineup shall be installed and tested at the factory.

H. Horizontal wiring compartments shall be accessible from the front with full width access at the top and bottom. Vertical wiring compartments shall be accessible to their full height and shall be isolated from the unit starters with a separate door.

I. Each terminal block, terminal, and conductor shall be permanently labeled to coincide with the identification indicated on the Drawings. All terminals provided for termination of external circuits shall be identified by inscribing circuit designations on the terminal block marking strips with indelible black ink. All wiring terminations shall be identified by printing on conductor identification sleeves. A conductor identification sleeve shall be provided on each end of each internal conductor.

2.05 SPACE HEATERS

A. As a minimum, space heaters shall be furnished in all motor control centers to prevent condensation of moisture within the unit. The heaters shall be located and thermally insulated such that no painted surface shall be damaged or discolored.

B. Space heater capacity shall be as required to maintain the internal temperature above the dew point. The space heaters shall be rated as indicated on the Data Sheets.

C. Space heaters shall be completely factory wired. Minimum heater wire size shall be #12 AWG.

D. Space heaters shall be humidistatically controlled.

E. Power supply for space heaters shall be as indicated on the Data Sheets.

1. When space heaters are powered from an external source, the entire circuit shall be wired to an accessible terminal block providing for a single connection of the external power source.

2.06 CIRCUIT BREAKERS

A. Feeder and nonmotor load breaker frame sizes and trip ratings shall be provided as indicated on the Drawings.

1. Breakers rated 225A and lower shall be thermal-magnetic trip units.
2. Breakers rated 250A and higher shall have microprocessor-based rms sensing trip units.
3. Automatic tripping of device shall be indicated by handle position.

B. Provide shunt trip devices, interlocks, auxiliary contacts, and other devices as shown on the Drawings.

C. Dual feeder breakers may be mounted together in the same compartment when practical.

D. Molded case circuit breaker compartments shall have an exterior disconnect switch handle similar to motor starter compartments that allows for the operation of the circuit breaker without the opening of the compartment door. All operating handles shall be capable of being padlocked in the OFF or OPEN position.

E. Branch circuit protection for feeder modules shall include one 3-pole single throw, 600 volt, molded case circuit breaker with a minimum interrupting rating that is compatible with the interrupt rating of the motor control center. All breakers shall be manually operated with quick-make, quick-break, trip-free mechanisms of the toggle type. The breakers shall be equipped with suitable arc quenching devices.

F. Circuit breakers shall have cable terminals that are rated at 90 degrees C and are suitable for use with 90 degrees C wire using the full NEC 90 degrees C rating.

G. All circuit breakers shall be provided by the same circuit breaker manufacturer.

2.07 MOTOR STARTERS

A. All motor starters shall be magnetic-type, 600V, 3-pole, NEMA Class with the appropriate de-rating factors applied. Starters shall be horsepower rated at the nominal MCC bus voltage.

B. All motor starters shall be supplied in the NEMA standard integral size. Minimum starter size shall be NEMA size 1.

C. Motor starters are to be draw-out type, arranged to minimize the number of vertical sections required. The total connected load of starters in a vertical section shall be within the vertical bus rating. Larger starters shall be arranged in the lower portion of vertical sections.

D. Motor starters and associated components shall be supplied as indicated on the Drawings. Components of each motor starter control module shall be as described in the following:

1. Construction:
    a. For starters Size 5 and smaller, starters shall be drawout combination type with stab connections.
    b. For starters Size 6 and larger, starters shall be bolt-on combination type.
    c. All starters shall be readily interchangeable with starters of similar size.

2. Motor Circuit Protector (MCP):
    a. MCP shall be located in the contactor common enclosure on line side of motor contactor unless indicated otherwise on the Drawings.
    b. MCP shall be supplied with a direct-acting operating handle and mechanism with stationary flange mounting and provisions for multiple padlocking.
3. Motor Running Protection:
    a. Each motor shall be protected while in the running state with solid state relays that have adjustable settings.
    b. Solidstate overload relays shall be provided with each motor that are insensitive to the ambient conditions. Overloads are to be supplied with a manual reset.
    c. Overload sizes shall be based on information furnished on the Drawings.
4. Contacts:
    a. A minimum of two normally open and two normally closed auxiliary contacts shall be supplied with each motor starter.
    b. Auxiliary contacts are to be wired to terminal strips in the same compartment.
5. Operating Coil: The rating of each starter operating coil shall be 120 Volts.
6. Control Power:
    a. Control power transformers (CPT) shall be supplied with each motor starter controller. Where practical, CPT’s shall be sized with 100 VA capacity in excess of operating coil requirements. Where not practical, CPT’s shall be sized with 50 VA excess capacity.
    b. All CPT’s are to be fused in both primary leads and in the ungrounded secondary lead, X1.
7. Motor Space Heater Circuits:
    a. Motor space heater circuits shall be provided for motors rated 30 hp and above as indicated on the Drawings.
    b. Where motor heater circuits are required, CPT’s shall be sized with 200 VA of extra capacity. Motor space heater circuit shall turn motor space heater on when motor is NOT running.
8. Safety Features:
    a. Internal 120V conductors for PCS motor control shall have yellow insulation to warn operating personnel of the conductors that may have external voltages present when the local motor starter compartment is not energized.

b. Each motor starter compartment shall have a permanent plastic yellow warning nameplate with black lettering that indicates to operating personnel that all voltages within motor starter compartment do not originate from within the motor controller center and that external 120V voltages from the PCS may be present at any time.

9. Controls and Indication:
   a. All motor control shall be performed by the PCS system. Motor starters shall not have Hand, Off, Auto (HOA) switches unless indicated on the Drawings.
   b. Each motor starter shall be supplied with a green and red LED status indicating light. Green shall indicate that the motor is not running. Red shall indicate that the motor is running. Where motor space heaters are specified a white LED status indicating light shall be provided to indicate motor space heater is 'ON'.

E. All lights, pushbuttons, and selector switches shall be NEMA Type 4/13, heavy duty, and water/oil tight.

2.08 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Engraved nameplates shall be furnished on the outside of each motor control center and each compartment door to identify the service of each device as indicated on the Drawings or load list. Nameplates shall be white with minimum 3/16-inch black lettering. Nameplates shall be fastened to motor control center using screws. As a minimum and per the Drawings, name plates shall indicate:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

2.09 FINISHES

A. Motor control centers shall be cleaned, primed, and painted according to Seller's standard finish specifications. The exterior color of all MCC's shall be ANSI No. 61, light grey. The interior color of all motor control centers shall be white.

2.10 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer's recommendations. Contractor shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Contractor shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle equipment as follows:

1. Each component to be properly packed and protected before shipment so it reaches Site without damage and with surfaces clean inside and out. In order to prevent damage during shipments, Seller shall carefully pack and brace components either within shipping container or on carrier.
2. Prior to shipment, access openings to be closed and sealed. Open ends to have covers or enclosures applied that excludes entry of dirt and moisture and of sufficient strength to minimize possibility of perforation or breakage during shipment.
3. Provide instructions for proper unpacking, installation, and onsite storage.
4. Deliver loose parts in boxed plywood containers and ship as a unit with equipment.
5. Equipment shall be adequately prepared for shipment and outdoor storage for a period of 6 months.

B. Identify equipment and shipping boxes by order number, Project name, Project location, equipment number, and description of contents. Use ink, paint, or other indelible material markings. Securely affix copy of completed packing list inside each separate shipping package.

C. Articles or materials that might otherwise be lost to be boxed and steel banded in bundles and marked for identification. Label each case, crate or bundle as to content, quantity and any special handling information.

D. Complete packing list to be transmitted to Site 30 days before shipment and copy shall accompany each shipment.

E. Notify Contractor 10 working days prior to arrival.

3.02 INSTALLATION

A. Equipment described in this Specification and listed in the Drawings shall be shipped per the Purchase Order. Contractor shall install all motor control centers in accordance with manufacturer's recommendations.

3.03 SOURCE QUALITY CONTROL

A. Provide notification not less than 10 working days prior to start of fabrication.

B. Factory Tests:

1. Provide notification not less than 15 days prior to conducting testing required by this section to permit representatives to be present during testing.
2. Comply with all specification requirements, documentation, and specified approvals and standards implemented by this section. Make available on request a copy of any part of quality assurance records. All tests, inspections, reports, and documentation are subject to review.
3. Make corrections to deficiencies as reported prior to shipment: representative has the right at no additional cost for a second inspection, if required, to ensure all deficiencies have been corrected prior to shipment.
4. Maintain records of all inspections and tests. Indicate nature and number of deficiencies found. Include quantities approved and rejected, and nature of corrective actions taken. On request, supply copies of all inspection and test data prior to or at time of shipment.
5. After the Motor Control Centers have been completely fabricated, they shall be subjected to and shall meet all requirements of the production tests listed in NEMA ICS 1 and NETA acceptance tests.
6. Motor Control Centers to be subjected to manufacturer's standard tests including but not be limited to the following:
    a. Control and secondary wiring continuity check.
    b. Mechanical operation tests.
    c. Clearance and mechanical adjustment check.
    d. Dielectric Tests between live parts and ground on both power and control circuits.

e. Electrical Tests including insulation resistance and overpotential tests on a completely assembled unit bus system.
f. Protective relays, meters, and transducers shall be inspected and tested in accordance with manufacturer's standards.
g. A complete functional check of equipment shall be performed after all component parts have been inspected and tested. Simulation of remote signals to be used for testing of each designed function. Functional checks shall verify all controls and interlocks shown on the Drawings.

C. Provide certified test reports on all supplied equipment prior to shipment.

D. Inspection and Test Plan (ITP): Manufacturer shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

3.04 MANUFACTURER'S SERVICES

A. A. Provide manufacturer's services as follows in coordination with the close-coupled low voltage switchgear specified under Specification 26 23 00, Low Voltage Metal Enclosed Switchgear:

1. Assistance to Contractor: 1 day, 1 trip.
2. Certificate of Proper Installation: 1 day, 1 trip.
3. Training Program: 1 day, 1 trip.
4. Functional and Performance Testing: 1 day, 1 trip.

3.05 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification:

1. Data Sheet.

END OF SECTION

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DATA SHEETS:
LOW-VOLTAGE MOTOR CONTROL CENTERS

PROJECT: COMBUSTION TURBINE GENERATOR 7 AT WEST POWER COMPLEX
PROJECT #: 469936
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: LOW VOLTAGE MOTOR CONTROL CENTER
TAG NO. WPCCTG-7-ELV60-MCC-<TBD>
P.O. NO.
LOCATION: NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
MANUFACTURER	-	By Contractor	
CATALOG NO.	-	By Contractor	
SITE CONDITIONS			
24 HR. AVG. AMBIENT DESIGN TEMPERATURE	ºF	By Contractor	
MAXIMUM AMBIENT TEMPERATURE	ºF	By Contractor	
MINIMUM AMBIENT TEMPERATURE	ºF	By Contractor	
SITE ELEVATION ABOVE SEA LEVEL	ft	55 ft	
SEISMIC CLASS	-	By Contractor	
GENERAL			
NOMINAL SYSTEM VOLTAGE	V	480 V	
MAXIMUM SYSTEM VOLTAGE	V	480 V	
MAIN INCOMING CABLE SIZE OR BUS	-	By Contractor	
PHASE	Qty	3	
WIRE	Qty	3	
FREQUENCY	Hz	60	
RATED CURRENT	A	800 A	
BUS MATERIAL	-	Cu	
BUS CONNECTION AREA PLATING MATERIAL	Ag/Tin	Tin	
FULLY INSULATED BUS	Y/N	Y	
SHORT CIRCUIT BRACING, RMS SYMMETRICAL	kA	65 kAIC	
HORIZONTAL BUS BAR:			
RATING	A	By Contractor	
MAXIMUM CONTINUOUS CURRENT CAPABILITY AT SITE AMBIENT CONDITIONS	A	By Contractor	
MATERIAL	-	Cu	
DIMENSIONS (L X W X H)	in	By Contractor	
VERTICAL BUS BAR:			
RATING	A	By Contractor	
MAXIMUM CONTINUOUS CURRENT CAPABILITY AT SITE AMBIENT CONDITIONS	A	By Contractor	
MATERIAL	-	Cu	
DIMENSIONS (L X W X H)	in	By Contractor	
GROUND BUS BAR:			
RATING	A	By Contractor	
MATERIAL	-	Cu	
DIMENSIONS (L X W X H)	in	By Contractor	
LOCATION	-	By Contractor	
GROUNDING CABLE SIZE	AWG	4/0 AWG	
BASIC IMPULSE LIGHTNING LEVEL (BIL)	kV	By Contractor	
ENCLOSURE			
NEMA TYPE	-	By Contractor	
MATERIAL	-	By Contractor	
MATERIAL THICKNESS	Gauge	By Contractor	
PROTECTIVE FINISH	-	By Contractor	
COLOR	ANSI	By Contractor	

DATA SHEETS:
LOW-VOLTAGE MOTOR CONTROL CENTERS

PROJECT: COMBUSTION TURBINE GENERATOR 7 AT WEST POWER COMPLEX
PROJECT #: 469936
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: LOW VOLTAGE MOTOR CONTROL CENTER
TAG NO. WPCCTG-7-ELV60-MCC-<TBD>
P.O. NO.
LOCATION: NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
NEMA WIRING CLASSIFICATION	-	By Contractor	
SHELTERED AISLE NEMA 3R ENCLOSURE	Y/N	By Contractor	
PLATFORM AND STAIRS REQUIRED	Y/N	By Contractor	
OVERHEAD CABLE TRAY WIDTH	in	By Contractor	
CABLE ENTRY	Top/Bottom	BOTTOM	
SPACE HEATERS:	Y/N	YES	
RATED VOLTAGE	V	220 V	
OPERATING VOLTAGE	V	120 V	
WATTAGE	kW	By Contractor	
VERTICAL SECTION DIMENSIONS (L X W X H)	in	By Contractor	
ASSEMBLED DIMENSIONS (L X W X H)	in	By Contractor	
WEIGHT	lbs	By Contractor	
SHIPPING DIMENSIONS (L X W X H)	in	By Contractor	
NUMBER OF SHIPPING SPLITS	Qty	By Contractor	
WIREWAYS CROSS SECTIONAL AREA:			
HORIZONTAL TOP WIREWAY	in^2	By Contractor	
HORIZONTAL BOTTOM WIREWAY	in^2	By Contractor	
VERTICAL WIREWAY	in^2	By Contractor	
CONTROLS			
FUNCTIONS:			
START/STOP	Y/N	YES	
HOA	Y/N	NO	
OTHER	-		
INDICATIONS:			
RUN	Y/N	YES	
OFF	Y/N	YES	
HAND	Y/N	NO	
AUTO	Y/N	NO	
OVERLOAD TRIP	Y/N	YES	
OTHER – MOTOR SPACE HEATER 'ON'	-	YES	
MOTOR STARTERS			
MANUFACTURER	-	By Contractor	
MODEL	-	By Contractor	
SIZE 1 FVNR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 2 FVNR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	

DATA SHEETS: **LOW-VOLTAGE MOTOR CONTROL CENTERS** **PROJECT:** COMBUSTION TURBINE GENERATOR 7 AT WEST POWER COMPLEX **PROJECT #:** 469936 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** LOW VOLTAGE MOTOR CONTROL CENTER **TAG NO.** WPCCTG-7-ELV60-MCC-<TBD> **P.O. NO.** **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 3 FVNR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 4 FVNR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 5 FVNR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 1 FVR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 2 FVR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 3 FVR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	

DATA SHEETS: **LOW-VOLTAGE MOTOR CONTROL CENTERS** **PROJECT:** COMBUSTION TURBINE GENERATOR 7 AT WEST POWER COMPLEX **PROJECT #:** 469936 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** LOW VOLTAGE MOTOR CONTROL CENTER **TAG NO.** WPCCTG-7-ELV60-MCC-<TBD> **P.O. NO.** **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 4 FVR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
SIZE 5 FVR			
CPT	VA	By Contractor	
MAXIMUM HORSEPOWER RATING	hp	By Contractor	
QUANTITY	Qty	By Contractor	
ELECTRONIC RELAY MODEL NUMBER	-	By Contractor	
DIMENSIONS (L X W X H)	in	By Contractor	
MAXIMUM SIZE CABLE TERMINATION ALLOWABLE, DETERMINED BY LUGS AND NEC BENDING RADIUS	AWG	By Contractor	
MOLDED CASE CIRCUIT BREAKERS			
MANUFACTURER		By Contractor	
MODEL, TYPE, OR SERIES		By Contractor	
AMPACITY / QUANTITY		By Contractor	
AMPACITY / QUANTITY		By Contractor	
AMPACITY / QUANTITY		By Contractor	
AMPACITY / QUANTITY		By Contractor	
AMPACITY / QUANTITY		By Contractor	
AMPACITY / QUANTITY		By Contractor	
INTERRUPT RATING		By Contractor	
SHORT CIRCUIT RATING		By Contractor	
LIST PARTS REQUIRING FIELD ASSEMBLY		By Contractor	
LIST OF REQUIRED MAINTENANCE TOOLS FURNISHED WITH EQUIPMENT		By Contractor	
SPECIAL REQUIREMENTS			
EQUIPMENT IS INTENDED TO BE INSTALLED AGAINST A WALL WITH NO REAR ACCESS			

SECTION 26 25 02
NON-SEGREGATED PHASE BUS DUCT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Design, manufacture, testing, and delivery of non-segregated phase bus duct (NSBD) and associated accessories. NSBD system shall be suitable for outdoor installation.

B. One-line diagrams, conceptual layout drawings, and phasing information are provided to show estimated lengths and required configuration of bus assembly.

C. Work to be provided by Supplier:

1. Design, furnish, and deliver non-segregated phase bus duct, accessory devices, and equipment as specified herein, complete from transformer connections to switchgear connections.
2. Furnish complete with accessories ready for installation, connections, and operation of electrical system indicated. Equipment shall consist of standard design and quality that meets or exceeds requirements of this Specification.
3. Furnishing of the following equipment and services to include, but not necessarily limited to the following:
    a. Non-segregated phase bus duct between transformer throat/bushings and switchgear flange/bus bars complete with conductors, insulators, enclosures, and all necessary hardware.
    b. Flexible links for all connections.
    c. Expansion joints.
    d. T-tap connections.
    e. Vapor barriers and wall penetration plates.
    f. Special tools or devices necessary for installation, operation and maintenance of NSBD.

D. Work provided by Others:

1. Furnishing and installation of bus support foundations.
2. Receiving and storage of bus on site.
3. Installation of NSBD.
4. Power source(s) for space heaters.
5. Bus support and ground connections.
6. Dimensioned drawings of Owner’s equipment to be interconnected with bus work.

7. Review of Supplier’s drawings.
8. Design, purchase, and installation of equipment to be interconnected with bus work.

E. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Scope of Work Combustion Turbine Generator System.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronic Engineers (IEEE):
   a. 605, Guide for Design of Substation Rigid-Bus Structures.
   b. 693, Recommended Practice for Seismic Design of Substations.
   c. C37.23, Standard for Metal-Enclosed Bus.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment.
   b. BU1, Busways.
4. American Society for Testing of Materials (ASTM):
   a. A123, Standard Specification for Zinc (Hot-Galvanized) Coatings on iron and Steel Products.
   b. B236, Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars).
5. American National Standards Institute (ANSI):
   a. C37.24, Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal Enclosed Switchgear.
   b. C37.31, Bus Insulators.
6. UL.

B. It shall be the Supplier’s responsibility to be knowledgeable of the requirements of these codes and standards. Any changes or alterations to the equipment to make it meet the requirements of these codes and standards shall be at the expense of the Supplier.

C. Whenever equipment, proposed by the Supplier, cannot fully meet the requirements of this Specification, such exceptions must be clearly stated by the Supplier. No exceptions shall be allowed, unless approved by the Owner in writing.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Provide Shop Drawings.
2. Test Reports.
3. Maintenance and Service Instructions.

B. The following Drawing type(s) shall be submitted for approval as a minimum:

1. Outline and General Arrangement drawings, completely dimensioned, showing:
   a. Dimensioned Plan and Elevation drawings, front view, other elevation views if pertinent, and shipping sections.
   b. Bus duct arrangement.
   c. Cross sectional views of bus bar arrangement, support blocks, and the totally-enclosed housing arrangement.
2. Bus termination details.
3. Location of space heaters and space heater wiring diagram indicating wiring terminal locations.
4. Conductor joint connection details.
5. Grounding connections.
6. Identification of all terminals, terminal blocks, and wires.
7. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle equipment as follows:

1. Each component to be properly packed and protected before shipment so it reaches site without damage and with surfaces clean inside and out. In order to prevent damage during shipments, Supplier shall carefully pack and brace components within shipping container.
2. Prior to shipment, access openings to be closed and sealed. Open ends of each bus housing to have covers or enclosures applied that excludes entry of dirt and moisture and of sufficient strength to minimize possibility of perforation or breakage during shipment.
3. Provide instructions for proper unpacking, installation, and onsite storage.
4. Deliver loose parts in boxed plywood containers and ship as a unit with equipment.

5. Equipment to be adequately prepared for shipment and outdoor storage for a period of 6 months.

B. Identify equipment and shipping boxes by order number, project name, project location, equipment number, and description of contents. Use ink, paint, or other indelible material markings. Securely affix copy of completed packing list inside each separate shipping package.

C. Articles or materials that might otherwise by lost shall be boxed and steel banded in bundles and marked for identification. Label each case, crate or bundle as to content, quantity, and any special handling information.

D. Before shipping, the NSBD shall be completely grid matched to ensure proper fit of parts. Equipment to be dismantled for shipment only to extent necessary as described in this section. NSBD shall be assembles for shipment in as few sections as possible to reduce field joints to a minimum. Sections and joints to be numbered and match-marked respectively in permanent and legible manner in order to facilitate erection. Section numbers and match-markings shall coincide with those shown on Supplier's drawings.

E. Complete packing list to be transmitted to site 30 days before shipment and a copy shall accompany each shipment.

F. Notify Owner 10 working days prior to arrival.

G. Preparation for shipment shall be in accordance with Supplier's standards, unless otherwise noted. The Supplier shall be solely responsible for the adequacy of the Preparation for Shipment provision employed with respect to material and application. The Supplier shall provide materials to their destination in ex-works condition when handled by commercial carrier systems. The Owner reserves the right to inspect and approve the equipment packaging prior to shipment.

1.05 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.06 WARRANTY AND GUARANTEES

A. Furnish Manufacturer's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. AZZ.
2. Eaton.
3. Powell.
4. Technibus.

B. Submit Product Data for each piece of electrical equipment provided.

C. The bus duct system shall have ratings as indicated on the Data Sheets.

D. Bus ratings shall take into account the site location ambient conditions and solar radiation gain.

E. The bus duct layout, including dimensions, general arrangement, and bus duct equipment entrance details shall be as indicated on the Drawings from the interface equipment supplier.

F. It shall be the bus duct Supplier's responsibility to match the bus duct connection flanges to switchgear and transformers, or other equipment as the design requires. Dimensions and details of the connecting equipment flange connections will be as indicated on the Drawings from the interface equipment.

G. All non-segregated bus duct shall be rated for the seismic requirements as identified on the Data Sheets.

H. When required, a neutral wire for the high resistance ground connection to the transformer X0 bushing shall be supplied with each bus duct section for field installation.

I. Supplier shall provide required outdoor support structures, indoor hangers, and attachment accessories.

2.02 CONDUCTORS

A. Design bus duct systems for nominal voltages, current and short circuit ratings, BIL, number of poles, and rated maximum voltages as specified on the Data Sheets.

B. Outdoor bus duct ampacity nameplate ratings shall include any deratings associated with exposure to solar radiation in accordance with applicable ANSI and IEEE Standards.

C. Design bus duct systems for continuous self-cooled current rating specified on the Data Sheets.

D. Bus duct system shall be designed and braced to withstand 3-phase fault currents and momentary 3-phase fault currents as specified on the Data Sheets.

E. Bus duct conductors shall be high-grade, 98 percent, minimum, pure copper bus bars and shall be designed to carry rated continuous current without exceeding temperature rise requirements specified in IEEE and NEMA standards. The current carrying capacity shall be based on actual service conditions including skin and proximity effects, the effects of the bus insulation, the bus duct enclosure, and the ambient temperature.

F. All bus duct rated above 600V shall have fully insulated conductors and conductor joints. Except at bolted terminations and connection points, all phase conductors in bus duct shall have an epoxy coated insulating material. Insulating materials shall be water resistant, flame-retardant, self-extinguishing, track-resistant, and rated for continuous operation at 105 C (class 130). The insulation level of the combined system shall meet or exceed the requirements in Table 5 of ANSI Standard C37.23.

G. All bus conductor connections shall be bolted with silver-to-silver contact surfaces to minimize contact resistance.

H. Bus duct connections to equipment shall be made with flexible connectors. Insulated cable is not an acceptable ‘flexible connector’. Flexible connections shall allow for electrical isolation. Flexible connectors shall have a continuous current rating equal to or greater than the main conductors.

I. Provisions shall be made for bus expansion, to prevent undesirable or destructive mechanical strains in the bus supports and connections, through an ambient temperature range as specified on the Data Sheets. Expansion joints shall be furnished where required.

J. All bolted joints, expansion joints, and bus connections to equipment, factory or field installed, shall be insulated by an easily removable boot with nylon fasteners. The length of overlap on each conductor shall not be less than 2 inches at expansion joints, and not less than 1 inch at other connections.

2.03 INSULATORS

A. Support bus conductors by blocks or post insulators of molded fiberglass, polymer, ceramic or porcelain. Bus supports shall be made from high quality dielectric material that offers high creep and high strength properties.

B. Insulators shall be flame-retardant, track-resistant, and non-hygroscopic.

C. Locate insulators to provide mechanical strength to withstand forces from momentary and short-circuit conditions specified.

2.04 ENCLOSURE

A. The enclosure shall be aluminum with stainless steel hardware. If used as a grounding conductor, the enclosure and joints shall be designed and sized to meet all the requirements of an equipment grounding conductor in accordance with the NEC. This may require bonding jumpers.

B. The enclosure shall be constructed to prevent undesirable or destructive mechanical expansion and contraction stresses as a result of bus duct temperature rise and/or the ambient temperature range as specified in Division 1, General Requirements. Expansion joints shall be furnished where required.

C. The bus duct enclosure shall include all necessary flexible connectors and hardware to connect the bus duct enclosure to the fixed equipment and supports.

D. Suitable accessories and fittings shall be furnished on the bus duct enclosure to accommodate bus duct system hangers and supports. Required support points shall be designated on the bus duct Drawings.

E. Provide full-access covers for maintenance and inspection.

1. Equip covers with corrosion-resistant captive fastening hardware.
2. Removable covers and plates shall have permanent match-mark identification.

F. Supply each section of enclosure with breather/drain for removal of condensation.

G. NEMA 2-hole copper grounding pads shall be provided on each terminal end of the bus duct and along the bus duct routing approximately every 50 feet at or near a support location, not to exceed 50 feet between grounding pads where overall bus duct enclosure length is greater than 50 feet, and at each transition from indoor to outdoor.

H. Provide outdoor metal enclosure for bus connection to interface equipment.

1. Design enclosures and bus to mate to the throat extensions and terminations provided on interface equipment.
2. Coordinate with interface equipment manufacturer(s) for final termination details.

2.05 STRUCTURAL SUPPORTS

A. Structural supports shall be designed to meet wind velocity and seismic conditions as specified in the equipment data sheets and shall be designed in accordance with the Jurisdictional Building Code for the project. Supports shall be rigid, self-supporting, steel beams.

B. Anchor bolts and foundation design for the structural members shall be coordinated with the Project foundation design.

C. Bus duct structural support design shall be coordinated with the overall Project design to ensure all Project design considerations impacted by the bus duct structural supports are met; such as, but not limited to, equipment access and maintenance. Support locations shall be at least 3’-0” from equipment to allow room for equipment maintenance.

D. Bus duct connecting to interface equipment shall not rely on such equipment for structural support. Bus duct shall only be supported by independent structural supports.

E. All support structures shall be made up of wide flange hot dipped galvanized steel in accordance with ASTM A123 specifications and the inspection manual for Hot-Dipped Galvanizing Products Published by the American Zinc Institute. Structures are to be galvanized both inside and out after all cutting, punching, welding, and cleaning have been completed. Galvanizing shall be done after fabrication.

F. Finished galvanized surfaces must be uniform in color and appearance. Surface texture must be free of excessive roughness, pimples, lumpiness, and runs.

G. Base plates shall be provided with a minimum of four anchor bolt holes.

2.06 SPACE HEATERS

A. Space heaters shall be furnished in all outdoor bus duct sections, as a minimum, to prevent condensation of moisture within the bus duct. The space heaters shall be located and thermally insulated such that no painted surface or bus insulation shall be damaged or discolored.

B. Space heater capacity shall be as required to maintain the compartment and the bus duct internal temperature above the dew point. Space heaters shall be rated at 240V ac and operate at 120V ac.

C. Space heaters shall be completely factory wired (except at shipping splits) with no exposed wiring inside the bus housing. Minimum space heater wire size shall be 12 AWG.

D. Space heaters shall be thermostatically controlled.

E. The space heaters shall be powered from an external source. The entire space heater power supply circuit shall be wired to a common accessible terminal block providing for a single connection of the external power source.

2.07 GROUNDING BUS

A. When required, a ground bus shall be furnished which will electrically connect all equipment connected to the bus duct. The ground bus shall be capable of carrying rated bus short-circuit current as specified in this Specification. The minimum ground bus size shall be 1/4 inch by 2 inch.

2.08 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. At least one nameplate shall be permanently attached to each bus duct run and/or device. The nameplate shall include information as listed below:

1. Manufacturer’s name.
2. Equipment tag number.
3. Voltage and current ratings.
4. Manufacturer’s serial number.

2.09 FIRE BARRIERS AND WALL PENETRATIONS

A. A fire-resistant divider or barrier shall be provided at all points where the bus duct extends through a building wall and fire walls as shown on the Drawings. The barrier shall have a minimum fire rating as that of the wall it penetrates.

B. Wall penetrations between indoor and outdoor locations shall be weather-resistant and watertight.

C. Wall penetrations shall include vapor barriers to prevent interchange of air between outdoor and indoor environments or environmentally controlled and non-environmentally controlled areas. Vapor barriers shall be either sealed or baffled to prevent interchange of air between bus sections in accordance with ANSI C37.23.

D. Bus assembly shall include mounting plates, gaskets, and hardware where bus penetrates building walls.

2.10 FINISHES

A. Manufacturing waste, such as metal chips and filings, welding rods and stubs, waste, rags, and debris are to be removed from interior of each component. Remove loose mill scale, rust, oil, grease, chalk, crayon, paint marks, and other deleterious material from interior and exterior surfaces.

B. Clean and prepare for painting and shop prime in accordance with manufacturer’s standard system.

C. Bus enclosure external finish color shall be as indicated on the Data Sheets. Interior finish of enclosure to be Supplier’s standard and may consist of special treatment to increase heat transmission. Interior coatings shall not fail or peel under conditions of operation.

D. Provide sufficient finish paint, one gallon minimum, for retouching after installation.

PART 3 EXECUTION

3.01 SOURCE QUALITY CONTROL

A. Inspection and Test Plan (ITP):

1. Manufacturer shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

B. Fabrication:

1. Notify Owner 10 working days minimum, prior to those fabrication steps and tests which Owner or designated representative desires to witness.
2. Owner will advise Supplier prior to production of those fabrication steps and shop inspection points that Owner or designated representative desires to witness.

C. Equipment Testing/Inspections:

1. General:
   a. Notify Owner not less than 10 working days prior to conducting inspection or testing.
   b. Comply with requirements, tests, inspections, reports, documentation, and specified approvals and latest applicable standards implemented by this section. Make available on request, a copy of any part of quality assurance records. Tests, inspections, reports, and documentation subject to inspection.
   c. Maintain records of inspections and tests. Indicate nature and number of deficiencies found, quantities approved and rejected, and nature of corrective actions taken. Furnish Owner copies of inspection and test data prior to or at time of shipment.
2. Shop Tests:
   a. Perform requisite factory tests to determine Work and materials are free from defects and to establish that design and construction meet requirements of this Specification.
   b. Provide certified copies of the following type tests for NSBD units of similar construction; temperature rise, momentary current, and impulse test.
   c. Non-segregated bus duct assemblies, insulators and seal-off bushings to have an ac high potential test as recommended in ANSI C37.23.

D. Repair and Retest:

1. If NSBD or accessories fail to pass specified tests, perform additional test to locate failure. After rework or repair of the failure, specified tests shall be repeated to ensure rework or repair meets Specification.
2. Rework or repair and retesting shall be done at Supplier’s expense.
3. Supplier to keep record of all failures detected during tests, rework or repair and any test data after repairs have been completed.

3.02 MANUFACTURER’S SERVICES

A. Provide manufacturer’s services as follows:

1. Certificate of Proper Installation: 1 day, one trip.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Data Sheets.

END OF SECTION

DATA SHEETS:
NON-SEGREGATED PHASE BUS DUCT

PROJECT: CTG 7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: NON-SEGREGATED PHASE BUS DUCT
TAG NO. CWPCTG-7-EMV60-BD-<TBD>
P.O. NO.
LOCATION: NEW ORLEANS, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
MANUFACTURER	-	By Contractor	
CATALOG NO.	-	By Contractor	
SITE CONDITIONS			
MAXIMUM AMBIENT TEMPERATURE	ºF	104	
MINIMUM AMBIENT TEMPERATURE	ºF	50	
MAXIMUM TEMP RISE OF CONDUCTOR ABOVE AMBIENT	ºC	50	
MAXIMUM CONDUCTOR OPERATING TEMPERATURE	ºC	By Contractor	
MAXIMUM ENCLOSURE OPERATING TEMPERATURE	ºC	30	
ELEVATION ABOVE SEA LEVEL	ft	0	
SOLAR RADIATION COMPENSATION SPECIFIED	Y/N	Y	
MAXIMUM ICE LOAD	inches	By Contractor	
WIND SPEED	mph		
SEISMIC ZONE	-		
GENERAL			
NOMINAL LINE VOLTAGE (RMS)	V	By Contractor	
FREQUENCY	Hz	60	
NO. OF POLES	-	3	
BUS BAR MATERIAL	-	CU	
JOINT AREA TREATMENT	Tin/Silver	Silver	
FULLY INSULATED BUS	Y/N	Y	
GROUND CONDUCTOR TYPE AND SIZE	-	None	
GROUND CONDUCTOR LOCATION	-	N/A	
TOTAL LOSSES IN 3-PHASE WATTS AT 65ºC RISE AMP RATING	W/ft	By Contractor	
REACTANCE AT 60 HERTZ	μΩ/ft	By Contractor	
RESISTANCE AT 20ºC	μΩ/ft	By Contractor	
WEIGHT PER 3-PHSE FOOT (CONDUCTOR AND ENCLOSURE)	lbs	By Contractor	
CONDUCTOR CENTER TO CENTER PHASE SPACING	inches	By Contractor	
CONDUCTOR SHAPE	-	By Contractor	
RECOMMENDED BUS SUPPORT SPAN DISTANCE	ft	By Contractor	

ENCLOSURE			
WEATHERPROOF	Y/N	Y	
MATERIAL	-	Aluminum	
MINIMUM MATERIAL THICKNESS	-	By Contractor	
PROTECTIVE FINISH	-	By Contractor	
FINISH COAT COLOR	-	By Contractor	
VERTICAL SECTION DIMENSIONS (L x W x H)	inches	By Contractor	
MAXIMUM SHIPPING DIMENSIONS (L x W x H)	inches	By Contractor	
NUMBER OF SHIPPING SECTIONS	-	By Contractor	
VOLTAGE CLASS	V	By Contractor	
BASIC IMPULSE LEVEL (BIL)	kV	By Contractor	
SHORT CIRCUIT AMPERES AT MAX VOLTAGE (RMS SYMM)	kA	By Contractor	
MOMENTARY S.C. AMPS AT MAX VOLTAGE (RMS ASYMM)	kA	By Contractor	
DURATION OF FAULT	Cycle	By Contractor	
CONTINUOUS CURRENT RATING	A	By Contractor	
ACCESSORIES			
SPECIAL ERECTION AND MAINTENANCE TOOLS	Y/N	By Contractor	
REMOVABLE LINK	Y/N	Y	
SPACE HEATER RATED VOLTAGE	V	240VAC 60Hz	
SPACE HEATER OPERATING VOLTAGE	V	120VAC 60Hz	
NUMBER OF POWER SOURCES PROVIDED BY OTHERS	-	0 By Contractor	

DATA SHEETS:
NON-SEGREGATED PHASE BUS DUCT

PROJECT: CTG 7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: NON-SEGREGATED PHASE BUS DUCT
TAG NO. CWPCTG-7-EMV25-BD-<TBD>
P.O. NO.
LOCATION: NEW ORLEANS, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
MANUFACTURER	-	By Contractor	
CATALOG NO.	-	By Contractor	
SITE CONDITIONS			
MAXIMUM AMBIENT TEMPERATURE	ºF	104	
MINIMUM AMBIENT TEMPERATURE	ºF	50	
MAXIMUM TEMP RISE OF CONDUCTOR ABOVE AMBIENT	ºC	50	
MAXIMUM CONDUCTOR OPERATING TEMPERATURE	ºC	By Contractor	
MAXIMUM ENCLOSURE OPERATING TEMPERATURE	ºC	30	
ELEVATION ABOVE SEA LEVEL	ft	0	
SOLAR RADIATION COMPENSATION SPECIFIED	Y/N	Y	
MAXIMUM ICE LOAD	inches	By Contractor	
WIND SPEED	mph		
SEISMIC ZONE	-		
GENERAL			
NOMINAL LINE VOLTAGE (RMS)	V	By Contractor	
FREQUENCY	Hz	25	
NO. OF POLES	-	3	
BUS BAR MATERIAL	-	CU	
JOINT AREA TREATMENT	Tin/Silver	Silver	
FULLY INSULATED BUS	Y/N	Y	
GROUND CONDUCTOR TYPE AND SIZE	-	None	
GROUND CONDUCTOR LOCATION	-	N/A	
TOTAL LOSSES IN 3-PHASE WATTS AT 65ºC RISE AMP RATING	W/ft	By Contractor	
REACTANCE AT 25 HERTZ	μΩ/ft	By Contractor	
RESISTANCE AT 20ºC	μΩ/ft	By Contractor	
WEIGHT PER 3-PHSE FOOT (CONDUCTOR AND ENCLOSURE)	lbs	By Contractor	
CONDUCTOR CENTER TO CENTER PHASE SPACING	inches	By Contractor	
CONDUCTOR SHAPE	-	By Contractor	
RECOMMENDED BUS SUPPORT SPAN DISTANCE	ft	By Contractor	

ENCLOSURE			
WEATHERPROOF	Y/N	Y	
MATERIAL	-	Aluminum	
MINIMUM MATERIAL THICKNESS	-	By Contractor	
PROTECTIVE FINISH	-	By Contractor	
FINISH COAT COLOR	-	By Contractor	
VERTICAL SECTION DIMENSIONS (L x W x H)	inches	By Contractor	
MAXIMUM SHIPPING DIMENSIONS (L x W x H)	inches	By Contractor	
NUMBER OF SHIPPING SECTIONS	-	By Contractor	
VOLTAGE CLASS	V	By Contractor	
BASIC IMPULSE LEVEL (BIL)	kV	By Contractor	
SHORT CIRCUIT AMPERES AT MAX VOLTAGE (RMS SYMM)	kA	By Contractor	
MOMENTARY S.C. AMPS AT MAX VOLTAGE (RMS ASYMM)	kA	By Contractor	
DURATION OF FAULT	Cycle	By Contractor	
CONTINUOUS CURRENT RATING	A	By Contractor	
ACCESSORIES			
SPECIAL ERECTION AND MAINTENANCE TOOLS	Y/N	By Contractor	
REMOVABLE LINK	Y/N	Y	
SPACE HEATER RATED VOLTAGE	V	240VAC 60Hz	
SPACE HEATER OPERATING VOLTAGE	V	120VAC 60Hz	
NUMBER OF POWER SOURCES PROVIDED BY OTHERS	-	0 By Contractor	

SECTION 26 26 13
LOW VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 SUMMARY

A. This section applies to motors specified within a motor-driven equipment specification package. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this Specification will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

B. Compliance with this Specification does not relieve Supplier of the responsibility for furnishing motors of proper design and mechanically suited to meet operating guarantees at the specified service conditions.

C. Proposed design features having less than two years operating experience in similar service shall be specifically listed, and details provided for Purchaser review.

D. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 841, Standard for Petroleum and Chemical Industry – Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – up to and including 500 hp.
2. National Electrical Manufacturers Association (NEMA):
   a. MG 1, Motors and Generators.
   b. MG 2, Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators.

3. American Bearing Manufacturer's Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life of Roller Bearings.
4. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations.
5. National Fire Protection Association (NFPA): 70, National Electric Code.
6. UL:
   a. 674, Standards for Safety – Electric Motors for use in Hazardous (Classified) Locations.
   b. 1004, Standard for Safety – Rotating Electrical Machines.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Completed motor data sheet attached to this Specification for each motor supplied.
2. Standard motor data submittals including safety stall times.
3. Outline drawings, Preliminary and Certified.
4. Performance curves (speed-torque at 100 percent and 80 percent voltage).
5. Speed-current / acceleration curves at 100 percent and 80 percent voltage.
6. Stator and rotor thermal damage curve.
7. Wiring Diagram.
8. Installation Instructions.
9. Operating and Maintenance Manual.
10. Test Reports.

1.04 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.05 WARRANTY AND GUARANTEES

A. Furnish Manufacturer's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. ABB.
2. Baldor.
3. GE.
4. Hitachi.
5. Siemens.
6. TECO Westinghouse.
7. Toshiba.
8. WEG.

B. Submit Product Data for each piece of electrical equipment provided.

C. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

D. The Supplier shall be responsible for fully coordinating the design and construction of the motors with the mounting arrangement, connection, bearing requirements, end play, direction of rotation, vibration and other applicable requirements of the driven equipment.

E. All motors shall comply with NEMA MG-1 requirements unless otherwise specified herein.

2.02 HORSEPOWER RATING

A. As designated in motor-driven equipment specifications.

B. The motor rating, when multiplied by the service factor, shall be at least 15 percent greater than the maximum brake horsepower required by the driven equipment. Motors where subject to test block design basis shall be rated based on Test Block Condition.

C. For pumps the motor service factor may be used for determining motor size for end of curve conditions.

2.03 SERVICE FACTOR

A. All motors shall have 1.15 service factor.

B. When a service factor greater than 1.0 is provided, motor's nameplate hp rating shall be determined without taking advantage of the service factor, even for short durations.

2.04 AMBIENT TEMPERATURE

A. All motors shall be rated for an ambient temperature range of minus 5 degrees F to 105 degrees F, at elevation less than 3,300 feet.

2.05 VOLTAGE AND FREQUENCY RATING

A. Motor Voltage Rating, unless otherwise indicated in motor-driven equipment specifications, shall be the following:

Size	Voltage	Phases
Fractional HP	115/230	1
0.5HP through 300HP	460	3

B. Motors shall be able to start under load and accelerate to rated speed with minimum terminal voltage of 80 percent of motor rated voltage.

C. Insulation shall be Class F, to operate with a Class B temperature rise.

D. Motor power supply frequency shall be as specified on the Motor Data Sheet.

2.06 EFFICIENCY

A. All motors shall exceed MG 1 NEMA Premium Table 12-12 with one band minimum.

2.07 BEARINGS AND LUBRICATION

A. Direct Coupled: 130,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and 11.

B. Belt Drives: 50,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and 11.

2.08 SPECIAL FEATURES AND ACCESSORIES

A. All motors shall be provided with cast-in vibration pads (5-point vibration probe mounting locations).

B. All motors shall be capable of field conversion to F2 mounting.

C. Aluminum enclosures are not acceptable. Enclosures to be constructed of cast iron, cast steel, sheet steel, or steel plates.

D. All motors 30HP and above shall be equipped with space heaters, rated for 240V and operated at 120V.

E. All motors shall be equipped with Inpro bearing seals.

F. All exposed metal surfaces shall be protected with a corrosion-resistant polyester paint or coating.

G. Terminal housings shall be cast iron, gasketed, and watertight. Adequate room shall be supplied to meet cable training radius requirements.

H. All insulated windings shall be copper. The winding temperature rise for all motors, when operating at the nameplate horsepower multiplied by the service factor shall not exceed NEMA MG-1 class B insulation temperature rise (Table 12.43), determined by resistance method, and adjusted for site altitude and ambient temperature.

I. Inverter Duty Motors:

1. For inverter drive applications, motors shall exceed NEMA-MG1, Part 31.
2. Winding surge withstanding capability shall be 2400V (minimum).
3. Frame 400 and larger outboard (NDE) bearing shall be insulated and grounding brush on the inboard (DE) shaft.
4. Turn down ratio: as required for application.

J. Horizontal Motors Mounted Vertical (C-Face):

1. Down facing shaft shall be provided with a rain canopy covering the fan cowl air inlet.
2. Up facing shaft shall be designed such that no water can enter the motor via the shaft.
3. Provide two lifting lugs bolted to motor frame.

2.09 SPECIAL MOTORS

A. Where special purpose motors are required for the specific application, such as hoists requiring special torque motors, supply motors meeting the requirements of NEMA MG-1.

B. Two-speed motors shall be two winding, unless specified otherwise.

C. Motors in NEC Classified Areas shall be specific to the hazardous area requirements and shall be coordinated by the driven-equipment design, appropriate codes and standards, and subject to Engineer's approval.

2.10 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Engraved nameplates shall be furnished as indicated on the Drawings or equipment list. Nameplates shall be fastened to motor using screws. As a minimum and per the Drawings, name plates shall include:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

2.11 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer's recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to

each part showing equipment tag number, part name, or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. Test shall be in accordance with manufacturer's routine (production) tests and IEEE 112. Test reports shall be provided.

B. Inspection and Test Plan (ITP): Manufacturer shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

3.02 INSTALLATION

A. Installation and alignment with mechanical equipment shall be in strict accordance with manufacturer's instructions and recommendations.

3.03 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification:

1. Data Sheet.

END OF SECTION

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DATA SHEET: LOW VOLTAGE AC INDUCTION MOTORS **PROJECT:** CTG 7 **CP#:** 1419 **CLIENT:** SEWERAGE &WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** **TAG NO.** **WPCCTG-7-<SYS>-M-<SEQ#>** **P.O. NO.** **LOCATION:** **NEW ORLEANS, LA**	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
Motor Manufacturer	-	By Contractor	
Motor Catalog No.	-	By Contractor	
SITE CONDITIONS			
Area Class	-		
Division	-		
Group	-		
Local Motor Starter	Y/N	NO Remote Motor Starter	
RATINGS			
Power	hp	By Contractor	
Synchronous Speed	RPM	By Contractor	
Voltage	V	460	
Number of Phases	Qty	3	
Frequency	Hz	By Contractor	
Frame Size	-	By Contractor	
RPM @ Full Load	RPM	By Contractor	
Full Load Current	A	By Contractor	
Driven Load (maximum)	hp	By Contractor	
Design Type (A, B, C, D, E)	-	By Contractor	
Locked Rotor Code Letter	-	By Contractor	
Enclosure Type	-	TEFC	
CHARACTERISTICS			
Efficiency: 100% Full Load	%	By Contractor	
75% Full Load	%	By Contractor	
50% Full Load	%	By Contractor	
Full Load Current: 100% Full Load	A	By Contractor	
75% Full Load	A	By Contractor	
50% Full Load	A	By Contractor	
Locked Rotor Current	A	By Contractor	
Acceleration Time: No Load	sec	By Contractor	
Full Load	sec	By Contractor	
Motor Inertia	H	By Contractor	
DESIGN REQUIREMENTS			
Minimum Insulation Class (B, F, or H)	-	F	
Maximum Operating Temperature Rise (B, F, or H)	-	B	

DATA SHEET: LOW VOLTAGE AC INDUCTION MOTORS **PROJECT:** CTG 7 **CP#:** 1419 **CLIENT:** SEWERAGE &WATER BOARD OF NEW ORLEANS		**EQUIP NAME:** **TAG NO.** **WPCCTG-7-<SYS>-M-<SEQ#>** **P.O. NO.** **LOCATION:** **NEW ORLEANS, LA**	
DESCRIPTION	**UNITS**	**SPEC DATA**	**CONTRACTOR DATA**
Insulation Class Temperature Rise			
Hot-Spot Temperature Used to Determine Rise	ºC	By Contractor	
Service Factor	-	1.15	
Duty Type (Continuous, short-time, or intermittent)	-	Continuous	
No. of Speeds	1,2,3,4	By Contractor	
No. of Windings	1,2	By Contractor	
Motor Starting Method	-	Full Voltage	
Type of Speed Control	-		
Motor Rated for Use With VFD	Y/N	By Contractor	
Minimum System Voltage During Motor Start	%V	By Contractor	
Sound Level @ Full Load (3' (1 meter) distance)	dBA	By Contractor	
Bearing Type	-	By Contractor	
Bearing Estimated Life Expectancy	Hrs	By Contractor	
Winding RTDs	Y/N	By Contractor	
Vibration Monitoring	Y/N	By Contractor	
Motor Space Heater required:	Y/N	By Contractor	
Rated Voltage	V	220 VAC	
Operating Voltage	V	120 VAC	
Wattage	W	By Contractor	
Motor Terminal Box Location	-	By Contractor	
Size	-	By Contractor	
Mounting Position (Horizontal/Vertical)	-	By Contractor	
Weight	Lb	By Contractor	
Required Data for Motors Rated 60 hp and Larger			
Permissible Starts per Hour:		By Contractor	
With Motor at Rated Ambient	Qty	By Contractor	
With Motor at Rated Total Temp.	Qty	By Contractor	
Locked Rotor Time:			
Cold	Sec	By Contractor	
Hot	Sec	By Contractor	
Acceleration Time, Full Load:			
@ 100% Full Voltage	Sec	By Contractor	
@ 80% Full Voltage	Sec	By Contractor	
Maximum kVAR for PF Correction			
Nonreversing Ratchets	Y/N	By Contractor	

SECTION 26 29 23
LOW VOLTAGE VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. This section applies to heavy industrial application Pulse Width Modulated (PWM), separately-enclosed, preassembled, combination Variable Frequency Drives (VFD), as well as those panel-mounted VFDs intended for installation in separate enclosures, and those incorporated into machinery or processes as part of a packaged system, rated 600V or less for 3-phase motors rated, nominally, 1/2HP to 500HP or less. VFDs shall be designed, fabricated, selected, and installed for general or high-performance constant- or variable-torque loads as shown on, or as required by, Project documentation.

B. Compliance with this Specification does not relieve Supplier of the responsibility for furnishing VFDs of proper design and mechanically suited to meet operating guarantees at the specified service conditions.

C. Proposed design features, having less than 2 years' operating experience in similar service, shall be specifically listed, and details provided for Purchaser review and approval.

D. Related Sections: This section does not stand alone and is a part of the entire Specification which is the sum-total of all the sections. Related Sections listed below are listed for emphasis and do not preclude the applicability of any part of the entire Specification requirements. Related Sections of particular emphasis are as follows:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.
6. Section 26 26 13, Low Voltage AC Induction Motors.

1.02 DEFINITIONS

A. AFE: Active Front End.

B. CPT: Control Power Transformer.

C. DDC: Direct Digital Control.

D. DFE: Diode Front End.

E. EMI: Electro-Magnetic / Electromagnetic Interference.

F. IGBT: Insulated Gate Bipolar Transistor.

G. LED: Light-Emitting Diode.

H. MTBF: Mean Time Between Failure.

I. MTTR: Mean Time to Repair.

J. NC: Normally Closed.

K. NO: Normally Open.

L. NPC: Neutral Point Clamped.

M. OCPD: Over-Current/Overcurrent Protective Device.

N. PID: Proportional + Integral + Derivative (control action).

O. PWM: Pulse Width Modulation.

P. RFI: Radio-Frequency Interference.

Q. VFD: Variable Frequency Drive.

R. VSI: Voltage Source Inverter.

1.03 REFERENCES

A. The following is a list of standards applicable to the requirements of this Specification and which may be referenced in conjunction with this section:

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. 519, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
   b. 1566-2015, Standard for Performance of Adjustable-Speed AC Drives Rated 375kW and Larger.
2. International Electrotechnical Commission (IEC):
   a. 61000, Electromagnetic Compatibility.
   b. 61800-5-1, Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy.

c. 60068, Part 2-3, Basis Environmental Testing Procedures – Part 2: Tests- Test Ca: Damp Heat.
d. 60146-1-1, Semiconductor Converters – General Requirements and Line Commutated Converters – Part 1-1: Specification of Basic Requirements.
e. 60664-1, Insulation Coordination for Equipment Within Low-Voltage Systems.
f. 60447, Basic Safety Principles for Man-Machine Interface, Marking and Identification – Actuating Principles.
g. 61439-1,Low-Voltage Switchgear and Controlgear Assemblies – Part 1: General Rules.
h. 60364-1, Low-Voltage Electrical Installations – Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions.
i. 60204-1, Safety of Machinery – Electrical Equipment of Machines – Part 1: General Requirements.
j. 106, Guide for specifying Environmental Conditions for Equipment Performance Rating.
k. 529, Degrees of Protection Provided by Enclosure.
l. 1000, Electromagnetic Compatibility.
m. 1800, Adjustable Speed Electrical Power Drive Systems.
n. 60721-3-3, Classification of Environmental Conditions.
o. 60255-8, Overload Relays.
p. 60801-2, -3, -4, -5, Immunity Tests.
q. 60947-2, Low-Voltage Switchgear and Controlgear – Part 2: Circuit Breakers.

3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment.
   b. ICS Part 4, Overload Relays.
   c. ICS 7, Industrial Control and Systems Adjustable Speed Drives.
   d. ICS 7.1, Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drives.
4. American National Standards Institute (ANSI): 1210-2019, Performance Rating of Variable Frequency Drives.
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 79, Electrical Standard for Industrial Machinery.
6. Occupational Safety and Health Administration (OSHA): 1910.95, Occupational Noise Exposure.
7. UL:
   a. 508, Standard for Safety Industrial Control Equipment.
   b. 508A, Standard for Safety Industrial Control Panels.
   c. 508C, Power Conversion Equipment.
   d. 1449, Standard for Safety Surge Protective Devices.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data including, but not limited to, the information listed in this article.

B. Product Data: For each type and rating of VFD indicated.

1. Include dimensions and finishes for VFDs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: For each VFD indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFDs.
2. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

E. Product Certificates: For each VFD from manufacturer.

F. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

G. Source quality-control reports.

H. Field quality-control reports.

I. Sample Warranty: For special warranty.

J. Closeout Submittals:

1. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.
   a. In addition to items specified in Section 01 78 23, Operation and Maintenance Data, include the following:
      1) Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
      2) Manufacturer's written instructions for setting field-adjustable overload relays.
      3) Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      4) Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      5) Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
      6) Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

K. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   a. Power Fuses: Equal to 20 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   b. Control Power Fuses: Equal to 20 percent of quantity installed for each size and type, but no fewer than four of each size and type.
   c. Indicating Lights: Four of each type and color installed.
   d. Auxiliary Contacts: Furnish two spare(s) for each size and type of magnetic controller installed.
   e. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.05 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections, and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards, and Regulations, and that all specified tests have been satisfactorily completed.

D. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.06 WARRANTY AND GUARANTEES

A. Furnish Supplier’s extended guarantee or warranty with Owner named as beneficiary, in writing, as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner’s representative. The Supplier must be able to provide Owner with training and support service during the first year of operation.

E. Work not so fabricated, tested, installed, or constructed in accordance with the Specification and Drawings, any written guidance, or any modifications thereof, unsuitable for the purposes intended, shall be removed and made good by Supplier or Contractor at no additional cost to the Owner, Owner’s Representative, or Owner’s Engineer, including any additional costs for removal, transportation, design, engineering, fabrication, shipment, testing, certifications, installation, construction, or commissioning.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS (LISTED ALPHABETICALLY)

A. Allen-Bradley.

B. ABB.

C. Eaton / Cutler Hammer.

D. Rockwell Automation.

E. Siemens.

F. SquareD.

G. “Or-equal.”

2.02 SYSTEM DESCRIPTION

A. General Requirements for VFDs:

1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A or UL 508C as applicable.

B. Application per the Data Sheet:

1. Constant Torque:
   a. Positive-displacement pumps.
   b. Reciprocating and screw compressors.
2. Variable Torque:
   a. Centrifugal blowers and fans.
   b. Pumps.

C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, “Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both.”
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, “Definite-Purpose Inverter-Fed Polyphase Motors.”
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; maximum voltage equals input voltage per Data Sheet.

1. Constant Torque: 10 to 66 Hz, with torque constant as speed changes.
2. Variable Torque: 10 to 60 Hz, with voltage proportional to frequency throughout voltage range.

F. Unit Operating Requirements, unless noted otherwise on Data Sheet:

1. Input AC Voltage Tolerance: plus 10 and minus 15 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: not exceeding 5 percent.
3. Input Frequency Tolerance: plus or minus 5 percent of VFD frequency rating.
4. Minimum Efficiency: 97 percent at 100 percent rated output frequency.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: as indicated on the Drawings or Data Sheet.
7. Ambient Temperature Rating: Not less than 32 degrees F and not exceeding 104 degrees F, or per Section 01 61 00, Common Product Requirements, whichever is more restrictive.

8. Humidity Rating: Less than 95 percent (noncondensing) or per Section 01 61 00, Common Product Requirements, whichever is more restrictive.
9. Altitude Rating: Not exceeding 3300 feet or per Section 01 61 00, Common Product Requirements, whichever is more restrictive.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: below listed value times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    a. Constant Torque: 1.5.
    b. Variable Torque: 1.1.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 100 percent rated output frequency.
13. Speed Regulation: plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 2.5 kHz or as listed on Data Sheet; coordinated with the connected motor per motor manufacturers VFD application requirements.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking as listed on Data Sheet.

G. Inverter Logic: Microprocessor based, non-volatile memory, isolated from all power circuits.

H. Remote Control Interface: VFDs remote-control interface shall include signal over a minimum 40:1 speed range with the following minimum input/output parameters available, unless otherwise modified by Data Sheet.

1. Operating Range: 40:1.
2. Operating Setpoint Input: 0-100 percent via 4-20mA analog signal or ethernet equivalent.
3. On/Off Input: hardwired digital signal or ethernet equivalent.
4. General Alarm Output: hardwired digital signal or ethernet equivalent.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression per Data Sheet:
    a. Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2, or

b. Field-mounted surge suppressors complying with Division 26, Electrical, UL 1449 SPD, Type 2.

2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings field configurable.
6. Critical frequency rejection, with three, minimum, selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Power-Interruption Protection: To prevent drive from re-energizing motor after a power interruption until motor has stopped.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Integral Input Disconnecting Means and OCPD, if required per Data Sheet, shall be manufacturers standard with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating:
   a. VFD without bypass system: Not less than 115 percent of VFD input current rating.
   b. VFC with bypass system: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
2. Auxiliary Contacts:
   a. Blade Type Disconnect Switch: NO and NC arranged to activate before switch blades open.

b. Circuit Breaker Type Disconnect Switch: NO and NC arranged to activate with circuit-breaker handle and NO and NC alarm contact that operate only when circuit breaker has tripped.

2.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFDs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and per site conditions defined in Section 01 61 00, Common Product Requirements. The designated VFDs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term “withstand” means “the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”

2.04 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Local (HAND) /Remote (AUTO).
3. Running.
4. Overvoltage.
5. Line fault.
6. Overcurrent.
7. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
   a. Control Authority by user login: Supports at least four conditions:
      1) Off.
      2) Local manual control at VFD.
      3) Local automatic control at VFD.
      4) Automatic control through a remote source.

C. Indicating Devices: Digital display, and additional readout devices as required or as otherwise required per Data Sheet, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

D. Control Signal Interfaces:

1. Electric Input Signal Interface:
   a. A minimum of two programmable analog inputs: 0- to 10-V dc or 4- to 20-mA dc, and operator-selectable “x”- to “y”-mA dc.
   b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of two programmable analog output signals: 0- to 10-V dc or 4- to 20-mA dc, and operator-selectable “x”- to “y”-mA dc, which can be configured for any of the following:
   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of four programmable dry-circuit relay outputs (120V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

5. Communication Interface: Comply with communications link as listed on Data Sheet. Communication shall interface with control system for remote control and monitoring. Control features and monitoring points displayed locally at VFD shall be available through the communications link to control system. Minimum communication interface requirements:
   a. Ethernet TCP/IP.
   b. Modbus, DNP3, approved alternate.

E. PID Control Interface, if required per Data Sheet: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Per Data Sheet.

2.05 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. Output Filtering: Coordinate with motor manufacturer to determine need for, and options available for, conditioning output voltage. Options may include line inductors, dV/dT filters, output reactors, and motor termination filters.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.06 BYPASS SYSTEMS

A. Bypass Operation, if required per Data Sheet: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set mode and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode(s), as required per Data Sheet:

1. Manual operation only; requires local operator selection at VFD. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
2. Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Style:

1. Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
   a. Bypass Contactor: Load-break, NEMA-rated contactor.
   b. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
2. Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
   a. Bypass Contactor: Load-break, NEMA-rated contactor.
   b. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration:

1. Full-voltage (across-the-line) or reduced-voltage (autotransformer) type; per Data Sheet.
2. NORMAL/BYPASS selector switch.
3. HAND/OFF/AUTO selector switch.
4. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
5. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
6. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

7. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
8. Control Circuits: 120V ac; obtained from integral CPT, with primary and secondary fuses, with CPT control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
    a. CPT Spare Capacity: 100VA or a minimum of 10 percent, whichever is larger.
9. Overload Relays: NEMA ICS 2.
    a. Solid-State Overload Relays:
        1) Switch or dial selectable for motor-running overload protection.
        2) Sensors in each phase.
        3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
        4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    b. NO and NC isolated overload alarm contact.
    c. External overload reset push button.

2.07 OPTIONAL FEATURES

A. Multiple-Motor Capability, if required by Data Sheet: VFD suitable for variable-speed service to multiple motors. Overload protection shuts down VFD and motors served by it, and generates fault indications when overload protection activates.

1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.

2.08 ENCLOSURES

A. VFD Enclosure: NEMA 250, to comply with environmental conditions at installed location per Section 26 05 75, Basic Electrical Materials and Methods, unless otherwise required by Data Sheet.

2.09 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated and/or integral with multifunction panel display.

1. Push Buttons: Manufacturer’s standard, subject to review and approval by Engineer.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.

B. NC and NO bypass contactor auxiliary contact(s).

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Cooling Fan and Exhaust System: Manufacture’s standard coordinated NEMA 250 enclosure rating requirements as well as installed equipment location(s); UL 508 component recognized: Supply fan, with composite or stainless-steel intake, exhaust grills, and filters, as applicable; 120V ac; obtained from integral CPT, unless otherwise required by application.

F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

G. Spare control-wiring terminal blocks; 20 percent wired and 20 percent unwired.

2.10 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. As a minimum and per the Drawings, name plates shall include:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

2.11 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per OEM's recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning, and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing part item number, part name or description, Drawing reference, and equipment tag cross-reference for equipment with which the spare part and/or tool is intended for.

D. All spare parts and special tools shall be supplied new and unused.

E. Submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to its specified motor or a motor that is comparable to that for which the VFD is rated.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.02 DELIVERY, STORAGE, AND HANDLING

A. The Supplier shall be responsible for all pre-shipping storage, shipping, and handling. Items shall be stored, shipped, and handled in a manner which is consistent with safe and sound material handling practices and per OEM's recommendations.

B. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller or connect factory-installed space heaters to temporary electrical service.

C. Product Selection for Restricted Space: Drawings may indicate maximum dimensions for VFDs, including clearances between VFDs, adjacent surfaces, and other items that may be less than manufacturer's standard or recommended spacing; in such cases Supplier shall verify ability/acceptability for deviation from manufacturer's standard or recommended spacing and not impact warranty and ability to operate for design life of equipment.

3.03 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing entity per Project requirements specified elsewhere in the Specification to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections, as required per the Data Sheet.

C. Perform tests and inspections, with, if required per Data Sheet, the assistance of a factory-authorized service representative.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFD 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFDs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.05 INSTALLATION

A. Installation shall be per the Summary of Work requirements under supervision of the Supplier per the Summary of Work requirements.

3.06 STARTUP SERVICE

A. Engage a qualified startup services entity per Project requirements specified elsewhere in the Specification to perform startup and commissioning activities, and, if required per the Data Sheet, engage a factory-authorized service representative to advise during startup and commissioning.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Complete startup and commissioning activities per the coordinated Project startup and commissioning plan per Project requirements specified elsewhere in the Specification.

3.07 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as required and as may be specified in Section 26 05 73, Electrical Systems Analysis.

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.09 DEMONSTRATION

A. Engage a qualified trainer per Project requirements specified elsewhere in the Specification to perform training activities, and/or, if required per the Data Sheet, engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

3.10 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of the Specification:

1. Data Sheet.

END OF SECTION

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SECTION 26 29 23
LOW VOLTAGE VARIABLE FREQUENCY MOTOR CONTROLLERS
DATASHEET

Manufacturer:
Model Family / Series (if applicable):
Model Number:
Equipment Tag Number:

	PROJECT REQUIREMENT	VENDOR RESPONSE	ADDITIONAL COMMENTS
VFD Type (Voltage-Source Inverter; VSI):	Vendor to Indicate		
VFD Type (Current-Source Inverter; CSI):	Vendor to Indicate		
VFD Type (Load-Commutated Inverter; LCI):	Vendor to Indicate		
VFD Type (Cycloconverter or Matrix-Converter Topology; MC):	Vendor to Indicate		
VFD Type (Doubly-Fed Slip Recovery Topology or Doubly-Fed Slip):	Vendor to Indicate		
Number of Pulses (12-Pulse, 18-Pulse, 24-Pulse, etc.):	Vendor to Indicate		
Number of INPUT Phases (1PH or 3PH):	Vendor to Indicate		
Number of OUTPUT Phases:	3PH		
Horsepower Rating (HP):	Vendor to Indicate		
Rated Voltage (V):	Vendor to Indicate		
Rated FULL-LOAD Amps (A):	Vendor to Indicate		
Rated FUNDAMENTAL Frequencies (Hz):	Vendor to Indicate		
AUXILIARY POWER SUPPLY INTERFACE required by Unit (AC or DC, Volts, Amps, and Watts):	Vendor to Indicate		
(**ALL**) Control Methods USED by Unit (V/Hz Scalar, Field-Oriented/Vector, or Direct Torque):	Vendor to Indicate		
V/Hz Control Ratio (for All FUNDAMENTAL Frequencies Used):	Vendor to Indicate		
Enclosure Rating (NEMA Rating):	Vendor to Indicate		
Enclosure Rating (IP Rating):	Vendor to Indicate		
(**ALL**) VFD Configuration Methods INCLUDED with Unit (HMI Touchscreen, LCD, Software via Laptop, etc.):	Vendor to Indicate		
(**ALL**) VFD I/O Ports INCLUDED with Unit (Qty. & Type: Ethernet/IP, Serial, Fiber Optic, etc.):	Vendor to Indicate		
VFD Communication Protocols INCLUDED with Unit (Profibus, Ethernet/IP, Fieldbus, etc.):	Vendor to Indicate		
DIMENSIONS			
Frame Size:	Vendor to Indicate		
Height (mm [in]):	Vendor to Indicate		
Width (mm [in]):	Vendor to Indicate		
Depth (mm [in]):	Vendor to Indicate		
Mass / Weight (kg [lbs]):	Vendor to Indicate		
HARMONIC DISTORTION			
Percentage of Harmonic Distortion @ 3rd Harmonic under 50%-LOAD (%):	Vendor to Indicate		

Percentage of Harmonic Distortion @ 5th Harmonic under 50%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 7th Harmonic under 50%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 11th Harmonic under 50%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 13th Harmonic under 50%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 17th Harmonic under 50%-LOAD (%):	Vendor to Indicate		
Total Harmonic Distortion (THD; **2nd thru 17th Harmonic** over FUNDAMENTAL FREQUENCY) under 50%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 3rd Harmonic under 70%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 5th Harmonic under 70%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion of 7th Harmonic under 70%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 11th Harmonic under 70%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 13th Harmonic under 70%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 17th Harmonic under 70%-LOAD (%):	Vendor to Indicate		
Total Harmonic Distortion (THD; **2nd thru 17th Harmonic** over FUNDAMENTAL FREQUENCY) under 70%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 3rd Harmonic under 100%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 5th Harmonic under 100%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 7th Harmonic under 100%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 11th Harmonic under 100%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 13th Harmonic under 100%-LOAD (%):	Vendor to Indicate		
Percentage of Harmonic Distortion @ 17th Harmonic under 100%-LOAD (%):	Vendor to Indicate		
Total Harmonic Distortion (THD; **2nd thru 17th Harmonic** over FUNDAMENTAL FREQUENCY) under 100%-LOAD (%):	Vendor to Indicate		
NOISE LEVELS (A-WEIGHTING)			
Noise Levels (A-Weighting) under 0%-LOAD @ 3 meters (dBA):	Vendor to Indicate		
Noise Levels (A-Weighting) under 50%-LOAD @ 3 meters (dBA):	Vendor to Indicate		
Noise Levels (A-Weighting) under 70%-LOAD @ 3 meters (dBA):	Vendor to Indicate		
Noise Levels (A-Weighting) under 100%-LOAD @ 3 meters (dBA):	Vendor to Indicate		

COOLING SYSTEM & HEAT LOSS			
Cooling System (i.e., Air, Air-Water, Air-Other Fluid, Water):	Vendor to Indicate		
Heat loss generated @ 25 °C and 80% Relative Humidity (RH) under 0%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 25 °C and 80% Relative Humidity (RH) under 50%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 25 °C and 80% Relative Humidity (RH) under 70%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 25 °C and 80% Relative Humidity (RH) under 100%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 40 °C and 80% Relative Humidity (RH) under 0%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 40 °C and 80% Relative Humidity (RH) under 50%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 40 °C and 80% Relative Humidity (RH) under 70%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
Heat loss generated @ 40 °C and 80% Relative Humidity (RH) under 100%-LOAD (BTU, kJ, and kWh):	Vendor to Indicate		
SYSTEM EFFICIENCY			
Total System Efficiency (%) @ 25 °C and 80% Relative Humidity (RH) under 0%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 25 °C and 80% Relative Humidity (RH) under 50%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 25 °C and 80% Relative Humidity (RH) under 70%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 25 °C and 80% Relative Humidity (RH) under 100%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 40 °C and 80% Relative Humidity (RH) under 0%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 40 °C and 80% Relative Humidity (RH) under 50%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 40 °C and 80% Relative Humidity (RH) under 70%-LOAD:	Vendor to Indicate		
Total System Efficiency (%) @ 40 °C and 80% Relative Humidity (RH) under 100%-LOAD:	Vendor to Indicate		

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SECTION 26 33 55
DC/AC UPS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Specification includes the design, fabrication, and delivery of components for a complete Direct Current (DC) / Alternating Current (AC) Uninterruptable Power Supply (UPS) System, including:

1. Battery chargers/rectifiers.
2. Inverters.
3. Static transfer switch.
4. Manual bypass switch.
5. Batteries.
6. Battery racks.
7. Interconnecting cables.
8. Terminations.
9. DC Switchboard.
10. DC distribution panel.
11. AC distribution panel.
12. Accessories such as meters, relays, input breakers, output breakers, etcetera as necessary to provide a complete system.

B. Work provided by Supplier:

1. Design, furnish, and deliver DC/AC UPS System.
2. Furnish all required accessories ready for installation, connection, and operation. Equipment shall consist of standard design and quality that meets or exceeds requirements of this Specification.
3. Shipment of DC/AC UPS System equipment to location listed in Contract.
4. Shipment of batteries to the location listed in Contract.
5. Furnishing of the following equipment to include, but not necessarily limited to the following:
    a. Battery system, battery rack, battery chargers, DC panelboard(s).
    b. Special tools or devices necessary for installation, operation, and maintenance.
6. Receipt and unloading of DC/AC UPS System equipment by others.
7. Installation of DC/AC UPS System equipment by others.

C. Related Sections, as applicable, and not limited to the following:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.

4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.
6. Section 26 05 75, Basic Electrical Materials and Methods.
7. Section 26 24 16, Panelboards.

NOTE: Where a more restrictive or stringent requirement is specified in a Related Section, the more restrictive or stringent requirement shall apply.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Industrial Safety Equipment Association (ISEA): Z358.1 – Emergency Eyewash and Shower Equipment.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 446, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
   b. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
   c. 484, Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications.
   d. 485, Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
   e. 519, Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems.
   f. 946, Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations.
3. International Building Code (IBC): IBC – 2012.
4. National Fire Protection Association (NFPA): 70, National Electrical Code.
5. National Electrical Manufacturers Association (NEMA): PB1, Panelboards.
6. UL:
   a. 489, Standard for Safety: Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   b. 1564, Standard for Safety Industrial Battery Chargers.

B. All design, equipment, installation, testing, materials, and devices shall meet all state and local codes and standards.

C. In cases where the specified codes and standards include differing requirements, the more stringent requirements shall apply.

D. Standards of foreign organizations shall not be used.

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data as listed below:

1. Completed Data Sheets.
2. Preliminary and final electrical one-line diagram for the system.
3. Plan and elevation outline drawings.
4. Schematic diagrams.
5. Connection diagrams.
6. Terminal Strip Schedule listing terminal strip tag number, terminal strip configuration, terminal strip voltage rating, terminal strip terminal numbering, and terminal usage in reverse-address form.
7. Heat loading data for complete system at 100 percent load, in Btu.
8. Any special handling and/or installation requirements for batteries.
9. Discharge and charging profile for battery.
10. Battery sizing calculation per IEEE 485.

1.04 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.05 WARRANTY AND GUARANTEES

A. Furnish Manufacturer’s extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Suppliers listed below (or Approved Alternates):

1. Eaton.
2. GE.
3. Mitsubishi Electric.
4. Schneider Electric.
5. SEI Power.
6. Siemens.

B. Submit Product Data for each piece of electrical equipment provided.

C. DC/AC UPS System equipment shall be suitable for floor mounting and provided with a 4 inch, minimum, base to allow the cabinet bottom to be above the finished floor.

D. Unless otherwise specified, equipment compartments shall be designed to allow for top or bottom entry of power, control, and ground cables. Compartments for power cables shall have adequate braces for cable support.

E. The DC/AC UPS System shall be designed such that damage or loss of functionality will not occur during or following the specified seismic loading.

F. All indicating lights furnished shall be LED type.

G. All wire interconnections between system components shall be provided within the enclosures. Wiring for external control and alarm circuits shall be terminated on terminal blocks located for convenient access.

H. DC/AC UPS System shall be listed to UL 1778.

2.02 BATTERIES

A. Battery system shall be used as the stored energy source for the AC UPS and provide power to DC loads.

B. Battery cells shall be maintenance-free and shall comply with UL 924. Cell design shall be pre-filled with immobilized type electrolyte, hermetically sealed and ready for service. “Oxygen recombination” principle shall be used to achieve non-watering criteria for cells. Batteries shall comply with applicable UL standards.

C. Battery system shall operate between 105V dc and 140V dc on a nominal 125V dc system with a minimum life expectancy of 20 years.

D. Battery system shall be suitable for service in ambient temperatures between 65 and 110 degrees F.

E. Cell cases and covers shall be constructed of nonconductive, flame- and heat-retardant material. Cases and covers shall be guaranteed against breakage due to manufacturing defects.

F. Minimum cell voltage at the end of the duty cycle shall not drop below 1.78V dc per cell so the minimum battery terminal voltage does not drop below 105V dc.

G. Batteries shall be sized in accordance with the load profiles as listed in the Data Sheets. All loads are at 125V dc.

H. Basis for battery sizing calculation shall be IEEE 485 at 77 degrees F.

I. Battery short circuit contributions shall be calculated and submitted to Engineer.

J. Provide stainless steel bolts, washers, and nuts for high-torque, low-resistance cable terminations.

K. Furnish batteries factory pre-charged to 100 percent of capacity to minimize charging time in the field and specified maximum pre-installation storage duration without loss of charge below manufacturer’s acceptable limits.

L. Provide the following accessories:

1. Cell numbering scheme; including one set of numerals per cell (one unique number per cell) suitable for permanent attachment to cells.
2. Warning labels.
3. Cell and rack connectors.
4. Five connectors to connect cells on either side of removed cell. Slot connectors to allow horizontal adjustment to compensate for unequal cell spacing.
5. Connector bolts with acid resistant nuts.
6. Solderless lugs for each battery.

7. Minimum of one cell removal device including cell lifting apparatus with strap and spreader bar.
8. Vinyl-coated assembly wrenches.
9. Grease that prevents oxidation.

2.03 BATTERY RACK

A. Battery racks shall be designed to meet applicable building code and seismic requirements specified herein; including a calculation proving compliance authored and sealed by a Professional Engineer.

B. Tiered modular steel tray racks shall be furnished that are suitable to accommodate all cells of the battery system. The battery rack shall be configured to minimize floor space and sized to fit within battery area dimensions listed on Data Sheets.

C. Battery rack design shall allow removal/replacement of any cell without disturbing other cells.

D. Battery racks shall be made from heavy-duty corrosive resistant steel. The support steel shall have provisions for connecting to the plant grounding system.

E. Battery racks shall include non-aging equaling plastic or molded rubber rail covers.

F. Battery rack shall be painted with a minimum of two coats of acid resistant paint. One quart of touchup acid-resistant paint for battery rack system shall be shipped with the system. Hardware (bolts, nuts, washers, etc.) shall be made of acid resistant material.

G. Battery rack shall be designed to withstand seismic forces as stated in the Site Conditions.

H. Battery rack shall include spill containment where flooded-cell batteries are used.

2.04 BATTERY CHARGERS

A. Battery chargers shall be industrial grade and designed for high efficiency conversion of AC to DC power while simultaneously supplying power to DC loads while charging system batteries at equalizing voltage level.

B. Each battery charger shall be self-regulating, solid-state, and suitable for parallel operation. If automatic load sharing is specified on Data Sheets, cross compensation shall be provided for equal sharing of charger loads.

C. Battery charger reliability shall be no less than 140,000 hours Mean Time Between Failures (MTBF).

D. Battery charger shall be suitable for operation with the input voltage, as specified in the Data Sheets, plus or minus 10 percent, with regulated plus or minus 0.5 percent output from no load to full load and plus or minus 1 percent when on equalize.

E. Battery charger shall be suitable for operation over plus or minus 5 percent supply voltage frequency variation.

F. Each battery charger shall be suitable for operation on an AC feeder with an available short circuit current of 65,000 amperes rms symmetrical.

G. Each battery charger shall be equipped with input AC and output DC molded case circuit breakers.

1. AC breaker shall be 3-pole with minimum interrupting current rating of 65kA.
2. DC breaker shall be 2-pole with minimum interrupting current rating of 20kA.

H. Battery charger shall be supplied with an automatic load limiting feature to limit output current to 115 percent of its rated load without tripping the AC or DC breaker.

I. Battery charger must be capable of picking up a discharged battery without tripping breakers.

J. Battery charger shall be designed to prevent battery from discharging back into charger in the event of a DC power failure or other charger malfunction.

K. Battery charger shall provide input filtering to minimize harmonic feedback into power source. Maximum total harmonic distortion levels shall be limited to 20 percent as per IEEE 519. Provide output filtering to ensure 2 percent RMS or less (100mV max) ripple with battery connected.

L. Battery charger shall be sized to fully charge batteries from complete discharge in 24 hours while supplying the continuous normal steady-state loads. In a configuration with parallel battery chargers, each individual battery charger shall meet this requirement.

M. Battery chargers shall use a controlled ferroresonant or SCR design and be capable of regulated and filtered voltage operation with battery disconnected (battery eliminator type), with a maximum ripple of 100mV rms under these conditions.

N. Each battery charger shall also be equipped with the following via discrete devices or equivalent functionality via a micro-processor based system with a graphical display interface:

1. Output DC voltmeter, 3.5-inch scale, 2 percent accuracy at full scale.
2. Output DC ammeter, 3.5-inch scale, 2 percent accuracy at full scale.
3. Float voltage potentiometer.
4. Equalizing voltage potentiometer.
5. Float and equalize switch (voltage potentiometers shall be independent of each other).
6. AC power failure relay, with contacts to close on loss of AC power.
7. Remote shut-off input to allow remote shut-off from external relay contact; supervised contact where open external relay contact turns battery charger off.
8. DC low voltage alarm relay with contacts to close on low output voltage or loss of charger output. Alarm point shall be adjustable.
9. DC high-voltage alarm relay with 30-second fixed time delay. Contacts shall close on sustained high voltage and trip AC input circuit breaker with a 125V dc shunt trip coil. High voltage alarm point shall be adjustable.
10. Ground detection relay.
11. AC power “ON” pilot light.
12. Equalizing charge pilot light.
13. Trouble summary audible alarm with silence switch and output contact for remote indication. Trouble condition to be initiated by alarm conditions above or other system problem.

2.05 DC SWITCHBOARD

A. A DC switchboard shall be supplied to allow positive means of isolating major DC system components during system maintenance or after faults. DC components shall connect to the DC switchboard via molded case circuit breakers (MCCBs) as shown on the Drawings.

B. Main battery disconnect shall be supplied with magnetic trip only, shunt trip, and two form C auxiliary contacts.

C. LV buswork and molded-case circuit breakers shall be specified for DC application. Feeder MCCBs shall have thermal-magnetic trip units and a common trip handle for all poles.

D. Enclosure shall be NEMA 1 gasketed with removable cabinet front, concealed trim clamps and concealed hinge. The interior shall be equipped with a dead-front shield separate from the cabinet front.

E. Enclosure shall have adequate gutter space to include the additional required space for all wiring to the panel including cable loops within the enclosure.

F. Battery connection cables shall penetrate switchboard separately and each polarity shall be physically segregated within the panel with a rigid barrier.

2.06 PANELBOARDS

A. Panelboards shall be furnished in accordance with Section 26 24 16, Panelboards, as indicated on Data Sheets for this section and Section 26 24 16, Panelboards, and in addition to any additional requirements listed herein.

B. Panelboards shall be designed and fabricated in accordance with NEMA standards for panelboards. The completed assembly shall have a NEMA 12 rating.

C. Each panelboard and all current controlling devices in each panelboard shall bear the UL label and conform to the latest edition of the National Electrical Code (NEC).

D. The panelboard cabinet front shall be removable and shall be complete with hinged door and latch. The panelboard interior shall be equipped with a dead-front shield separate from the cabinet front.

E. The enclosure front shall be thoroughly cleaned and painted with at least one coat of rust resistant primer, and at least two coats of enamel. Indoor cabinets shall be ANSI 61 light gray, and outdoor cabinets shall be ANSI 24 gray.

F. Enclosures shall have adequate gutter space to include the additional required space for all wiring, assuming a fully equipped panelboard (i.e. all branch circuit positions are utilized), to the panel including cable loops within the enclosure; 7-inch minimum on sides and 5-inch minimum on top and bottom.

G. Panelboards shall be designed so that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machining, drilling, tapping, or shutdown of power.

H. Bus bars and conductive parts shall be tin plated copper.

I. Each panelboard shall include a separate ground bus.

J. Circuit breakers shall be UL 489, bolt-on type thermal magnetic trip, with common trip handle for all poles. Circuit breakers shall provide overcurrent protection with inverse time and instantaneous tripping characteristics.

K. A minimum of 20 percent spare breakers shall be provided in each panelboard.

L. Circuit breakers shall be ambient compensated at 40 degrees C.

M. Circuit breakers installed in the panelboard shall have identifiers with odd numbers on the left and even numbers on the right.

N. Panelboards and circuit breakers shall have the following ratings as shown on the Data Sheets:

1. DC Panelboards and circuit breakers rated at 48V dc or 125V dc.
2. DC panelboards and circuit breakers shall have a maximum short current rating that is greater than the available short circuit current from the batteries and chargers, but shall not be less than 20kA.

2.07 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. Each separate enclosure and/or functional piece of equipment shall have a rigid laminated phenolic nameplate. The nameplate shall have a white background, with equipment name and equipment number engraved with black letters. The main equipment nameplate shall be 2-inch lettering, where supplemental functional nameplates shall be a minimum of 3/8-inch lettering. As a minimum and per the Drawings, name plates shall include:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

C. Engraved nameplates shall be provided above indicating lights, operator controls, interior components, and for indicating each position selector switches.

2.08 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer’s recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 TESTING AND INSPECTION

A. Provide notification to Engineer not less than 15 days prior to conducting testing required by this section to permit Engineer to be present during testing.

B. Comply with all specification requirements, documentation, and specified approvals and standards implemented by this section. Make available upon request by Engineer a copy of any part of quality assurance records. All tests, inspections, reports, and documentation are subject to review by Engineer or Engineer's representative.

C. Make corrections to deficiencies as reported by Engineer or Engineer's representative prior to shipment. Engineer has the right, at no additional cost, for a second inspection to ensure all deficiencies have been corrected prior to shipment.

D. Supplier to maintain records of all inspections and tests. Indicate nature and number of deficiencies found by the Supplier and the Engineer's deficiency reports.

E. Tests:

1. After the DC systems have been completely fabricated, they shall be subjected to and shall meet all requirements of the production tests listed in the IEEE, NEMA, UL, and ANSI standards.
2. Tests shall include:
    a. Control and wiring check tests.
    b. Mechanical operation tests.
    c. Clearance and mechanical adjustment check tests.
    d. Dielectric tests between live parts and ground on both power and control circuits.
    e. Batteries to be tested in accordance with IEEE 450.
3. The battery chargers shall be capable of passing the following tests:
    a. Four-hour heat run test at current limiting value.

b. Voltage regulation check from 0 – 100 percent of rated output with plus or minus 10 percent AC line voltage variation.

4. Provide certified test reports on equipment prior to shipment.

F. Inspection and Test Plan (ITP): Manufacturer shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

3.02 INSTALLATION

A. Equipment described in this section shall be shipped per the requirements of the Purchase Order for installation in accordance with the manufacturer's instructions.

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's services as follows:

1. Assistance to Contractor: 1 day, one trip.
2. Certificate of Proper Installation: 1 day, one trip.
3. Training Program: 1 day, one trip.
4. Functional and Performance Testing: 1 day, one trip.

3.04 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Data Sheets.

END OF SECTION

DATA SHEETS: DC / UPS SYSTEM **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** DC/AC UPS SYSTEM **TAG NO.** CWPCTG-7-EDC-BC-<TBD> CWPCTG-7 -EDC-BAT-<TBD> CWPCTG-7-EDC-SB-<TBD> CWPCTG-7-EUP60-UPS-<TBD> CWPCTG-7-EUP60-STS-<TBD> CWPCTG-7-EUP60-XFMR-<TBD> CWPTG-7-EUP60-PP-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
CHARGERS (CWPCTG-7-EDC-BC-<TBD>A, CWPCTG-7-EDC-BC-<TBD>B):			
MANUFACTURER	-	By Contractor	
CATALOG NO.	-	By Contractor	
QUANTITY	EA	2	
AMBIENT TEMPERATURE RANGE	ºC	per Site Conditions	
AC INPUT:			
INPUT VOLTAGE	VAC	480	
PHASE / WIRE	PH / W	3PH / 3W	
SYSTEM FREQUENCY	HZ	60	
AMPERAGE	A	By Contractor	
INPUT BREAKER AMP RATING	A	By Contractor	
RANGE TO MAINTAIN ±0.5% OUTPUT REGULATION	%	±10%	
DC OUTPUT:			
RATED OUTPUT VOLTAGE	VDC	125	
RATED OUTPUT AMPERAGE	A	By Contractor	
DC OUTPUT BREAKER RATED AMPERAGE	A	By Contractor	
AC/DC CONVERSION EFFICIENCY (MINIMUM)	%	By Contractor	
FLOAT VOLTAGE (±5% ADJUSTMENT)	VDC	By Contractor	
EQUALIZE VOLTAGE, (±5% ADJUSTMENT)	VDC	By Contractor	
REGULATION:			
FLOAT	%	By Contractor	
EQUALIZE	%	By Contractor	
AUDIBLE NOISE AT 1 METER	DBA	By Contractor	
CABLE ENTRY LOCATION	-		
ENCLOSURE RATING	NEMA	By Contractor	
ADDITIONAL FEATURES:			
AC INPUT VOLTMETER	Y/N	Y	
AC INPUT AMMETER	Y/N	Y	
DC OUTPUT VOLTMETER	Y/N	Y	
DC OUTPUT AMMETER	Y/N	Y	

DATA SHEETS: DC / UPS SYSTEM **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** DC/AC UPS SYSTEM **TAG NO.** CWPCTG-7-EDC-BC-<TBD> CWPCTG-7 -EDC-BAT-<TBD> CWPCTG-7-EDC-SB-<TBD> CWPCTG-7-EUP60-UPS-<TBD> CWPCTG-7-EUP60-STS-<TBD> CWPCTG-7-EUP60-XFMR-<TBD> CWPTG-7-EUP60-PP-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
BLOCKING DIODE	Y/N	Y	
INPUT AC CIRCUIT BREAKER	Y/N	Y	
OUTPUT DC CIRCUIT BREAKER	Y/N	Y	
FLOAT VOLTAGE POTENTIOMETER	Y/N	Y	
EQUALIZING VOLTAGE POTENTIOMETER	Y/N	Y	
INDICATORS AND ALARMS:			
POSITIVE TO GROUND	Y/N	Y	
NEGATIVE TO GROUND	Y/N	Y	
OVER TEMPERATURE	Y/N	Y	
CHARGER FAILURE	Y/N	Y	
HIGH DC VOLTAGE (ADJUSTABLE, CLOSE ON HIGH V)	Y/N	Y	
AC POWER FAILURE (CONTACTS CLOSE ON LOSS OF POWER)	Y/N	Y	
LOW DC VOLTAGE (ADJUSTABLE, CLOSE ON LOW OUTPUT V)	Y/N	Y	
BLOWN FUSE	Y/N	By Contractor	
AUDIBLE ALARM WITH SILENCE BUTTON	Y/N	Y	
LAMP TEST PUSHBUTTON	Y/N	By Contractor	
INVERTER (CWPCTG-7-EUP60-UPS-<TBD>):			
MANUFACTURER	-	By Contractor	
CATALOG/SERIAL NO.	-	By Contractor	
TYPE	-	By Contractor	
QUANTITY	EA	1	
AMBIENT TEMPERATURE RANGE	ºC	per Site Conditions	
RATED OUTPUT KVA	KVA	30 kVA (minimum) Contractor to finalize	
DC INPUT:			
DC/AC CONVERSION EFFICIENCY (MINIMUM)	%	By Contractor	
DC INPUT VOLTAGE	VDC	125 VDC	
DC INPUT VOLTAGE RANGE	-%, +%	±10%	
RATED INPUT AMPERES	A	By Contractor	
INPUT BREAKER AMPERE RATING	A	By Contractor	
AC OUPUT:			

DATA SHEETS: DC / UPS SYSTEM

PROJECT: CTG 7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: DC/AC UPS SYSTEM
TAG NO. CWPCTG-7-EDC-BC-<TBD>
CWPCTG-7-EDC-BAT-<TBD>
CWPCTG-7-EDC-SB-<TBD>
CWPCTG-7-EUP60-UPS-<TBD>
CWPCTG-7-EUP60-STS-<TBD>
CWPCTG-7-EUP60-XFMR-<TBD>
CWPTG-7-EUP60-PP-<TBD>
P.O. NO. BY CONTRACTOR
LOCATION: NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
AC VOLTAGE	VAC	120 VAC 1PH (unless otherwise required By Contractor)	
AC VOLTAGE REGULATION	-%, +%	±1%	
FREQUENCY	HZ	60 HZ	
RATED AMPERES	A	By Contractor	
AC OUTPUT BREAKER AMPERE RATING	A	By Contractor	
AC BYPASS INPUT BREAKER AMPERE RATING	A	By Contractor	
CABLE ENTRY LOCATION	-	By Contractor	
ENCLOSURE RATING	NEMA	By Contractor	
ADDITIONAL FEATURES:			
FUNGUS/MOISTURE SPRAY	Y/N	By Contractor	
ROTARY DRUM REMOTE BYPASS SWITCH	Y/N	N	
HIGH INTERRUPT AC AND DC BREAKERS	Y/N	Y	
INDICATORS AND ALARMS:			
POSITIVE TO GROUND	Y/N	Y	
NEGATIVE TO GROUND	Y/N	Y	
OVER TEMPERATURE	Y/N	Y	
LATCHING ALARM	Y/N	Y	
BYPASS SOURCE HIGH VOLTAGE	Y/N	Y	
BYPASS SOURCE LOW VOLTAGE	Y/N	Y	
HIGH DC DISCONNECT	Y/N	Y	
AC VOLTAGE OUTPUT HIGH	Y/N	Y	
AC VOLTAGE OUTPUT LOW	Y/N	Y	
BLOWN FUSE	Y/N	By Contractor	
OUT OF SYNCHRONISM	Y/N	Y	
AUDIBLE ALARM WITH SILENCE PUSHBUTTON	Y/N	Y	
BATTERIES (CWPCTG-7-EDC-BAT-<TBD>):			
MANUFACTURER	-	By Contractor	
CATALOG/SERIAL NO.	-	By Contractor	
TYPE	-	By Contractor	
SIZE	Amp-Hr	By Contractor	
NOMINAL SYSTEM VOLTAGE	VDC	125	
MAXIMUM SYSTEM VOLTAGE	VDC	140	

DATA SHEETS: DC / UPS SYSTEM **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** DC/AC UPS SYSTEM **TAG NO.** CWPCTG-7-EDC-BC-<TBD> CWPCTG-7 -EDC-BAT-<TBD> CWPCTG-7-EDC-SB-<TBD> CWPCTG-7-EUP60-UPS-<TBD> CWPCTG-7-EUP60-STS-<TBD> CWPCTG-7-EUP60-XFMR-<TBD> CWPTG-7-EUP60-PP-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
MINIMUM SYSTEM VOLTAGE	VDC	105	
FLOAT VOLTAGE	VDC/cell	2.25	
BOOST VOLTAGE	VDC/cell	By Contractor	
FINAL DISCHARGE VOLTAGE	VDC/cell	1.75	
QUANTITY OF CELLS IN SERIES	EA	60	
LIFE OF BATTERY (MINIMUM)	yrs	20	
PLATE MATERIAL	-	By Contractor	
DUTY CYCLE TOTAL DURATION	min	By Contractor	
DUTY CYCLE LOADING: (REFER TO DUTY CYCLE DIAGRAM)			
CONTINUOUS RANGE	min	By Contractor	
CONTINUOUS AMPERAGE	A	By Contractor	
MOMENTARY RANGE	min	By Contractor	
MOMENTARY AMPERAGE	A	By Contractor	
NON-CONTINOUS RANGE	min	By Contractor	
NON-CONTINUOUS AMPERAGE	A	By Contractor	
RANDOM LOADS DURATION	min	By Contractor	
RANDOM LOADS AMPERAGE	A	By Contractor	
AGING FACTOR	%	110	
TEMPERATURE CORRECTION	%	100	
DESIGN MARGIN	%	110	
NUMBER OF TOTAL PARALLEL PLATES PER CELL	qty	By Contractor	
DIMENSIONS:			
INDIVIDUAL BATTERY LENGTH/WIDTH/HEIGHT	inches	By Contractor	
OVERALL RACK LENGTH/WIDTH/HEIGHT	inches	By Contractor	
BATTERY WORKING SPACE LENGTH/WIDTH/HEIGHT	ft	By Contractor	
BATTERY WORKING SPACE VENTILATION	isolated/common	By Contractor	
WEIGHTS:			
WEIGHT OF INDIVIDUAL CELL	lbs	By Contractor	
WEIGHT OF HEAVIEST SHIPPING PIECE	lbs	By Contractor	
TOTAL RACK AND BATTERY WEIGHT	lbs	By Contractor	

DATA SHEETS: DC / UPS SYSTEM **PROJECT:** CTG 7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** DC/AC UPS SYSTEM **TAG NO.** CWPCTG-7-EDC-BC-<TBD> CWPCTG-7 -EDC-BAT-<TBD> CWPCTG-7-EDC-SB-<TBD> CWPCTG-7-EUP60-UPS-<TBD> CWPCTG-7-EUP60-STS-<TBD> CWPCTG-7-EUP60-XFMR-<TBD> CWPTG-7-EUP60-PP-<TBD> **P.O. NO.** BY CONTRACTOR **LOCATION:** NEW ORLEANS, LA

DESCRIPTION	UNITS	SPEC DATA	CONTRACTOR DATA
ACCESSORIES:			
BATTERY DISCONNECT	Y/N	Y (integral with DC SB)	
MAIN DC DISTRIBUTION SWITCHBOARD (DC SB)	Y/N	Y	
DC DISTRIBUTION PANEL	Y/N	By Contractor	

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SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Lightning Protection Institute (LPI): 175, Standard of Practice.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 780, Standard for the Installation of Lightning Protection Systems.
3. UL:
   a. 96, Standard for Lightning Protection Components.
   b. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.02 DESIGN REQUIREMENTS

A. Provide lightning protection system design for all new structures of the Project.

B. Design lightning protection system to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

1.03 SUBMITTALS

A. Action Submittals:

1. Lightning protection system layout Drawings signed/sealed by a Louisiana PE.
2. Component locations.
3. Detailed plans.
4. Down conductor.
5. Connecting conductor.
6. Bond strap.
7. Air terminals.
8. Fittings.
9. Connectors.
10. Ground rods.

B. Informational Submittals:

1. Field test report.
2. Ground Witness Certification-Form LPI-175A.
3. Post-Installation Certification-Form LPI-175B.
4. UL 96 Master Label “C” Certification.

1.04 QUALITY ASSURANCE

A. Designer: Lightning protection system design shall be prepared by a professional engineer registered in the State of Louisiana.

B. System components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with UL 96.

C. Lightning protection system shall be installed under direct supervision of an LPI 175 Certified Master Installer.

D. Inspection of final installation and grounding connection shall be performed by an LPI-certified inspector.

E. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

F. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Thompson Lightning.
2. IPC Protection.
3. Erico Eritech Lightning Protection Systems.
4. VFC, Inc.

2.02 GENERAL

A. Complete system shall bear UL 96 Master Label C.

B. System Material: Copper or high copper content, heavy-duty bronze castings, Aluminum, unless otherwise specified.

C. Material shall comply in weight, size, and composition for the class of structure to be protected as established by NFPA 780.

2.03 COMPONENTS

A. Air Terminal:

1. Material: Solid copper rods with tapered or blunt points as required for application.
2. Diameter: 5/8 inch.
3. Length: Sufficient to extend minimum 10 inches above object being protected.
4. UL 96 Label B applied to each terminal.

B. Conductors:

1. Lightning System Conductors: Bare medium hard-drawn stranded copper, or stranded aluminum as required for the application**.**
2. Main Down Conductor: Smooth twist stranding.
3. Connecting Conductor: Concentric stranding.
4. Bonding Conductor: Flexible strap.
5. Main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.
6. Grounding Conductors: Stranded bare copper.

C. Cable Fastener and Accessories: Capable of withstanding minimum pull of 100 pounds.

D. Fittings:

1. Heavy-duty.
2. Bolts, Screws, and Related Hardware: Stainless steel.

E. Ground Rods:

1. Material: Copper.

F. Grounding Connections:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Hardware: Silicone bronze.

G. Cable Connections and Splicers:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.

H. Conduit: Schedule 40 PVC, as specified in Section 26 05 33, Conduit Installation.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

B. Aluminum materials shall be used where required to meet the galvanic corrosion requirements of UL 96A.

C. Provide pitchpockets or method compatible with roofing to waterproof roof penetrations.

D. Install system in inconspicuous manner so components blend with building aesthetics.

3.02 EXAMINATION

A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.03 INSTALLATION

A. Air Terminals:

1. Supports: Brackets or braces.
2. Parapet Bracket Attachment: Lag or expansion bolts.
3. Secure base to roof surface with adhesive or pitch compatible with roofing bond.
4. Provide terminal flashing at roof penetrations.

5. Perimeter Terminals:
    a. Maximum Spacing: 20 feet.
    b. Maximum Distance From Outside Edge of Building: 2 feet.
6. Roof Ridge Terminals: Maximum spacing 20 feet.
7. Mid-Roof Terminals: Maximum spacing 50 feet.
8. Provide blunt point air terminals for applications exposed to personnel.

B. Conductors:

1. Conceal whenever practical.
2. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.
3. Support: Maximum spacing for exposed conductors.
    a. Vertical: 3 feet.
    b. Horizontal: 4 feet.
4. Maintain horizontal and vertical conductor courses free from dips or pockets.
5. Bends: Maximum 90 degrees, with minimum 8-inch radius.
6. Install air terminal conductors on the structural roof surface before roofing composition is applied.

C. Bonding:

1. Bond to Main Conductor System:
    a. Roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
    b. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
2. Bond each steel column or major framing members to grounding system.
3. Bond each main down conductor to grounding system.

D. Grounding System:

1. Grounding Conductor:
    a. Completely encircle building structure.
    b. Bury minimum 1 foot below finished grade.
    c. Minimum 2 feet from foundation walls.
2. Interconnect ground rods by direct-buried copper cables.
3. Maximum Resistance: 3 ohms when connected to ground rods.

4. Connections:
    a. Install ground cables continuous between connections.
    b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
    c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
    d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
    e. Provide interconnections with electrical and telephone systems and all underground water, gas, sewer, and metal pipes.
    f. Provide electric service arrestor ground wire to building water main.

3.04 FIELD QUALITY CONTROL

A. Field Testing:

1. Isolate lightning protection system from other ground conditions while performing tests.
2. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
    a. Test Resistance to Ground: Maximum 3 ohms.
    b. Install additional ground rods as required to obtain maximum allowable resistance.
3. Test Report:
    a. Description of equipment tested.
    b. Description of test.
    c. Test results.
    d. Conclusions and recommendations.
    e. Appendix, including appropriate test forms.
    f. Identification of test equipment used.
    g. Signature of responsible test organization authority.

END OF SECTION

SECTION 26 43 00
TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 GENERAL

1.01 SUBMITTALS

A. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.

B. Submit manufacturer's UL certified test data and nameplate data for each Transient Voltage Surge Suppression (TVSS) device.

1.02 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. For power and signal circuits, TVSS devices shall comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units that are listed and labeled by UL.
2. For telephone circuit protection, TVSS devices shall comply with UL 497A.

B. ANSI Compliance: Use TVSS devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 GENERAL

A. All TVSS devices for power circuits, provided under this section, shall be the product of a single manufacturer.

B. TVSS devices shall be capable of performance at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 3,300 feet.

C. TVSS devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling capabilities and to afford safety protection from thermal overloads and short circuits.

D. Design TVSS devices for the specific type, voltage, and frequency of the electrical service. Single-phase and three-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.

E. Power Filter: The TVSS shall include a high frequency extended range power filter complimentary listed to UL 1283 as an electromagnetic interference filter.

2.02 MANUFACTURER

A. Innovative Technology, VanGuard Series.

B. Advanced Protection Technologies, Inc.

C. General Electric.

2.03 MAIN DISTRIBUTION TVSS

A. Provide TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.

B. Surge current capacity shall be not less than the following:

1. L-N Capacity: 200 kA.
2. L-G Capacity: 120 kA.
3. N-G Capacity: 120 kA.

C. Suppressor housing shall be in an enclosure that has the same NEMA rating as the equipment it protects and painted to match.

D. UL 1449 maximum suppression voltage shall not be more than:

System Voltage (*)	**Phase**	**L-L or L-N Suppression Voltage**
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800
* 25-Hz or 60-Hz frequency as applicable.		

2.04 PANELBOARD TVSS

A. Provide TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location Category B.

B. Surge current capacity shall be not less than the following:

1. L-L Capacity: 80 kA.
2. L-N Capacity: 80 kA.
3. L-G Capacity: 80 kA.
4. N-G Capacity: 80 kA.

C. Suppressor shall be in an enclosure that has the same NEMA rating as the panel it protects or the TVSS may be integral to a panelboard.

D. UL 1449 maximum clamp voltage shall not be more than:

System Voltage (*)	Phase	L-L or L-N Clamp Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800
* 25-Hz or 60-Hz frequency as applicable.		

2.05 ANNUNCIATION

A. Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contacts which operate when the unit fails.

2.06 SURGE COUNTER

A. Provide each TVSS rated above 100 kA with a counter displaying the number of voltage transients that have occurred on the unit input. The counter shall be battery backed and retain the count through system power outages.

2.07 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Use bi-polar 1,500-watt silicon avalanche diodes between the protected conductor and earth ground.

C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).

D. Breakdown voltage shall not exceed 36 volts.

2.08 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Suppressors shall be a hybrid design with a minimum of three stages, utilizing solid-state components and operating bi-directionally.

C. Suppressors shall meet or exceed the following criteria:

1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform): 2,000 occurrences.
3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of the normal applied signal voltage by 200 percent.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

A. Install TVSS when indicated on the Drawings and, as applicable:

1. Main Distribution TVSS in or near each low-voltage switchgear (load center).
2. Main Distribution TVSS in or near each motor control center.
3. Panelboard TVSS in or near each distribution panelboard unless otherwise indicated.

B. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.

1. Use secondary protectors on lines that do not exit the structure.
2. Use primary protectors on lines that exit and enter the structure.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install suppressors according to manufacturer’s recommendations.

B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

C. Connecting wires shall be as short as possible with gently twisted conductors, tied together, to prevent separation. Connecting wires shall not exceed 24 inches in length at any point.

D. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.

E. Provide dedicated disconnecting means for TVSS devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for TVSS devices installed at panelboards. The interrupting capacity of the circuit breakers shall be that specified for the other breakers at that location.

END OF SECTION

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SECTION 26 50 00
LIGHTING

PART 1 GENERAL

1.01 SUMMARY

A. This Specification includes supply and installation of:

1. Interior lighting fixtures and accessories.
2. Exterior lighting fixtures and accessories.
3. Ballasts.
4. Poles.
5. Lighting control systems.
6. Emergency lighting systems.

B. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 61 00, Common Product Requirements.
3. Section 26 00 00, Electrical General Requirements.
4. Section 26 00 10, Electrical Summary of Work Combustion Turbine Generator System.
5. Section 26 05 75, Basic Electrical Materials and Methods.

NOTE: where a more restrictive requirement is specified in a Related Section, the more restrictive requirement shall apply.

1.02 REFERENCES

A. All materials provided and work performed, as described within this Specification, shall adhere to the latest edition of the following Standards, as applicable:

1. American National Standards Institute (ANSI):
   a. C78.42, High Pressure Sodium Lamps.
   b. C81.61, Specifications for Bases (Caps) for Electric Lamps.
   c. C82.1, Line Frequency Fluorescent Lamp Ballasts.
   d. C82.2, Fluorescent Lamp Ballasts – Methods of Measurement.
   e. C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
   f. C136.20, Roadway Lighting Equipment – Fiber-Reinforced Plastic (FRP) Lighting Poles.
2. American Society for Testing and Materials (ASTM): B 429 – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
3. Institute of Electrical and Electronics Engineers (IEEE): C2 – National Electrical Safety Code.
4. Illuminating Engineering Society of North America (IESNA).

5. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    b. 270, Procedure for Fluorescent Lamp/Ballast/Fixture Performance Comparison.
6. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code.
    b. 101, Life Safety Code.
7. UL:
    a. 496, Lampholders.
    b. 542, Fluorescent Lamp Starters.
    c. 595, Marine-Type Electric Lighting Fixtures.
    d. 676, Underwater Luminaires and Submersible Junction Boxes.
    e. 773, Plug-in, Locking Type Photocontrols for Use With Area Lighting.
    f. 773A, Nonindustrial Photoelectric Switches for Lighting Control.
    g. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
    h. 924, Emergency Lighting and Power Equipment.
    i. 935, Fluorescent-Lamp Ballasts.
    j. 1029, High-Intensity-Discharge Lamp Ballasts.

B. All electrical construction shall be performed in accordance with the National Electrical Code, state, local, and Federal Codes, as applicable to the project site.

1.03 DEFINITIONS

A. Not used.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition, supply engineering data, as listed below:

1. Manufacturer’s data including, but not limited to:
    a. Dimensioned and detailed drawings in booklet form with separate sheet or sheets for each fixture, assembled in luminaire “type” alphabetical order and showing:
        1) Materials of construction.
        2) Arrangement of components and wiring.
        3) Gasketing for weather tightness.
        4) Means of mounting luminaire and adjusting aspect.
        5) Finish.
        6) Photometric data with lamp or lamps specified.
        7) Electrical data including volts, amperes, and watts.

8) For roadway type lighting fixtures, light distribution data according to IESNA roadway classification type.

b. Lamp data:
1) ANSI designation.
2) Initial and mean lumen output.
3) Average rated hours of lamp life and lamp mortality curve.
4) Color temperature and color rendering index.

c. Ballast data:
1) ANSI designation.
2) Voltage.
3) Corresponding lamp.
4) Line operating and starting amperes.
5) Watts and watt losses.
6) Percent allowable line voltage variation range and lamp crest factor.
7) Total current harmonic distortion.
8) Minimum lamp starting temperature.
9) Normal and maximum ballast operating temperature.

d. Pole data:
1) Dimensions and details.
2) Handholes and wire entry details.
3) Mast or bracket arms and connection to poles.
4) Base plate and anchor bolt details.
5) Wind load and deflection.
6) Finishes.

B. Manufacturer's data and connection diagrams for dimmers and dimming systems.

C. Connection diagrams for lighting control systems.

D. Outline drawings, connection diagrams, and instruction books for inverter type power units.

E. Such other similar information as Engineer may request.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Luminaires provided shall be UL labeled for the specific application and location in which they are used.

B. Luminaires shall be furnished completely assembled with wiring and mounting devices and be ready for installation at locations shown on the Drawings.

C. Packager shall supply 10 percent, or a minimum of one luminarie where 10 percent is less than one, spare luminaries of each type used on the Project for Owners use. These spares may be used by the Packager prior to system turnover to the Owner but shall be replaced at no cost to the Owner.

2.02 LAMPS

A. Light-Emitting Diode (LED):

1. Shall be energy efficient type.
2. Color shall be appropriate for the application task.
3. Shall be dimmable.

B. Fluorescent:

1. Shall be energy efficient type.
2. Color shall be cool white.

C. High Intensity Discharge:

1. Shall be high pressure sodium outdoors and metal halide indoors, unless noted otherwise on the Drawings.
2. Color shall be color corrected.

D. Incandescent:

1. Shall be energy efficient type.
2. Color shall be soft white.

E. Incandescent Quartz:

1. Shall be energy efficient type.
2. Color shall be translucent.

F. Tungsten Halogen:

1. Shall be energy efficient type.
2. Color shall be frosted white.

G. Acceptable manufacturers:

1. General Electric Co.
2. Osram Sylvania.
3. Phillips Lighting Company.
4. Acuity Holophane.
5. “Or-equal,” Owner approval.

H. Packager shall supply 10 percent, or a minimum of one lamp where 10 percent is less than one, spare lamps of each type used on the Project for Owners use. These spares may be used by the Packager prior to system turnover to the Owner but shall be replaced at no cost to the Owner.

2.03 BALLASTS

A. Ballasts shall meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.

B. Ballasts shall be certified by electrical testing laboratory to conform to Certified Ballast Manufacturer specifications.

C. Fluorescent magnetic core and coil ballast, “Magnetic Ballast”:

1. Type: Energy efficient. Rapid start.
2. Thermal protection: UL Class P with internal automatic resetting.
3. Power factor not less than 90 percent.
4. Maximum allowable noise level shall be 30 decibels at 2 feet from installed fixture.
5. Dimming ballasts shall be capable of operating two 40W rapid start lamps. Include auxiliary components required for proper control.

D. Fluorescent hybrid electromagnetic ballast, “Hybrid Ballast”:

1. Type: Rapid start.
2. Thermal protection: UL Class P with internal automatic resetting.
3. Conform to CBM label requirements.
4. Power Factor not less than 90 percent.
5. Provide switching integral to ballast which cuts off filament current in lamps when started.

E. Fluorescent, solid-state, electronic ballast, “Electronic Ballast”:

1. Type: Rapid start.
2. Thermal protection: UL Class P with internal automatic resetting.
3. Conform to CBM label requirements.
4. Power factor not less than 90 percent.
5. Maintain constant light output of 4’ rapid-start fluorescent lamps over operating ranges of 90V to 145V (120V ballasts) and 200V to 320V (277V ballasts).
6. Input current third harmonic content not to exceed 13 percent.
7. Total harmonic distortion (THD) shall be less than 20 percent.
8. Provide sequenced start progression which first heats cathode filaments and then ignites lamp.

9. Frequency of operation shall be 20 kHz or greater, and operate without visible flicker.
10. Meet requirements of Federal Communications Commission Rules and Regulations, Part 18.

F. Metal Halide:

1. Types:
   a. Autotransformer with capacitor and ignitor for lamps 150W and less.
   b. Constant wattage autotransformer with capacitor for lamps above 150W.
2. Shall be high power factor.
3. Shall provide reliable operation at temperatures above -20 degrees C ambient.
4. Insulation class shall be 180 degrees C.

G. Manufacturers:

1. MagneTek Lighting Products.
2. Advance Transformer Co.
3. Motorola Lighting Inc.
4. SLI Inc.
5. General Electric Co.
6. “Or-equal,” Owner approval.

2.04 LIGHTING CONTROLS

A. Electrically-held contactor, non-latching type:

1. For control of selected lights as indicated on the Drawings.
2. Rated current: as shown on the Drawings.
3. Rated voltage: as indicated on the Drawings.
4. Coils shall be rated for 120V control power.
5. Rated frequency: 60-Hz.
6. Number of poles: as indicated on the Drawings.
7. Control transformers shall be rated 480V / 120V, unless specified otherwise on the Drawings.
8. Contactor shall be provided with a Hand-Off-Auto switch on the contactor cover.
9. Contactor enclosures shall be NEMA 12 rated, unless specified otherwise on the Drawings.
10. Contactor control: photocell.
11. Manufacturers:
    a. Allen-Bradley.
    b. General Electric.
    c. “Or-equal,” Owner approval.

B. Mechanically-held contactor, latching type:

1. For control of selected lights as indicated on the Drawings.
2. Rated current: as shown on the Drawings.
3. Rated voltage: as indicated on the Drawings.
4. Coils shall be rated for 120V control power.
5. Rated frequency: 60-Hz.
6. Number of poles: as indicated on the Drawings.
7. Control transformers shall be rated 480V/120V, unless specified otherwise on the Drawings.
8. Contactor shall be provided with a momentary-contact On and Off pushbuttons.
9. Contactor enclosures shall be NEMA 12 rated, unless specified otherwise on the Drawings.
10. Manufacturers:
    a. Allen-Bradley.
    b. General Electric.
    c. "Or-equal," Owner approval.

C. Photocell controls:

1. Automatic ON/OFF switching photo control.
2. Enclosure: weatherproof, integral to fixture, self-contained, die-cast aluminum.
3. Shall have time delay feature to prevent false switching. Minimum time delay on turn-off shall be 15 seconds.
4. Shall be field adjustable to control operating levels.
5. Capable of reliable operation within a temperature range of -30 to 140 degrees F.
6. Manufacturers:
    a. Precision Multiple Controls, Inc.
    b. Paragon.
    c. Fisher-Pierce.
    d. Tork.
    e. "Or-equal," Owner approval.

D. Time switches:

1. Digital electronic time switches with number of channels indicated on the Drawings. Each channel shall be independently programmable and shall have Form-C contact outputs rated for 10 amperes at 120V.
2. Shall have the following features, as a minimum:
    a. Selectable am/pm or 24-hour format.
    b. 1-minute time resolution.
    c. Programmable up to 48 events per channel.
    d. Weekly or 365-day capability.
    e. Holiday capability.

f. User programmable daylight savings time adjustment option.
g. Automatic leap year compensation.
h. Battery backup with rechargeable batteries and 72-hour capacity.
i. Individual manual ON/OFF override control for each channel.

3. Manufacturers:
   a. Paragon.
   b. Tork.
   c. Intermatic.
   d. "Or-equal," Owner approval.

E. Occupancy sensors:

1. General:
   a. Sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.
   b. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to cycling of air conditioner or heating fans.
   c. Sensors shall have readily accessible, user adjustable controls for time delay and sensitivity.
   d. In event of failure, bypass manual OVERRIDE ON key shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
   e. Units shall have an extra Form C (1-NO-1-NC) contact for interface with building system. Units shall be designed to be mountable in standard electrical box.
   f. Units shall have capability of being ordered with integral power pack.
2. Passive Infrared:
   a. Wall switch sensors shall be capable of detection of motion at desk top level up to 300 square feet and gross motion up to 1,000 square feet.
   b. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1,200 watts at 277 volts and shall have 180-degree coverage capability.
   c. Bi-level wall switch sensors shall accommodate up to two loads from 0 to 800 watts at 120 volts; 0 to 1,200 at 277 volts, for each load.
   d. Passive infrared sensors shall have a multiple segmented lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
   e. Wall switches shall be compatible with electronic ballasts.
3. Dual Technology Units:
   a. Unit to be ceiling mounted for 360-degree coverage.

b. Unit shall utilize both passive infrared and ultrasonic technologies and be easily programmed to accommodate different environmental and architectural conditions.
c. Unit must detect up to 2,000 square feet with no blind spots.
d. No audio dual technology units will be accepted.

4. Circuit Control Hardware—CU Power Packs:
   a. Control Units: Able to mount through a 1/2-inch knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of two sensors.
   b. Relay contacts shall have ratings of:
      1) 13A, 120V ac tungsten.
      2) 20A, 120V ac ballast.
5. Wiring: Control wiring between sensors and control units shall be Class II, 14-AWG, stranded, UL Classified, PVC insulated or Teflon jacketed cable approved for use in plenums, where applicable.
6. Manufacturers:
   a. Honeywell.
   b. Leviton.
   c. Watt Stopper.
   d. "Or-equal," Owner approval.

F. Low Voltage Remote Control Wiring System:

1. Provide a complete low-voltage, remote control wiring system for control of lighting fixtures as indicated on the Drawings. System shall be complete with transformers, rectifiers, relays, switches, master switches, electronic controls, enclosures, wall plates, and wiring. System and components shall be of same manufacturer.
2. Remote control wiring shall be in accordance with Article 725, Class 2 of NFPA 70.
3. Provide for direct-wired connection of:
   a. Standard of pilot light switches for individual control of relays.
   b. Two independent master override inputs which allow ON/OFF control of all relays while still supporting individual control of each relay.
4. Relay panels shall be configured to allow future addition of up to two master controls of programmable control of all relays.

2.05 LIGHTING POLES

A. Shall be rated, with luminaire, to withstand steady winds, as indicated in Division 1, General Requirements, without incurring damage.

B. Shall be fabricated from steel, extruded aluminum, fiberglass or concrete, as indicated on the Drawings.

C. Packager shall supply 10 percent, or a minimum of one pole where 10 percent is less than one, spare poles of each type used on the Project for Owners use. These spares may be used by the Packager prior to system turnover to the Owner but shall be replaced at no cost to the Owner.

2.06 EMERGENCY LIGHTING SYSTEM

A. Emergency lighting system shall consist of selected lighting fixtures supplied from inverter-type power units.

B. Lighting fixtures for emergency lighting are identified on the Drawings. Provide nameplate on or near Luminaire to identify “Emergency Light”.

C. Power Units:

1. Self-contained, including batteries, charger, inverter, and transfer devices to deliver rated output under normal and abnormal conditions, including complete power failure.
2. Load characteristics: Capable of powering incandescent and fluorescent lighting.
3. Quantity and identification: As indicated on the Drawings.
4. Ratings:
    a. Output capacity at 0.85 lagging power factor shall be as indicated on the Drawings.
    b. Input voltage shall be 120V ac, single-phase, 60-Hz unless indicated otherwise on the Drawings.
    c. Output voltage shall be since wave with less than 10 percent voltage total harmonic distortion. Voltage regulation shall be plus 10 percent no-load to full-load.
    d. Units shall be capable of delivering full-rated capacity for minimum of 90 minutes following failure of ac supply according to NFPA 101.
    e. Transfer time from normal to emergency power supply and back to normal power supply shall be 1 second, maximum.
    f. Low Voltage Protection; Units shall have low voltage protection that will protect the battery from deep discharge during extended power failures by disconnecting the load upon low battery voltage.
    g. Units shall be rated for ambient temperature range of 0 – 40 degrees C.
5. Inverter, charger, transfer switches, and basic circuitry shall be of solid-state construction.

6. Batteries shall be wet cell, pocket plate, nickel cadmium type with 15-year prorated warranty and life expectancy of 20 years.
   a. Assemble cells in high-impact, heat-resistant, injection molded plastic containers.
   b. Provide complete with post straps and connecting hardware.
7. Battery charger:
   a. Automatic regulated type to maintain float voltage within 0.05V.
   b. Capacity to fully recharge battery within 12 hours following 90 minutes of emergency operation.
8. Output circuit arrangement:
   a. One power circuit energized from normal ac supply which transfers to inverter upon normal power supply failure.
   b. Provide fuse or circuit breaker in output circuits.
9. Accessories:
   a. Light to indicate normal ac supply is available.
   b. Light to indicate proper functioning of charger.
   c. Light to indicate unit is providing emergency power.
   d. Test switch to simulate loss of normal power supply.
   e. ac ammeter to monitor output current.
   f. dc voltmeter to monitor battery voltage.
10. Enclosure:
   a. Wall-mounted, NEMA 1, unless otherwise specified on the Drawings.
   b. Mount controls in upper portion and batteries in lower portion. Provide barrier between control equipment and batteries.
   c. Finish shall be corrosion-resistant. Color shall be manufacturer's standard.
11. Manufacturers:
   a. Exide Electronics Lightalarms.
   b. Emergi-Light.
   c. Dual-Lite.
   d. "Or-equal," Owner approval.

2.07 EMERGENCY LIGHTING UNITS

A. Self-contained battery-powered units that automatically turn on lights upon ac power failure and turn off lights upon restoration of service.

B. Units shall be UL listed.

C. Battery shall be nickel-cadmium, rechargeable, sealed, maintenance-free with 5-year warranty, minimum. Battery shall be rated 12V and shall be capable of operating unit for 90 minutes following power failure.

D. Battery charger and switching circuits shall be of solid-state type for use on 115V ac supply.

E. Units shall have two halogen-type lamps each.

F. Units shall be suitable for use in ambient temperature range of 0 to 40 degrees C.

G. Accessories:

1. Test switch for testing lamps and battery.
2. Pilot light to indicate that unit is connected to live ac supply.

H. Packager shall supply 10 percent, or a minimum of one emergency lighting unit where 10 percent is less than one, spare emergency lighting units of each type used on the Project for Owners use. These spares may be used by the Packager prior to system turnover to the Owner but shall be replaced at no cost to the Owner.

PART 3 EXECUTION

3.01 GENERAL

A. Determine locations and arrangement of equipment from the Drawings.

B. Locations shown on the Drawings are approximate unless dimensioned. Choose precise location to clear obstructions and to provide sufficient space for operation and maintenance.

C. Coordinate timing of installation and location of equipment with other trades.

D. Install equipment in strict accordance with manufacturer's recommendations.

E. Perform all construction in accordance with the NEC.

F. Repair factory finishes where they become damaged during construction.

G. Install all equipment level and plumb.

H. Install all equipment to meet seismic requirements as specified in Division 1, General Requirements.

3.02 LUMINAIRES

A. Provide proper hangers, pendants, and canopies as necessary for a complete installation.

B. Support lighting fixtures from building framing or floor slabs, independently of conduit system and suspended ceilings.

C. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount luminaires.

D. Mounting heights shown for pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.

E. Mounting heights shown for wall-mounted luminaires are measured from center of mounting plate to finished floor or finished grade, whichever is applicable.

F. Install each luminaire outlet box with galvanized stud.

G. Pendant Mounted:

1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
3. Provide twin-stem hangers on single luminaires.

H. Pole Mounted:

1. Provide cast-in-place or precast concrete base, as required.
2. Provide branch circuit in-line fuses in pole base handhole.

I. Swinging Type: Provide, at each support, safety cable capable of supporting four times vertical load from structure to luminaire.

J. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
   a. Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
   b. In concealed locations, install junction boxes to be accessible by removing luminaire.

6. Wiring and Conduit:
   a. Provide wiring of temperature rating required by luminaire.
   b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
   a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
   b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
   c. Fasten chain or wire to each end of luminaire.

K. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 3/8-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

L. Building Exterior: Flush-mounted back box and concealed conduit, unless otherwise indicated.

3.03 LAMPS

A. Provide in each fixture, number and type for which fixture is designed, unless otherwise noted.

3.04 BALLASTS

A. Install in accordance with manufacturer’s recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.05 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

B. Dimming Systems:

1. Install in accordance with manufacturer’s recommendations.
2. Do not connect ballasts or equipment to dimming system unless acceptable to dimming system manufacturer.

C. Occupancy Sensors: Locate and aim sensors in correct location required for complete and proper volumetric coverage within range of coverage(s) of controlled areas per manufacturer's recommendations. Rooms shall have 90 to 100 percent coverage to completely cover controlled area to accommodate all occupancy habits of single or multiple occupants at any location within room(s). Locations and quantities of sensors shown on the Drawings are diagrammatic and indicate only rooms which are to be provided with sensors. Provide additional sensors if required to properly and completely cover respective room.

3.06 EMERGENCY BALLAST

A. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing.

B. Install monitoring light and double-pole switch adjacent to light fixture.

C. Wire in accordance with manufacturer's wiring diagrams.

3.07 EMERGENCY LIGHTING UNIT

A. Install in accordance with manufacturer's recommendations.

B. Provide permanent circuit connections with conduit and wire.

C. Connect to branch circuit feeding normal lighting in area ahead of all local switches.

D. Provide separate circuit wiring to luminaire.

3.08 CLEANING

A. Remove labels and markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace defective lamps at time of Substantial Completion.

END OF SECTION

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SECTION 40 00 10
PIPING SUMMARY OF WORK

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. Supplier shall adhere to this summary of Work. The Work shall include the fabrication, assembly, erection, testing, cleaning, and commissioning of all piping, fittings, valves, supports and piping specialties, as called for on the Drawings and Specifications, and by the codes and standards listed herein.

B. Supplier shall be responsible for developing any required installation, commissioning, and testing procedures and submit for Engineer approval.

C. The following list of Specification sections shall be used by Supplier in conjunction with this summary of Work:

1. Section 40 42 16, Power Plant Piping and Equipment Insulation.
2. Section 40 50 20, Aboveground Power Plant Piping.
3. Section 40 55 00, Power Plant Valves.
4. Section 48 58 68, Welding of Power Plant Piping.

1.02 SYSTEM DESCRIPTIONS

A. Supplier’s Scope of Work includes all piping on the combustion turbine generator package, interconnecting piping as required between Supplier-furnished auxiliary skids and main package. The piping systems on the combustion turbine package include, but are not limited to, fuel gas, fuel oil, instrument air, lube oil, fire suppression reagent, and water injection.

PART 2 PRODUCTS

2.01 PIPING

A. All piping shall be in accordance with ASME B31.1, BPVC and consistent with the referenced piping specification sections issued for this Project.

2.02 VALVES

A. All Valves shall be in accordance with ASME B31.1, BPVC and consistent with the referenced valve specification sections issued for this Project.

B. Valve type is defined by the data sheets in Sections 40 55 00, Power Plant Valves. Deviation from these documents is not allowed unless agreed upon by the Owner and Engineer.

2.03 EXPANSION JOINTS

A. All Expansion joints shall be in accordance with ASME B31.1 and consistent with the referenced expansion joint specification sections issued for this Project.

2.04 SPECIALTY ITEMS

A. All specialty items shall be in accordance with ASME B31.1.

2.05 INSULATION

A. Supplier shall insulate piping as required. In accordance with OSHA requirements, the maximum skin temperature of insulated piping shall be 140 degrees F where piping is readily accessible by personnel.

PART 3 EXECUTION

3.01 GENERAL

A. Supplier shall verify dimensions, valve and piping component locations and support configuration prior to fabrication.

3.02 INSPECTION, EXAMINATION AND TESTING

A. Piping and piping subassemblies shall be inspected, examined and tested according to Chapter VI of ASME B31.1, and Specifications.

B. Pressure testing shall be performed at the test pressure determined by the Supplier in accordance with ASME B31.1.

C. Supplier shall provide high point vents and low point drains as required for hydrotesting. Sections of pipe hydrotested shall be fully vented prior to hydrotest and fully drained and dried upon completion of a successful hydrotest.

END OF SECTION

SECTION 40 42 16
POWER PLANT PIPING AND EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Specification covers the general requirements for design, material, supply and installation of external thermal insulation for piping, tanks, and equipment operating from ambient to 550 degrees F, located aboveground either inside or outside of buildings.

B. This Specification shall not be applied to the following insulation systems:

1. Exterior insulation systems to maintain cold temperatures.
2. Insulation systems for HVAC equipment.
3. Refractory systems and internal insulation systems for process piping and equipment.
4. Pre-traced, pre-insulated tubing for instrumentation, samples, and chemical injections.
5. Insulation for Underground pipe.
6. Removal or remediation of asbestos.

1.02 DEFINITIONS

A. Heat Conservation Insulation is defined by Insulation Code H.

B. Personnel Protection Insulation is defined by Insulation Code P.

C. Piping that does not require insulation is defined by Insulation Code N.

D. Freeze Protection (Winterization) insulation is defined by Insulation Code W.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section and supplemental Data Sheets:

1. American Society of Mechanical Engineers (ASME):
   a. A13.1, Scheme for the Identification of Piping Systems.
   b. B31.1, Power Piping.
2. ASTM International (ASTM):
   a. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

b. B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
d. C195, Standard Specification for Mineral Fiber Thermal Insulating Cement.
e. C335, Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
f. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
g. C450, Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
h. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
i. C547, Standard Specification for Mineral Fiber Pipe Insulation.
j. C552, Standard Specification for Cellular Glass Thermal Insulation.
k. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Application.
l. C585, Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
m. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
n. C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
o. C1086, Standard Specification for Glass Fiber Felt Thermal Insulation.
p. C1094, Standard Guide for Flexible Removable Insulation Covers.
q. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
r. C1729, Standard Specification for Aluminum Jacketing for Insulation.
s. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

3. The Society for Protective Coatings (SSPC):
   a. SP-1, Solvent Cleaning.
   b. SP-2, Hand Tool Cleaning.
   c. SP-3, Power Tool Cleaning.

B. All materials shall comply with the ASTM specifications, as applicable, listed in this Specification and other ASTM specifications accepted as industry standards for thermal insulating materials.

1.04 REFERENCE SECTIONS

A. The following Specifications are included for reference and form an integral part of this Specification.

1. Section 01 33 00, Submittal Procedures.
2. Section 01 61 00, Common Product Requirements.
3. Section 09 90 01, Painting and Protective Coatings.
4. Section 40 50 20, Aboveground Power Plant Piping.
5. Section 48 58 68, Welding of Power Plant Piping.

1.05 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Action Submittals:

1. Shop Drawings:
   a. Supplier's Literature: Require data to include but not necessarily be limited to the following: Insulation details showing how equipment, vessels, manways, removable covers, control valves, instrumentation, and tanks will be insulated.
      1) Type of insulation.
      2) Insulation details including thickness, density, etc.
      3) External and internal facing.
      4) Maximum and minimum temperature ratings.
      5) Fire and Smoke ratings.
      6) Thermal conductivity.
      7) Description of adhesives, cements, and tapes.
      8) Description of mechanical fastening systems.
      9) Description of finishing and flashing materials and methods.
      10) Installation instructions.
      11) Method of sealing and securing insulation.
      12) Jacket details such as material, thickness, and profile.
      13) Jacket coating details such as paint type, coating thickness, emissivity, and color.
      14) Method of sealing and securing jacketing.
      15) Quality assurance document.
2. Coated aluminum jacket samples (of each color) for Owner approval.

C. Information Submittals: Certification that insulating materials are free of asbestos.

1.06 PROJECT CONDITIONS

A. Do not install products under environmental conditions outside Supplier's absolute limits.

B. Table 2A and 2B reflect insulation thicknesses based on design conditions (summarized below).

1. Heat Loss:
   a. Ambient Temperature = 80 degrees F.
   b. Wind Speed = 0.0 mph.
   c. Jacket Emissivity = 0.8.
2. Outer Surface Temperature:
   a. Maximum Outer Surface Temperature = 140 degrees F.
   b. Inside Building Design Ambient Temperature = 122 degrees F.
   c. Wind Speed = 0.0 mph.
   d. Jacket Emissivity = 0.8.

C. Table 2C reflects insulation thicknesses based on average conditions (summarized below). In the event of extreme ambients. Owner implements safety procedures which include limiting personnel access to areas which contain hot pipe.

1. Outer Surface Temperature:
   a. Maximum Outer Surface Temperature = 140 degrees F.
   b. Inside Building Ambient Temperature = 90 degrees F.
   c. Wind Speed = 1.0 mph (reflective of fans circulating air).
   d. Jacket Emissivity = 0.8.

1.07 HEAT CONSERVATION

A. Heat Conservation shall apply to all pipe and equipment as required by the Supplier. Heat Conservation shall be considered for process stability to control process temperatures.

1.08 PERSONNEL PROTECTION

A. Personnel Protection, Insulation Code P, shall apply to all accessible pipe and equipment which have an operating temperature greater than 140 degrees F.

B. The extents of Personnel Protection shall be as follows:

1. All indoor pipe and equipment shall be classified as accessible unless otherwise noted on the Drawings.

2. All outdoor pipe and equipment within 7 feet vertically, 3 feet horizontally, or 1 foot below any access area, walkway, stairway, or platform shall be classified as accessible.

C. Surface temperature of jacket for personnel protection shall not exceed 140 degrees F.

D. Alternates to insulation (such as mesh or perforated cladding) for Personnel Protection may be considered but shall be approved by the Engineer and Owner.

1.09 FREEZE PROTECTION

A. Piping containing commodities susceptible to freezing, Insulation Code W, shall be winterized as follows:

1. All lines greater than NPS 4 inches to NPS 30 inches (except as noted online List): Insulate (W) all lines with 2 inches insulation, including the bypass lines, except where the lines have been sloped for free draining or intended to drain when stagnant.
2. Insulation at AG/ UG piping interfaces shall be continued on the underground piping segment. Underground piping insulation and jacketing shall extend from the underside of the AG/UG flange set to a distance below frost depth. Reference Section 01 61 00, Common Product Requirements for frost depth.
3. Freeze protection insulation on pipe that enters buildings shall extend 12 inches into building or in accordance with insulation manufacturer's recommendations.

1.10 INSULATION FOR SUPPLIER SKID PIPING

A. Unless shown on Supplier's drawings, Contractor shall use Tables 2A or 2B as appropriate to determine the correct insulation thickness for on-skid Supplier furnished piping.

B. Engineer to review and approve prior to installation.

1.11 INSULATION MATERIALS

A. Calcium silicate shall be used for all carbon steel aboveground piping systems. It shall also be used for rigid equipment insulation applications.

B. Mineral fiber blanket shall be used for non-rigid equipment applications.

C. Fiberglass shall be used for all stainless steel aboveground piping systems.

1.12 JACKETING MATERIALS

A. Coated aluminum jacketing shall be used for all aboveground piping and vessels and equipment.

B. Waterproof, heat sealable jacketing shall be used for all underground piping.

1.13 PIPE MARKINGS

A. Pipe markers shall be used for all aboveground piping as a means for fluid service identification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials shall be asbestos-free, chloride-free, polyurethane-free, non-corrosive, and compatible with adjacent materials.

B. Insulation materials for application to stainless steel shall comply with ASTM C795.

C. Insulation materials shall have a flame spread rating of 25 or less, when tested in accordance with ASTM standard E84.

D. Mastics, cements, and adhesives shall be suitable for the service temperatures and weather conditions.

E. Items specified or referenced by Manufacturer's name and/or number in the sections below are intended to describe the type and quality level of the product, and are not intended to be restrictive or to exclude similar items offered by other Manufacturers. All alternatives must be approved by the Engineer prior to use.

2.02 INSULATION

A. Materials:

1. Fiberglass:
   a. One-piece, heavy density, preformed in accordance with ASTM C547 Type I, and suitable for 850 degrees F.
   b. Manufacturers and Products:
      1) Owens-Corning; Fiberglass ASJ.
      2) Johns-Manville; Micro-Lok.
      3) "Or-equal."

2. Mineral Fiber:
   a. One-piece, minimum 8-pound density per cubic foot, preformed in accordance with ASTM C547 Type II, and suitable for 1,200 degrees F.
   b. Manufacturers and Products:
      1) Roxul Techton 1200.
      2) Fibrex Coreplus 1200.
      3) "Or-equal."
3. Calcium Silicate Block: Conform to ASTM C533 Type I, minimum 10 pound-density per cubic foot, and suitable for 1,200 degrees F.
   a. Manufacturer and Product: Johns-Manville Corp.; Thermo 12 Gold.
4. Mineral Fiber Block:
   a. Nominal 8-pound density per cubic foot, suitable for 1,200 degrees F, and conforming to ASTM C612 Type IV B.
   b. Manufacturers and Products:
      1) Roxul RHT80 Board.
      2) Fibrex FBX 1280.
      3) "Or-equal."
5. Mineral Fiber Blanket:
   a. Nominal 4-pound density per cubic foot, suitable for 1,200 degrees F, and conforming to ASTM C553 Type VII.
   b. Manufacturers and Products:
      1) Roxul RW40 Blanket.
      2) Fibrex FBX 1230 Flexible Batt.
      3) "Or-equal."
6. Cellular Glass Block:
   a. Conform to ASTM C552, and nominal 8.5-pound density per cubic foot.
   b. Manufacturer and Product: Pittsburgh Corning Foamglass.
7. Fiberglass Board:
   a. Semirigid, nominal 3-pound-density per cubic foot, suitable for 450 degrees F and conform to ASTM C612 Type IB.
   b. Manufacturer and Product:
      1) Owens-Corning; Type 703.
      2) "Or-equal."
8. Loose insulating wool as manufactured by Roxul; Roxul 1200 Loose Insulating Wool.
9. Cellular Glass/Foam Glass
   a. Nominal 7.5-pound density per cubic foot, molded preformed, and suitable for 180 degrees F, ASTM C552-00.
   b. Manufacturer and Product:
      1) Pittsburgh Corning Foamglas.
      2) "Or-equal."

2.03 FLEXIBLE REUSABLE INSULATION COVERS

A. The insulation covers shall withstand removal and reinstallation without losing its properties.

B. In accordance with ASTM C1094.

C. Shall be used for valves, flanges, unions, pumps, blowers, heat exchangers, strainers, orifice plates, removable nozzles, expansion joints, and other similar in-line items requiring maintenance.

D. Thermal conductivity that is equal to or better than adjacent pipe insulation and jacketing.

E. Insulation thickness:

1. 2 inches when adjacent insulation thickness is 1-1/2 inches or less.
2. Minimum 1-inch greater than adjacent insulation when thickness is 2 inches or greater.

F. Resultant surface temperature of not more than 140 degrees F.

G. Quilted multi-layer construction consisting of a minimum of, from hot side out:

1. Knitted stainless wire mesh.
2. Stainless steel foil.
3. Thermal insulation.
4. Silicone impregnated fiberglass cloth.
5. Knitted stainless steel wire mesh.

H. Insulation material shall be glass fiber, unsupported needled felt binder free thermal insulation per ASTM C1086.

I. Silicone impregnated fiberglass cloth shall have a weight of one pound per square yard and contain a minimum of 25 percent silicone by weight, Alpha MAritex Style #3259-2-SS “Or-equal.”

J. All materials shall be quilted together on a maximum of 9 inches centers with stainless steel quilt anchors and outer seams shall be fastened together with hog rings spaced on 1-inch centers.

K. The covers shall be of a minimum number of pieces with joints located to eliminate any water penetration into the insulation or toward the hot facing. The weight of any single piece of the cover shall not exceed 30 pounds.

L. The covers shall be positioned so that their natural seam is positioned on the gravitational bottom of the fitting.

M. The covers shall fit tight to the fittings and protrusions and shall be held in place with bands and laced wire. They shall be of sufficient width to overlap the adjacent weatherproofing by a minimum of 5 inches on each side of the fitting.

N. Each piece of the cover shall have an embossed metal tag permanently attached with specific information such as equipment or pipeline number, size, rating and fitting type.

O. Valve covers shall include the valve bonnet.

P. Water ingress protection: The entire cover shall be covered with a silicone coated fabricated fabric to prevent water from entering the insulation at the seams. The protection cover shall extend 6 inches beyond the insulation cover and be secured in place with drawstrings.

2.04 JACKETING AND LAGGING

A. Aboveground Pipe:

1. Factory Coated Aluminum Jacketing:
   a. ASTM B209 alloy 3105 or 3003 with H-14 temper.
   b. Furnish with factory applied integral moisture barrier on interior surface and factory applied coating on exterior surface.
      1) Manufacturer and Product:
         a) ITW/Childers.
         b) RPR Products.
         c) “Or-equal.”
   c. Aluminum Jacketing Thicknesses:
      1) Piping Up to 8-Inch Diameter: 0.016-inch thick.
      2) Piping 10 Inch and Larger Diameter: 0.024-inch thick.
   d. Stucco-embossed non-glare/non-reflective finish.
   e. Factory Coating:
      1) In accordance with ASTM C1729 Type II ($\varepsilon = 0.8$).
      2) Final color shall be as directed by Owner.

B. Equipment, Vessels, and Tanks:

1. Factory Coated Aluminum Lagging:
   a. ASTM B209, 0.040-inch thick, 5005 clad aluminum alloy with a flat, natural color, stucco-embossed non-glare/non-reflective finish.

b. Furnish with factory applied integral moisture barrier on interior surface and factory applied coating on exterior surface.
c. Factory coating in accordance with ASTM C1729 Type II ($\varepsilon = 0.8$).
d. Use 0.050-inch thick when applied in areas where personnel may walk.

C. Flashing for Aluminum Panels: Flat aluminum sheet for flashing ribbed lagging shall be 0.032-inch thick, alloy 5005, half-hard temper, with stucco-embossed non-glare/non-reflective finish matching lagging.

D. Jacketing for flanges, ends of heat exchangers, and similar areas shall be machine-formed to required contour, and shall be in the fewest practical number of pieces consistent with fabrication, assembly, and removal requirements.

2.05 REINFORCING MATERIAL

A. Poultry Wire Mesh: 1-inch hexagonal wire mesh, woven from No. 20-gauge wire, galvanized after fabrication, and furnished in 48-inch width rolls.

B. Welded Wire Fabric: 6 by 6, W2.9 by W2.9.

C. Expanded Metal Mesh:

1. 1.8 pounds per square yard unpainted carbon steel for use as facing for retention of fibrous insulation.
2. Flat, rerolled type will not be acceptable.
3. Manufacturer:
   a. Expanded Metal Engineering Co.
   b. “Or-equal.”

D. Fabric Reinforcing Membrane:

1. Open-weave polyester fabric, glass fiber cloth or knitted tape.
2. Manufacturers and Products:
   a. Foster Division of H.B. Fuller Co.; Mast-a-Fab Cloth.
   b. Childers Products Co.; Chil-Glas No. 5.
   c. “Or-equal.”

2.06 FASTENERS

A. Tie Wire (Dead Soft Type 302 Stainless Steel):

1. 14-gauge AWG for 12 inches and smaller pipe.
2. 12-gauge AWG for 14 inches and larger pipe.

B. Stainless Steel Bands:

1. 1/2-inch by 0.020-inch, Type 304 stainless steel band with Type 304 stainless steel wing seals.
2. Manufacturer and Product:
   a. Gerrard; Type 304 stainless steel.
   b. “Or-equal.”

C. Carbon Steel and Stainless Steel Insulation Pins:

1. No. 10-gauge “CD” carbon steel pins for surface temperatures up through 750 degrees F.
2. Type 304 stainless steel “stored arc” pins for surface temperatures over 750 degrees F.
3. Lengths suitable for insulation thickness.
4. Furnish with l-inch extra length so ends can be bent over after installation of insulation fastener.
5. Manufacturers:
   a. Nelson Stud Welding Company.
   b. K.S.M. Company.
   c. H. A. Jones Company.
   d. “Or-equal.”

D. Push-On Type Insulation Fasteners:

1. Speed clip type, 2-1/2-inch square by 0.0175-inch thick, for use with corresponding gauge insulation pins.
2. Clips:
   a. Carbon steel.
   b. Use Type 304 stainless steel clips on Type 304 insulation pins.
3. Manufacturers:
   a. Nelson Stud Welding Company.
   b. K.S.M Company.
   c. H. A. Jones Company.
   d. “Or-equal.”

E. Arc Welded Studs:

1. End-weld Studs: Type 316 stainless steel, 1/2-inch diameter by length required, each with hex-nut and standard washer.
2. Manufacturer:
   a. Nelson Stud Welding Co.
   b. “Or-equal.”

F. Self-Tapping Screws:

1. Panhead Type “A” slotted, No. 14 by 3/4-inch, Type AB thread, Type 316 stainless steel with indented hexagon concave head with neoprene washer.
2. Manufacturers:
   a. Parker-Kalon.
   b. H. M. Harper.
   c. Townsend Co.
   d. Camcar.
   e. Armco, Inc.
   f. “Or-equal.”
3. Alternative: Stainless steel hex head screws without washer, No. 8 by 1/2-inch.

G. J-hooks and speed clips, carbon steel or Type 316 stainless steel, may be used with welded wire mesh for supporting insulation over stiffeners.

H. S-hooks, carbon steel or Type 316 stainless steel, may be used to support insulation on vertical sections of pipe.

2.07 MISCELLANEOUS MATERIALS

A. Insulating and Finishing Cement:

1. Blend of mineral fibers, inorganic refractory materials and hydraulic setting binder, suitable for 1,200 degrees F, and conforming to ASTM C195.
2. Manufacturer and Product:
   a. Johns Manville; CalCoat 127.
   b. “Or-equal.”

B. Flashing compound, suitable for 250 degrees F maximum, as manufactured by:

1. Childers Products Co.; Chil-Joint CP-70.
2. Foster Division of H. B. Fuller Co.; Foamseal Sealant 30-45.
3. “Or-equal.”

C. Flashing compound, suitable for operating temperatures from 250 degrees F to 550 degrees F as manufactured by:

1. IGS Industries; Duct-Tite.
2. “Or-equal.”

D. Weathercoating mastic as manufactured by:

1. Childers Products Co.; Vi-cryl CP-10-1 or CP-11-1.
2. Foster Division of H. B. Fuller Co.; Sealfast GPM 35-01 or 45-01.
3. "Or-equal."

E. Bitumastic as manufactured by:

1. Koppers Company, Inc.; Bitumastic No. 50.
2. "Or-equal."

F. Asphalt aluminum paint as manufactured by:

1. Garland Co., Inc.; Garla-Brite.
2. "Or-equal."

G. Welding Machines:

1. Pin Type:
   a. Capacitor discharge type, portable, 110 volts.
   b. Manufacturers and Products:
      1) K.S.M. Company; Model CD-60.
      2) Nelson Stud Welding Co.; "Stored Arc Process."
      3) H. A. Jones Company; NSA-106 or NSA-50.
      4) "Or-equal."
2. Stud Type: As manufactured by:
   a. K.S.M. Company.
   b. "Or-equal."

H. Silicone Caulk as manufactured by:

1. 3M; Marine Grade Silicone Sealant.
2. Dow Corning; 732 Clear Silicone.
3. Dow Corning; 733 Glass-Metal Silicone Sealant.
4. "Or-equal."

2.08 PIPE MARKINGS

A. Design and location of markers shall comply with ASME A13.1.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 50 20
ABOVEGROUND POWER PLANT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers minimum requirements for the installation of complete piping systems. Installation includes procurement, packaging, furnishing, receiving, storing, handling, fabrication, assembly, erection, supporting, cleaning, coating, insulating, filling, flushing, non-destructive examination, testing, restoration and inspection of complete aboveground piping systems, including loose piping furnished with equipment and miscellaneous structural attachments for supports.

B. In the event of any apparent conflict between this section and other referenced sections, codes, standards and documents, then Contractor shall refer the conflict to Engineer in writing for resolution.

C. No departures shall be made from this Specification and referenced sections, codes, standards and documents unless particular requirements are waived or modified in writing by Engineer. Contractor shall submit written requests for departures to Engineer for approval. Following the list of exceptions, if any, Contractor shall add a statement that no other exceptions are taken to this Specification.

1.02 DEFINITIONS

A. The following terms shall be understood to mean:

1. Large Bore Pipe (LB): Piping NPS 2-1/2 inch and larger.
2. Small Bore Pipe (SB): Piping NPS 2 inch and smaller.

1.03 REFERENCES

A. The following is a list of codes and standards which may be referenced in this section:

1. American Society of Mechanical Engineer’s (ASME):
   a. A13.1, Scheme for the Identification of Piping Systems.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.25, Butt Welding Ends.
   d. B31.1, Power Piping.
   e. BPVC Section II, Materials Part C Specification for Welding Rods, Electrodes, and Filler Metals.
   f. BPVC Section IX, Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

g. PCC-1, Guidelines for Pressure Boundary Bolted Flange Joint Assembly.

2. ASTM International (ASTM):
   a. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
3. Pipe Fabrication Institute (PFI): ES-3, Fabricating Tolerances.
4. Manufacturers' Standardization Society of the Valve and Fittings Industry (MSS):
   a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. SP-69, Pipe Hangers and Supports - Selection and Application.
   c. SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
5. U.S. Department of Labor Occupational Safety and Health Administration (OSHA): 29 CFR Parts 1926/1910.

1.04 REFERENCE SECTIONS

A. Section 01 33 00, Submittal Procedures.

B. Section 09 90 01, Painting and Protective Coatings.

C. Section 40 00 10, Piping Summary of Work.

D. Section 40 55 00, Power Plant Valves.

1.05 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Information Submittals:

1. Drawing list and submittal schedule.
2. Fabrication, testing, and commissioning sequence schedule.
3. Expediting reports.
4. Certified Material Test Reports (CMTRs).
5. Information Submittals for Field Fabricated Piping:
   a. Heat and lot numbers, which provide traceability for materials.
   b. Manufacturer's Certificate of Compliance.

c. Weld repair records complete with evaluations.
d. Weld maps for all field welds including the unique welder's identification symbol described in Section 48 58 68, Welding of Power Plant Piping, and the date the Work was performed.
e. Evaluations of radiographic film (RT), ultrasonic examinations (UT), liquid penetrant examinations (PT), and magnetic particle examinations (MT) and any other examinations performed. Radiographic evaluations shall show date, line number, weld identification symbol, film number, serial number, film combinations, interpretations, and other pertinent information for each weld radiographed.
f. NDE reports to document RT, UT, PT, MT and visual (VT) weld examinations.
g. Pressure test reports, containing at least the following information:
    1) Complete description of pipe system including boundary limits, complete line numbers, Drawings and P&ID's indicating test boundaries.
    2) Test description including test pressure, test medium, temperature of test medium, ambient temperature, time of day, test duration, leakage rate, and date of test.
    3) Record of joint repairs including date, extent of repairs, and responsible individual.
    4) Record of cleaning including date and responsible individual.
    5) Signature, date, and title of Engineer's or Owner's representative witnessing operation.

C. Action Submittals:

1. Supplier's Quality Control Manual and Quality Assurance Manual.
2. Inspection and Test Plan (ITP).
3. Inspector and NDE personnel qualifications.
4. Welding Procedure Specifications and Welding Performance Qualification Test results in accordance with ASME B31.1, Appendix III.
5. Fabrication Procedures, including but not limited to:
    a. Cutting procedures.
    b. Welding procedures.
    c. Hot work procedures (specifically around operating equipment).
    d. Bending procedures.
    e. Pre-heat and Post-weld Heat Treatment (PWHT) procedures.
    f. NDE procedures.
    g. PMI procedures.
    h. Cleaning and blasting procedures.
    i. Painting procedures.
    j. Testing procedures.
    k. Commissioning procedures.

6. Manufacturer's data sheets or catalog cut sheets for purchased piping components and in-line devices and recommendations for handling, storage, and installation of components.
7. Internal cleaning/flushing procedures (including fuel gas air blows, etc.).
8. Pressure testing procedures.
9. Cleaning/Flushing fluid data.
10. Testing fluid data.
11. Manufacturer's Data Report (MDR), including but not limited to:
    a. Cover Page.
    b. Table of Contents.
    c. Inspection Release Certificate.
    d. Relevant documents such as mill certificates, weld maps, completed ITPs, test results, etc.
    e. Deviations, concessions, and Nonconformity Reports (if applicable).

PART 2 PRODUCTS

2.01 MATERIALS

A. Piping materials should be as shown below. Substitutions can be made with approval of Engineer.

1. Fuel Gas System (before final filter coalescer): Carbon Steel, ASTM A106 Grade B, Schedule 40 (minimum) seamless.
2. Fuel Gas System (after final filter coalescer): Stainless Steel, ASTM A312 TP304/304L/316/316L, Schedule 40S (minimum) seamless.
3. Fuel Oil System: Carbon Steel, ASTM A106 Grade B, Schedule 40 (minimum) seamless.
4. Instrument Air System: Stainless Steel, ASTM A312 TP304/304L/316/316L, Schedule 40S.
5. Emission Control Water Injection: Stainless Steel, ASTM A312 TP304/304L/316/316L.
6. Lube Oil System: Stainless Steel, ASTM A312 TP304/304L/316/316L.

B. Valves:

1. Provide vent and drain valves as specified in Section 40 55 00, Power Plant Valves.
2. Provide necessary grease and lubricant required in accordance with manufacturer's requirements.

C. Pipe Supports:

1. Supplier pipe support materials shall be furnished in accordance with MSS SP-58.

2. All supplemental structural steel support members shall be coated in accordance with Section 09 90 01, Painting and Protective Coatings.

PART 3 EXECUTION

3.01 GENERAL

A. The Work required by this Specification shall be conducted in compliance with applicable OSHA Standards.

3.02 FABRICATION

A. In accordance with ASME B31.1, ASME BPVC (as applicable), and this section.

3.03 DELIVERY, STORAGE, AND HANDLING

A. General:

1. Store and handle materials in manner that will minimize corrosion and prevent damage to pipe and piping components, including their end connections and coatings.
2. Store pipe aboveground on Contractor's furnished dunnage. Use sufficient number of supports to prevent pipe from sagging or coming into contact with ground. Either contoured or padded blocks shall also be used with coated pipe to prevent damage to coatings.
3. If pipe shall be partially or completely submerged due to rainfall, or any other cause, pipe shall be carefully examined, and water, together with any dirt, trash, or other foreign matter that may have entered shall be removed. Internal of pipe shall be blast cleaned back to original and wall thickness checked.

B. Acceptance at Jobsite:

1. Repair damage to pipe, fittings, specialty items, coatings, or linings to Engineers' satisfaction at no extra cost.
2. Damaged items not repaired to Engineer's satisfaction shall be removed from Site and replaced.

C. Special Piping (e.g., PVC, CPVC, polyethylene, fiberglass, plastic-lined steel, preinsulated) materials shall be handled and stored in accordance with manufacturer's recommendations.

D. End Protection: Material furnished by Supplier in accordance with this Specification shall have machined surfaces protected until installation as follows:

1. Flange Faces:
   a. Cover with bolted or clamped plastic or wood cover of adequate size and strength to prevent damage to face.
   b. Coat carbon steel and low-alloy flange faces with suitable rust preventative.
2. Buttweld Ends: Cover with plastic protectors to prevent damage to bevels.
3. Threaded Connections:
   a. Plugged or capped.
   b. Temporary thread protectors used during shipment and handling shall be plastic or sheet metal.

3.04 INSTALLATION

A. General:

1. Supplier shall conduct pre-installation inspections: Inspect each pipe spool, valve, threaded opening and gasket surface for damage and internal cleanliness prior to installing.

B. Piping:

1. In accordance with requirements of ASME B31.1, ASME BPVC (as applicable) and this section.
2. Install perpendicular or parallel to major equipment, building structure, and floor levels. Exception is given for piping which is specified with slope on the Drawing.
3. Piping, including tubing, shall be installed in accordance with the following requirements:
   a. Do not install above or within horizontal distance of 3 feet from electrical equipment such as switchgear, switchboard, control panel, motor control, contactor, communication equipment, batteries, battery charger, and motor generator.
   b. Install with minimum of 7 feet 6 inches of headroom over passageway and walkway. Pipe shall not be run near the floor, nor across walkways or working spaces where they would be a hazard.
   c. Where piping is specified to be field routed clearances shall be maintained to allow installation, operation, and maintenance of equipment.

C. Joints:

1. Threaded:
   a. Threaded fittings shall not be used for natural gas, compressed air, or ammonia service.
   b. Tapered and conforming to ASME B1.20.1.
   c. Pipe ends shall be reamed to full inside diameter to remove burrs and obstructions.
   d. For pipe systems exposed to line temperatures of less than 400 degrees F, use Teflon as joint sealant for threaded joints and Never-Seez Mariner's Choice by Bostik lubricating compound (or Engineer approved equal) for lines operating between 400 and 900 degrees F that will not be seal welded.
   e. If seal welded, make without thread lubricant or Teflon.
   f. Insulate dielectric threaded joints in accordance with Power Piping Standard PP-2, Dielectric Threaded Joints located at end of section.
2. Flanged Joints:
   a. Installation shall be in accordance with ASME PCC-1.
   b. Make up with flange faces parallel, and bolt holes straddling normal horizontal and vertical centerlines of flanges, unless otherwise shown on the Drawings.
   c. Protect gaskets and flange faces from damage until installation is complete.
   d. Special precautions must be taken when making up steel-to-cast iron flanged joints. Steel flange shall be flat faced or have its raised face removed.
   e. Gaskets:
      1) Temporary Flanged Joint: May be made up with less expensive sheet gaskets and special gaskets saved for permanent installation.
      2) Verify that proper gaskets are installed for permanent installation.
   f. Gaskets and gasket surfaces on flanges shall be clean, unpainted, and undamaged.
   g. Bolt threads shall be coated with Never-Seez Mariner's Choice by Bostik (or Engineer approved equal). The lubricant shall be applied to the full length of all bolt threads. All bolts shall extend completely through their nuts by at least one full effective thread, but not more than 3/8 inch.
   h. Flanges shall be made up by tightening diametrically opposite bolts in succession to load gasket evenly.
   i. Replace cap screws and machine bolts that have bottomed out before joint is tight with proper length screws or bolts.

j. When flanged joint has been made up and subsequently loosened, install new gasket prior to retightening.
k. Dielectric flanged joints shall be installed in accordance with Power Piping Standard PP-1, Dielectric Flanged Joints located at end of section.
l. Fuel Oil Leak Detection:
1) Contractor shall install tightly sealed flange belts on all flanges and flanged valves in oil services.
2) On insulated piping and equipment, the tightly sealed flange belt shall include a 1/8-inch NPS connection nipple. Tubing shall be provided at the connection nipple and extend beyond the insulation to protect the insulation against any possible leakage from the flange connection.
3) Other types of flanged belts may be used with Engineer and Owner approval.

3. Welded Joints:
a. Buttweld Ends:
1) Make for butt weld joints by mechanical beveling machines, unless otherwise approved by Engineer.
2) Clean bevels to bright metal prior to welding.
3) Repair any beveled edge of pipe that has been damaged to satisfaction of Engineer.
4) Grind uneven and torch cut bevel faces to smooth true surface.
5) Joint preparation in accordance with ASME B16.25.
b. Butt weld ends welded completely by process other than GTAW shall be prepared in accordance with ASME B16.25 Fig. 2(a) or 3(a).
c. When assembling socket weld joints, pipe or tube shall be bottomed out in socket, marked, and then withdrawn approximately 1/16 inch prior to welding.
d. Pipe ends shall be reamed to full inside diameter to remove burrs and obstructions.

D. Austenitic Stainless Steel: The following requirements will apply when fabricating austenitic stainless steel or nickel alloy components:

1. Fabricate stainless and nickel alloy pipe in a separate area from carbon and alloy steel pipe fabrication.
2. Control tools used in fabrication in such a way as to minimize contact with steel alloys or free iron. Brushes shall be identified and controlled for stainless steel use only.
3. Perform grinding with resin or rubber bonded aluminum oxide or silicon carbide grinding wheels which are identified and controlled for their use on these materials only.
4. Block sequence welding and peening of welds are prohibited.

5. Acceptable cleaning solvents are new or redistilled acetone (acetone reclaimed by other methods shall not be used), alcohol (ethyl, methanol, or isopropanol), or toluene (toluol). Halogenated cleaning solvents shall not be used for cleaning or degreasing.

E. Cutting and Drilling Structures:

1. Drilling and cutting of structures required for proper installation of piping or bolts shall be performed only with written permission of Engineer.
2. Holes in grating or floor plate shall be banded and reinforced as required for strength and safety.
3. Holes in concrete floor shall be provided with machine cut steel pipe sleeves.

F. Rainhoods, Flexible Weatherproofing, and Penetration Seals: Installed as shown on the Drawings for piping passing through roof, wall, and floor sleeves.

G. Equipment Connections:

1. When attaching piping to equipment connections, special care shall be taken that excessive stresses are not transmitted to, and imposed upon, such connections.
2. All equipment shall be grouted and/ or bolted to its foundation prior to final bolting or welding of the connection piping.
3. Piping connections to vessels or equipment shall be properly aligned before bolting up.
   a. For flanged connections, flange bolts shall slide into bolt holes freely and the spacing between the flanges shall be 1/16 inch unless specified otherwise on the Drawings.
   b. For welded connections, tolerances shall be within the limits of ASME B31.1 or the manufacturer’s requirements, whichever is more restrictive.
4. Field heating to accommodate minor fit-up problems is not allowed.
5. Cold spring or pre-loading of nozzles is not allowed.
6. Connections which may cause excessive loading are not allowed.
7. Owner’s Representative shall witness installation.
8. Piping which vibrates excessively shall be anchored or snubbed as directed by the Engineer.

H. Piping Tolerances:

1. Dimensional tolerances for fabricated piping shall be in accordance with PFI ES-3 and this Specification.

2. Internal misalignment of butt-weld ends in piping to be joined shall not exceed 1/16 inch for NPS 24 and smaller and 1/8 inch for NPS 26 and larger.
3. Dimensions of installed piping shall be in accordance with PFI Standard ES-3 unless otherwise noted.
4. Flanges in pipe runs shall not be out of square more than 3/64-inch per foot of outside diameter of flange.
5. Angular tolerances shall be plus or minus 1/2 degree.
6. After piping has been positioned, check flanges and connections to mechanical rotating equipment for alignment. Flanges shall be parallel within 1/64-inch per foot of flange diameter and not put any strain on equipment casings.
7. Flex hoses and expansion joints shall be installed straight and without strain or as indicated on the Drawings.
8. No cold springing will be allowed for pipe fit-up.
9. Remove improperly fitted pipe and replace.

I. Valves:

1. In accordance with Section 40 55 00, Power Plant Valves and manufacturer's recommendations.
2. Control valves shall be installed in such a manner that they can be operated from main operating floors or platforms. Use of ladders or special operating devices may be used for valves not normally operated.
3. Valves shall be installed with all identification tags attached. Tags shall remain attached to the valves permanently.
4. Drawings will normally indicate the position of valve stems on sizes 2 inches and above. Stems shall not be installed in a position below horizontal.

J. Pipe Supports:

1. General:
   a. In accordance with MSS SP-58.
   b. Weld pipe supports to structural steel framing by shielded metal arc method only and in accordance with Section 48 58 68, Welding of Power Plant Piping, and AWS D1.1. Welds shall run parallel to axis of beam span and shall be staggered, with cooling allowed between subsequent deposits.
   c. Make weldments of attachments to piping prior to postweld heat treatment.
   d. Flame cut holes on structural steel and/or base plates is specifically not allowed.

e. Adequate temporary supports shall be installed during erection and testing so as not to overstress tubing, piping, or equipment to which piping is connected.
f. Pipe stanchions:
   1) LB Piping: Stanchion base plates shall sit directly on structural steel members. If required, grating shall be removed and banded.
   2) SB Piping: Stanchion base plates may sit on grating with written approval of Contractor. Stanchions shall not to be welded to grating.
   3) Stanchions shall not to be welded to structural steel unless shown on the Drawings.

K. Flow Nozzles and Orifices:

1. Weld-in type flow nozzles are normally completely assembled and welded by the flow nozzle manufacturer.
2. Each section of piping containing a weld-in type flow nozzle shall indicate the direction of flow and have the flow nozzle number stamped on a steel band securely attached to the pipe.
3. Orifice flanges shall be oriented as shown on the isometric Drawings.
4. Internal surface of welds between orifice flanges and connecting pipe shall be ground smooth.

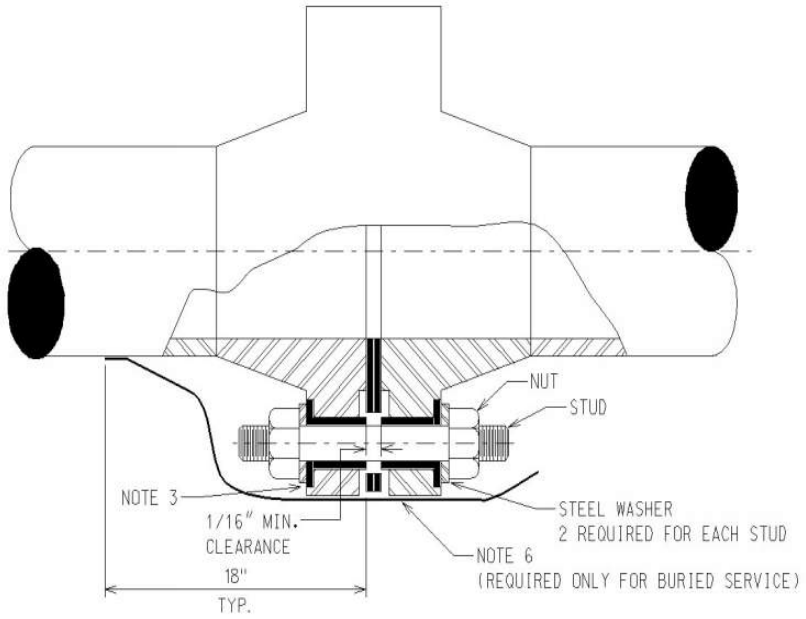
L. Vents and Drains: Supplier shall provide location and/or proximity to other critical elements of high point vents and low point drains in piping systems as required for Supplier-provided equipment.

M. Piping Furnished with Equipment:

1. All piping, valves, and fittings furnished with equipment shall be installed in accordance with the manufacturer’s requirements and this section.
2. In the event of a conflict between the manufacturer’s requirements and the requirements of this section the Engineer shall be notified in writing for resolution of the conflict.

3.05 QUALITY ASSURANCE

A. Welders and welding procedures shall be in accordance with Section 48 58 68, Welding of Power Plant Piping.



NOTES:

1. GASKET SHALL BE OF NON-METALIC OR NON-GRAPHITE-IMPREGNATED MATERIAL. MATERIAL TO BE PHENOLIC LAMINATE AS SUITABLE TO SERVICE TEMPERATURE OF LINE AND THE FLANGE TYPE, PSIPRODUCTS, F. H. MALONEY OR EQUAL.

2. SLEEVES AND WASHERS SHALL BE ONE PIECE OF ACETAL RESIN OR NYLON MATERIAL. USE TWO FOR EACH STUD.

3. REMOVE BURRS OR OTHER FOREIGN PARTICLES FROM FLANGE FACES, BOLT HOLES AND STUDS.

4. FOLLOW MANUFACTURER'S RECOMMENDED PRACTICE FOR INSTALLATION.

5. TEST FLANGE AFTER INSTALLATION AND REPLACE ANY CRACKED SLEEVES OR WASHERS WHICH MAY CAUSE "SHORTING OUT." USE CONTINUITY TESTER, FLASHLIGHT WITH LEADS, ETC.

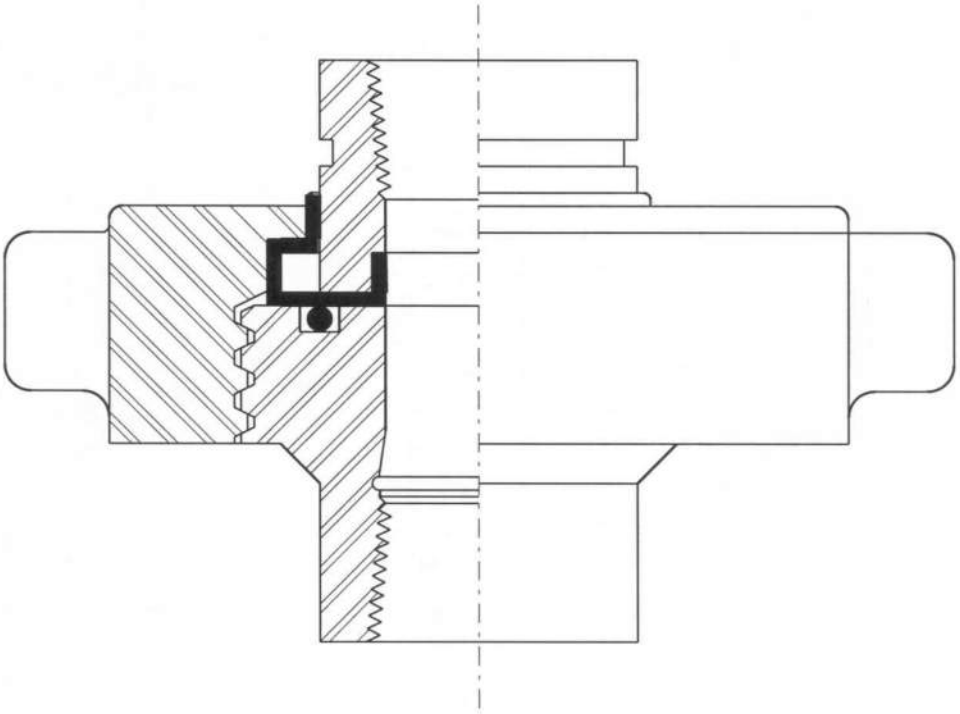
6. AFTER INSTALLATION IS COMPLETE, PRIMER AND THREE WRAPS OF TAPE SHALL BE APPLIED TO FLANGE PERIMETERS AND EXTENDED 18" ON BOTH SIDES OF FLANGES. USE SCOTCHRAP, POLYKEN, OR EQUAL TO MANUFACTURER'S INSTRUCTIONS.

POWER PIPING STANDARD

PP-1
DIELECTRIC FLANGED JOINT

PP1.DGN 1 NONE

WHD 08/16/06
CAJ 08/16/06
SDH 08/16/06
NA / /



POSITIVE PRESSURE SEAL PROVIDED BY "O" RING FOR USE WITH GAS, CRUDE, BRINE, WATER, AIR, AMMONIA AND LUBRICATING OILS - UP TO 275 DEG. F.

SIZES: 1000# CWP OCTAGON NUT
1/2" - 3/4" - 1" - 1 1/4" - 1 1/2" - 2"

SIZES: 3000# CWP HANDLE BAR OR OCTAGON NUT
1/2" - 3/4" - 1" - 1 1/4" - 1 1/2" - 2" - 2 1/2" - 3"

AFTER INSTALLATION IS COMPLETE, PRIMER AND THREE WRAPS OF TAPE SHALL BE APPLIED TO UNION AND EXTENDED 18" ON BOTH SIDES OF UNION. USE SCOTCHRAP, POLYKEN, OR EQUAL TO MANUFACTURER'S INSTRUCTIONS. COATING IS ONLY REQUIRED FOR BURIED SERVICE.

POWER PIPING STANDARD

PP-2
DIELECTRIC THREADED JOINT

PP2.DGN	0	NONE

WHD	11/12/01
SDH	11/12/01
SDH	11/12/01
NA	/ /

END OF SECTION

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SECTION 40 55 00
POWER PLANT VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Specification defines the requirements for the design, fabrication, testing, delivery, and performance of manual and motor operated valves and supplements the Purchase Order.

B. Standard valves consist of ball, butterfly, gate, globe, check and plug valves of cast iron, bronze, carbon steel, stainless steel, alloy steel, or plastic.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section.

1. American National Standards Institute (ANSI): C540, Standard for Power Actuating Devices for Valves and Sluice Gates.
2. American Petroleum Institute (API):
   a. 594, Check Valves: Wafer, Wafer-Lug, and Double Flanged Type.
   b. 598, Valve Inspection and Testing.
   c. 599, Metal Plug Valves - Flanged and Welding Ends.
   d. 602, Compact Steel Gate Valves - Flanged, Threaded, Welding, and Extended-Body Ends.
   e. 607, Fire Test for Soft-Seated Quarter-Turn Valves.
   f. 609, Butterfly Valves; Double-Flanged, Lug- and Wafer-Type.
3. American Society of Mechanical Engineers (ASME):
   a. B1.1, Unified Inch Screw Threads.
   b. B1.20.1, Pipe Threads General Purpose.
   c. B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. B16.5, Pipe Flanges and Flanged Fittings.
   e. B16.10, Face-to-Face and End-to-End Dimensions of Valves.
   f. B16.11, Forged Fittings, Socket-Welding and Threaded.
   g. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   h. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings.
   i. B16.25, Buttwelding Ends.
   j. B16.34, Valves, Flanged, Threaded, and End.
   k. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings.
   l. B31.1, Power Piping.
   m. BPVC Section I, Rules for Construction of Power Boilers.
   n. SA-105/SA-105M, Standard Specification for Carbon Steel Forgings for Piping Applications.

o. SA-182/SA-182M, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
p. SA-193/SA-193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
q. SA-194/SA-194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
r. SA-216/SA-216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
s. SA-276, Standard Specification for Stainless Steel Bars and Shapes.
t. SA-307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
u. SA-395/SA-395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
v. SA-479/SA-479M, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
w. SA-703/SA-703M, Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts.
x. SA-961/SA-961M, Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications.
y. SA-985/SA-985M, Standard Specification for Steel Investment Castings, General Requirements, for Pressure-Containing Parts.

4. ASTM International (ASTM):
   a. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   c. A182/A182M, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   d. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   f. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   g. A276, Standard Specification for Stainless Steel Bars and Shapes.
   h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   i. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   j. A479/A479M, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   k. A703/A703M, Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts.

l. A961/A961M, Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications.
m. A985/A985M, Standard Specification for Steel Investment Castings, General Requirements, for Pressure-Containing Parts.
n. B61, Standard Specification for Steam or Valve Bronze Castings.
o. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
p. B117, Salt Spray Test.
q. B164, Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
r. B283, Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).

5. American Water Works Association (AWWA):
   a. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 Inches Through 144 Inches.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C508, Swing-Check Valves for Waterworks Service, 2 Inches through 24 Inches.
   d. C509, Resilient-Seated Gate Valves for Water Supply Service.
6. Factory Mutual (FM).
7. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions.
   b. SP-45, Bypass and Drain Connections.
   c. SP-55, Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components.
   d. SP-61, Pressure Testing of Steel Valves.
   e. SP-67, Butterfly Valves.
   f. SP-68, High Pressure - Offset Seat Butterfly Valves.
   g. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
   h. SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
   i. SP-72, Ball Valves with Flanged or Butt-Welding Ends for General Service.
   j. SP-78, Cast Iron Plug Valves, Flanged and Threaded Ends.
   k. SP-80, Bronze Gate, Globe, Angle and Check Valves.
   l. SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.
   m. SP-91, Guidelines for Manual Operation of Valves.
   n. SP-102, Multi-turn Valve Actuator Attachment – Flange and Driving Component Dimensions and Performance Characteristics.
   o. SP-105, Instrument Valves for Code Applications.
8. UL.

1.03 REFERENCE SPECIFICATIONS

A. The following documents are included for reference and form an integral part of this Specification.

1. Section 01 33 00, Submittal Procedures.
2. Section 01 61 00, Common Product Requirements.

1.04 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Informational Submittals:

1. Shop Drawings: Provide for each type and size of valve:
   a. Complete descriptive literature, including operating and design pressures/temperatures, dimensions, maintenance pull space requirements, any limitations on valve mounting position, weights and center of gravity, bevel detail of butt weld end connection, materials of construction, recommendations for field welding, packing torque requirements, and post weld heat treatment of valves, and options.
   b. Recommended spare parts if disassembly for post weld heat treatment is required for installation, with unit prices.
   c. Recommended spare parts for 1 year's operation with unit prices.
      1) Recommended spare parts if disassembly for post weld heat treatment is required for installation.
      2) Recommended spare parts for construction, commissioning and startup.
   d. For motor operated valves (in addition):
      1) Principal dimensions, incoming power, general construction, and outline of the actuator mechanism.
      2) Operating Characteristics:
         a) Output torque or thrust.
         b) Voltage and frequency.
         c) Number of phases.
         d) Nominal power at running torque.
         e) Nominal power at locked rotor.
         f) Current at running torque.
         g) Current at locked rotor.
         h) Speed or travel time.
      3) Actuator options being supplied.
      4) Electrical wiring diagrams with list of symbols.
2. Inspection and Test Plan (ITP).
3. Operation and Maintenance Manuals.

4. Certified Material Test Report (CMTR):
    a. For carbon steel valves Class 300 and higher.
    b. Furnish for both body and bonnet material.
    c. Signed by manager of valve manufacturer's quality control department and shall show the name of supplier, name of prime material manufacturer and plant location, purchase order number, actual test results of chemical analysis and mechanical properties in accordance with the material specification, and Buyer's project number.
5. Certificate of Compliance (COC):
    a. Required for valves not covered by CMTR.
    b. Furnish for both body and bonnet material.
    c. Certify that valve is new and complies with requirements of this Specification.
    d. Certifies manufacturing standard that applies to valve.
    e. Signed by manager of valve manufacturer's quality control department and shall show the name of supplier, name of prime material manufacturer and plant location, purchase order number, actual test results of chemical analysis and mechanical properties in accordance with the material specification, and Buyer's project number.
6. Certified Test Report: Furnish for valves in Class 300 and higher.
7. Erection and installation instructions, including specific welding procedures.
8. Hydrotest Certification.
9. Inspection records.
10. Repair records complete with inspection and welding procedures and qualifications.
11. Motor Operated Valve (in addition):
    a. Manufacturer's test reports for the following:
        1) Voltage, phase, and frequency.
        2) Stroke time (seconds).
        3) Seating (or maximum dynamic) torque.
        4) Seating load amps.
        5) Torque-switch and limit-switch function.
    b. AC motor data sheet.
    c. Wiring diagram and field connections.
    d. Electrical requirements – volts, phase, amps, kW.
    e. Utility requirements (air, water, steam and other utilities).
12. Performance curves (include Cv).
13. Bill of materials (with Supplier and part numbers).

1.05 MARKING AND IDENTIFICATION

A. Equipment numbering shall be as generally defined in Section 01 58 53, Project Equipment Identification with equipment unique identification requirements defined herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Division 01, General Requirements.

B. Shipping:

1. When items are shipped in containers, identify each container with at least manufacturer's name, material description, size, purchase order number, valve data sheet/commodity code and applicable valve tag number.
2. The ends of all valves shall be sealed to prevent entry of foreign materials.
3. Protect flange faces and butt weld ends with wood, wood fiber, or plastic covers.
4. Close female threaded and socket weld openings with plastic or metal plugs.
5. All entrances to internal wiring shall be protected to prevent entrance of moisture, dust, dirt, and other deleterious material.
6. Drain unit of liquid prior to shipment.
7. Unit shall be disassembled only to such extent as may be necessary to facilitate field handling and to prevent damage during shipment.
8. Loose components shall be strung on wire and securely attached to valve or be furnished in a box.
9. Ship metal seated valves in closed position.
10. Ship resilient seated valves in open position.
11. Metal seated swing check valves shall be blocked closed and furnished with instructions (attached to valve) to remove blocking before installation.
12. Valves for chlorine service shall be individually packaged with desiccant in clear polyethylene bags or Buyer approved substitute.

C. Identify shipping boxes by Purchase Order number, Owner's name, Buyer's name, Project name, Project location, equipment number, and description of contents. Use ink, paint, or other indelible material markings. Securely affix a copy of the completed packing list to each separate shipping package.

D. Storage: Protect valves to withstand at least 6 months of unsheltered storage at jobsite before installation.

1.07 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.08 WARRANTY AND GUARANTEES

A. Furnish Manufacturer's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 SITE CONDITIONS

A. The site location and conditions for the equipment specified herein are provided in Division 1, General Requirements.

2.02 COMPONENTS

A. Valve Data Sheets: See supplemental information attached at end of section.

B. Valves:

1. General:
   a. Valves and accessories shall conform to the applicable Valve Data Sheet, and requirements of this Specification.
   b. Valve List specifies quantity, size, type of valve, and accessories.
   c. Valve Data Sheets specify pressure rating, end connection, and materials for each type of valve.
   d. Valves shall be new and shall not contain asbestos materials (e.g., bonnet gaskets, stem packing).

e. Butt Weld Ends:
    1) Beveled in accordance with ASME B16.25.
    2) Bored to match pipe schedule specified on Valve Data Sheet.
    3) Schedule bore ends for carbon steel shall be beveled in accordance with ASME B16.25 Fig. 2(a).
    4) Backing rings are prohibited.

2. Valve Accessories: Accessories shall be manufacturer's standard, unless otherwise specified herein, and shall consist of but not be limited to, the following:
    a. Chain Wheels and Chain:
        1) High quality malleable iron designed so chain has positive grip on wheel at all times.
        2) Complete unit shall be suitable for specified operating conditions.
        3) Chain wheel operated valves, without gear operators, shall be furnished complete with impact wheel type operator.
        4) Complete with chain guides and nonrusting chain.
        5) Chain shall be forged link construction. Chain lengths, when specified, are given in feet in continuous chain.
    b. Drain Connections: Size for each valve in accordance with MSS-SP-45 and shall be plugged.
    c. Bypasses:
        1) Size in accordance with Series A of MSS-SP-45.
        2) Include bypass valve and pipe.
3. Valve Operators:
    a. General:
        1) As specified on Valve Data Sheet.
        2) Shall provide external indication of disc position and open counterclockwise.
        3) Input force shall be in accordance with MSS SP-91 and at no time shall the required rim force exceed 160 pounds. Each operator shall transmit the torque required to seat or unseat the valve against the maximum differential pressure. The maximum differential pressure shall be the design pressure on the Line List.
    b. Gear Operators:
        1) Gear operators shall be manufacturer's standard design and materials for type of valve specified herein.
        2) Orientation will be determined by Buyer after receipt of Supplier's drawings.
        3) Worm gear type for quarter turn valves.
        4) Totally enclosed grease packed and sealed gear case.
        5) Self-locking type to a hold a position with a locking stem thread on the valve.
        6) Provide with handwheel and provision for air wrench operation.

c. Worm Gear Operators: Shall be heavy duty weatherproof industrial type with high strength cast iron or steel housing, hardened steel gears, valve position indicator and travel stops.
d. Bevel Gear Operators: Shall be totally enclosed type with hardened gears and sealed bearings, pinion drive shaft keyed to handwheel, air wrench drive attachment, metal can type stem protector (if not already protected by actuator, pipe nipples and caps, or indicator), and stainless steel indicator.
e. Manual Operation:
1) Multi-turn valves shall have provision for operation with portable air wrenches.
2) Orientation of the handwheel axis of the manual operator shall be such as to permit easy and safe access for operation.
3) Direction of rotation to close the valve shall be clearly marked on the face of each handwheel.
4) Mechanical position indicator shall be integrally mounted on each manual gear operator.

4. Adjustable Limit Switches:
a. NAMCO snap action switches for manually operated valves.
b. Enclosure:
1) Clean Dry Locations: NEMA 12.
2) Normally Wet or Damp Locations: NEMA 4X.
3) Outdoor Locations: NEMA 4X.
4) Corrosive Environment; NEMA 4X.
c. Devices that interface with Buyer's equipment shall have the following minimum contact ratings:
1) ac: NEMA A300 rated, Form C contacts suitable for 300V ac, 10 amperes continuous, 60 amperes make, 6 amperes break at 120V ac. These ratings are based on inductive loads.
2) dc: NEMA P300 rated, Form C contacts suitable for 125V dc, 5 amperes continuous, 1.1 amperes make or break at 125V dc.

5. Locking Devices:
a. Allows valve to be locked open or closed with standard padlock.
b. Permanent and integral part of handwheel and yoke or lever.

6. Extension Stems: Complete with required couplings, universal joints, supporting brackets, and extra strong pipe stems.
7. Floor Stands and Indicators: Manufacturer's standard.

C. Factory Finish:

1. Surface Preparation:
a. Shall be painted in accordance with manufacturer's standard practice.
b. Nameplates, identification tags, machined mating surfaces, and stainless steel material shall not be painted.
c. Stem of rising stem valves and exposed threads shall be coated with antiseize lubricant.

2.03 SPECIAL TOOLS

A. If required, manufacturer shall quote and provide one complete set of special tools required for installation and adjustment of the valves and operators.

2.04 SOURCE QUALITY CONTROL

A. Valves and appurtenances shall be products of well-established firms who are fully experienced, minimum five years, reputable and qualified in the manufacture of the particular equipment to be furnished.

B. Where practical, valves of the same type shall be identical, and the product of one Manufacturer, varying only with size. Exception to this requirement may be taken when the Manufacturer's standard product line does not include all necessary sizes.

C. Tests:

1. Manufacturer shall perform nondestructive examination (NDE) of all buttweld ends. The type of NDE performed shall be in accordance with the buttweld requirements of Table 136.4 of ASME B31.1. All NDE procedures and acceptance criteria shall in be accordance with ASME B16.34.
2. Each metallic valve shall have both its shell and seat pressure tested in accordance with applicable manufacturing standard.
3. Hydrostatic seat test for gear operated valves shall be performed on completely assembled valve with seat closed by applicable manual gear or motor operator.
4. Valves manufactured in accordance with API Standards shall be seat tested with high-pressure closure test per API 598.
5. Valves pressure rated in accordance with ASME B16.34 shall meet seat leakage requirements of MSS SP-61.
6. Hydrostatic seat closure test is required for carbon steel and stainless steel valves.
7. If bypass is required to be furnished, then bypass shall be welded to main valve and hydrostatically tested to prove that piping and bypass valve will withstand pressure not less than 150 percent of main valve's 100 degrees F pressure rating.
8. Each completed electric motor operated valve assembly shall be cycled from full open to full closed and back to full open for verification of limit and torque switch function and setting, and ability of motor operator to open and close valve after seat leakage test has been performed.

D. Inspection: Owner shall have right to inspect at any stage of fabrication equipment, materials, and associated QA/QC documentation covered by this Specification including Suborder(s). Contractor shall include this notation on any Suborder(s).

E. Repair and Restoration:

1. Repair defects in body of cast or forged carbon, alloy, and stainless steel valves by applicable manufacturing standard.
2. Retest repaired valves.
3. Repair of body defects in cast iron, bronze, and nonmetallic valves is not permitted.
4. Buyer reserves right to reject any valve with weld repairs.

F. Inspection and Test Plan (ITP): Manufacturer shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner 3 weeks (or as otherwise specified) prior to testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. All valves shall be installed in strict accordance with Manufacturer's instructions.
2. If handwheel orientation is not shown on the Drawings, valve stems shall be in vertical position.
3. Assemble valve operator to valve such that the manual hand-wheel and electrical indicators and pushbuttons are accessible.

B. Butterfly Valves:

1. Separate mating flanges for resilient seat butterfly valves sufficiently so valves do not have to be wedged or forced into position.
2. Set discs in open position prior to tightening mating flange bolting.
3. Operate valve through entire open/ close cycle after tightening of bolts. Verify that disc or seat has not been jammed or damaged.

C. Check Valves

1. Tag to indicate whether internals have been removed, jacked open, or left unaltered.
2. Bag internal parts that have been removed, tag with valve number, and securely attach bag to appropriate valve.

D. Lubricated Plug Valves: Lubricate with sealant appropriate for service.

3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Valve Index and Data Sheets.

END OF SECTION

SECTION 40 55 00
POWER PLANT VALVES
VALVE INDEX AND DATA SHEETS

Valve Data Sheet	Description	Rev	Date
VBAC03	Ball, std, CL 150, RF, CS, fire safe	0	06/04/21
VBAC04	Ball, std, CL 150, RF, GO, CS, fire safe	0	06/04/21
VBBC01	Ball, std, CL 300, RF, CS, fire safe	0	06/04/21
VBBC02	Ball, std, CL 300, RF, GO, CS, fire safe	0	06/04/21
VBDC03	Ball, full port, CL 600, SW, CS, fire safe	0	06/04/21
VBDC04	Ball, full port, CL 600, SW x FNPT, CS, fire safe	0	06/04/21
VBDN02	Ball, CL 600, SW, SS	0	06/04/21
VBDN03	Ball, CL 600, SW X FNPT, SS	0	06/04/21
VBQB05	Ball, 400 psig (CWP), TE, bronze	0	06/04/21
VBUN01	Ball, 1500 psig, tube fitting, SS	0	06/04/21
VCAC01	Check, swing, CL 150, RF, CS	0	06/04/21
VCAC03	Check, wafer, CL 150, CS	0	06/04/21
VCBC02	Check, swing, CL 300, RF, CS	0	06/04/21
VCBC03	Check, wafer, CL 300, CS	0	06/04/21
VCBC05	Check, swing, CL 300, RF, CS, BPVC SEC II	0	06/04/21
VCNE01	Check, wafer, CL 150, CS	0	06/04/21
VCQB02	Check, swing, CL125, TE, bronze	0	06/04/21
VCSC01	Check, piston, CL 800, SW, CS	0	06/04/21
VCSC02	Check, swing, CL 800, SW, CS	0	06/04/21
VCSC03	Check, piston, CL 800, SW, CS, BPVC SEC II	0	06/04/21
VCSN01	Check, piston, CL 800, SW, SS	0	06/04/21
VCVN01	Check, poppet, 2000 psig, tube fitting, SS	0	06/04/21
VFAC01	Butterfly, Wafer, CL 150, GO, CS	0	06/04/21
VFBC01	Butterfly, Wafer, CL 300, GO, CS (Note 1)	0	06/04/21
VFBC02	Butterfly, Wafer, CL 300, GO, CS, BPVC SEC II (Note 1)	0	06/04/21
VFNE01	Butterfly, Lug, CL 125, DI	0	06/04/21

Valve Data Sheet	Description	Rev	Date
VFNE02	Butterfly, Lug, CL 125, GO, DI	0	06/04/21
VGAC03	Gate, CL 150, RF, CS	0	06/04/21
VGAC04	Gate, CL 150, RF, GO, CS	0	06/04/21
VGBC03	Gate, CL 300, RF, CS	0	06/04/21
VGBC04	Gate, CL 300, RF, GO, CS	0	06/04/21
VGBC07	Gate, CL 300, RF, CS, BPVC SEC II	0	06/04/21
VGBC08	Gate, CL 300, RF, GO, CS, BPVC SEC II	0	06/04/21
VGSC01	Gate, CL 800, SW, CS	0	06/04/21
VGSC02	Gate, CL 800, SW X FNPT, CS	0	06/04/21
VGSC03	Gate, CL 800, SW, CS, BPVC SEC II	0	06/04/21
VGSC04	Gate, CL 800, SW X FNPT, CS, BPVC SEC II	0	06/04/21
VLAC02	Globe, CL 150, RF, CS	0	06/04/21
VLBC02	Globe, CL 300, RF, CS	0	06/04/21
VLBC04	Globe, CL 300, RF, CS, BPVC SEC II	0	06/04/21
VLNB01	Globe, CL 125, FF, CI	0	06/04/21
VLNB02	Globe, CL 125, FF, GO, CI	0	06/04/21
VLRB01	Globe, CL 125, TE, bronze	0	06/04/21
VLSC01	Globe, CL 800, SW, CS	0	06/04/21
VLSC02	Globe, CL 800, SW X FNPT, CS	0	06/04/21
VLSC03	Globe, CL 800, SW, CS, BPVC SEC II	0	06/04/21
VLSN01	Globe, CL 800, SW, SS	0	06/04/21

Notes:

1. Lug type valves are an acceptable alternate and may be preferred for Contractor's startup and commissioning activities. Contractor and Seller to confirm end connection prior to purchase order.

SECTION 40 55 00 VALVE DATA SHEET VBAC03	
Item	**Description**
Type	Ball, Regular Port, Trunnion (Fire Safe, Note 1).
Rating	Class 150.
Standards	ASME B16.34, ASME B16.10, API 607.
Ends	Flanged, Class 150RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A105/A105M or A216/A216M, Grade WCB.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B7
Ball	Type 316 Stainless Steel.
Seat	Reinforced Teflon.
Stem Type/Material	Trunnion, Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Flexible Graphite.
Operator	Lever.
Size	3” – 4”

Notes:
1. Valve, seat, and stem packing shall incorporate anti-static design, which is suitable for natural gas service.

SECTION 40 55 00 VALVE DATA SHEET VBAC04	
Item	**Description**
Type	Ball, Regular Port, Trunnion (Fire Safe, Note 1).
Rating	Class 150.
Standards	ASME B16.34, ASME B16.10, API 607.
Ends	Flanged, Class 150RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A105/A105M or A216/A216M, Grade WCB.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B7
Ball	Type 316 Stainless Steel.
Seat	Reinforced Teflon.
Stem Type/Material	Trunnion, Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Flexible Graphite.
Operator	Enclosed Gear Operator.
Size	6” – 10”

Notes:
1. Valve, seat, and stem packing shall incorporate anti-static design, which is suitable for natural gas service.

SECTION 40 55 00 VALVE DATA SHEET VBBC01	
Item	**Description**
Type	Ball, Regular Port, Trunnion (Fire Safe, Note 1).
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10, API 607.
Ends	Flanged, Class 300RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A105/A105M or ASTM A216/A216M, Grade WCB.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B7.
Ball	Type 316 Stainless Steel.
Seat	Reinforced Teflon.
Stem Type/Material	Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Flexible Graphite.
Operator	Lever.
Size	3" – 4”

Notes:
1. Valve, seat, and stem packing shall incorporate anti-static design, which is suitable for natural gas service.

SECTION 40 55 00 VALVE DATA SHEET VBBC02	
Item	**Description**
Type	Ball, Regular Port, Trunnion (Fire Safe, Note 1).
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10, Short Pattern, API 607.
Ends	Flanged, Class 300RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A105/A105M or ASTM A216/A216M, Grade WCB.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B7.
Ball	Type 316 Stainless Steel.
Seat	Reinforced Teflon.
Stem Type/Material	Trunnion, Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Flexible Graphite.
Operator	Enclosed Gear.
Size	6" – 10”

Notes:
1. Valve, seat, and stem packing shall incorporate anti-static design, which is suitable for natural gas service.

SECTION 40 55 00 VALVE DATA SHEET VBDC03	
Item	**Description**
Type	Ball, Full Port, 3-Piece Swing Away (Fire Safe, Note 1).
Rating	Class 600.
Standards	ASME B16.34, API 607.
Ends	Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASTM A105/A105M or A216/A216M, Grade WCB.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B7.
Ball	Type 316 Stainless Steel.
Seat	Reinforced Teflon.
Stem Type/Material	Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Flexible Graphite.
Operator	Lever.
Size	1/2" – 2”

Notes:
1. Valve, seat, and stem packing shall incorporate anti-static design, which is suitable for natural gas service.

SECTION 40 55 00 VALVE DATA SHEET VBDC04	
Item	**Description**
Type	Ball, Full Port, 3-Piece Swing Away (Fire Safe, Note 1).
Rating	Class 600.
Standards	ASME B16.34, API 607.
Ends	Socket Weld inlet, ASME B16.11 x Female NPT outlet, ASME B1.20.1.
Body Material	Carbon Steel, ASTM A105/A105M or A216/A216M, Grade WCB.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B7.
Ball	Type 316 Stainless Steel.
Seat	Reinforced Teflon.
Stem Type/Material	Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Flexible Graphite.
Operator	Lever.
Size	1/2" – 2”

Notes:
1. Valve, seat, and stem packing shall incorporate anti-static design, which is suitable for natural gas service.

SECTION 40 55 00 VALVE DATA SHEET VBDN02	
Item	**Description**
Type	Ball, Full Port, 3-Piece Swing Away.
Rating	Class 600.
Standards	ASME B16.34.
Ends	Socket Weld, ASME B16.11.
Body Material	Stainless Steel, ASTM A351/ A351M, Grade CF8M.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B8M.
Ball	Type 316 Stainless Steel.
Seat	PEEK.
Stem Type/Material	Type 316 Stainless Steel, ASTM A276/A276M.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Graphite.
Operator	Lever.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VBDN03	
Item	**Description**
Type	Ball, Full Port, 3-Piece Swing Away.
Rating	Class 600.
Standards	ASME B16.34.
Ends	Socket Weld inlet, ASME B16.11 x Female NPT outlet, ASME B1.20.1.
Body Material	Stainless Steel, ASTM A351/ A351M, Grade CF8M.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M, Grade B8M.
Ball	Type 316 Stainless Steel.
Seat	PEEK.
Stem Type/Material	Type 316 Stainless Steel.
Stem Packing/Seals	Flexible Graphite.
Body Gasket/Seals	Graphite.
Operator	Lever.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VBQB05	
Item	**Description**
Type	Ball.
Rating	400 psig (CWP), 125 psig (SWP).
Standards	Manufacturer's Standard.
Ends	Female Thread, ASME B1.20.1, NPT.
Body Material	Bronze.
Ball	Brass (Chrome Plated).
Seat	PTFE.
Stem Type/Material	Brass.
Stem Packing/Seals	RPTFE.
Operator	Lever.
Size	1/2" – 2"

SECTION 40 55 00 VALVE DATA SHEET VBUN01	
Item	**Description**
Type	Ball, 2-way
Rating	1500 psig @ 100F, 800 psig @ 300F (Swagelok).
Standards	ASME B16.34.
Ends	Tube Fitting
Body Material	Stainless Steel, ASTM A351/A351M, Grade CF3M.
Bonnet Type & Material	N/A.
Bolting	ASTM A193/A193M Grade B8M, ASTM A194/A194M Grade 8M
Ball	Type 316 Stainless Steel, ASTM A276/A276M**.**
Seat	PTFE.
Stem Type/Material	Type 316 Stainless Steel, ASTM A276/A276M**.**
Stem Packing/Seals	PTFE.
Body Gasket/Seals	N/A.
Operator	Lever.
Size	1/4” – 1”

SECTION 40 55 00 VALVE DATA SHEET VCAC01	
Item	**Description**
Type	Check, Swing.
Rating	Class 150.
Standards	ASME B16.34, ASME B16.10.
Ends	Flanged, Class 150 RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Grade WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Grade WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	13CR.
Seat	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	N/A.
Stem Packing/Seals	N/A.
Body Gasket/Seals	Nonasbestos.
Operator	N/A.
Size	2 1/2” – 24”

SECTION 40 55 00 VALVE DATA SHEET VCAC03	
Item	**Description**
Type	Check, Wafer.
Rating	Class 150.
Standards	ASME B16.34, API Std. 594.
Ends	Serrated Facing to Fit between Class 150 RF, ASME B16.5 Flanges.
Body Material	Carbon Steel, ASTM A216/A216M, Grade WCB.
Spring	Type 316 Stainless Steel.
Disc	Split, Type 316 Stainless Steel.
Seat	TFE Neoprene
Stem Type/Material	N/A.
Stem Packing/Seals	N/A.
Body Gasket/Seals	N/A.
Operator	N/A.
Size	3” – 6”
Type	Check, Wafer.

SECTION 40 55 00 VALVE DATA SHEET VCBC02	
Item	**Description**
Type	Check, Swing.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10.
Ends	Flanged, Class 300RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Grade WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Grade WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	13CR.
Seat	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	N/A.
Stem Packing/Seals	N/A.
Body Gasket/Seals	Nonasbestos.
Operator	N/A.
Size	2 1/2” – 16”

SECTION 40 55 00 VALVE DATA SHEET VCBC03	
Item	**Description**
Type	Check, Wafer.
Rating	Class 300.
Standards	ASME B16.34, API Std. 594.
Ends	Serrated Facing to Fit between Class 300 RF, ASME B16.5 Flanges.
Body Material	Carbon Steel, ASTM A216/A216M, Grade WCB.
Spring	Type 316 Stainless Steel.
Disc	Split, Type 316 Stainless Steel.
Seat	TFE Neoprene
Stem Type/Material	N/A.
Stem Packing/Seals	N/A.
Body Gasket/Seals	N/A.
Operator	N/A.
Size	3” – 6”
Type	Check, Wafer.

SECTION 40 55 00 VALVE DATA SHEET VCBC05	
Item	**Description**
Type	Check, Swing.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10.
Ends	Flanged, Class 300RF, ASME B16.5.
Body Material	Carbon Steel, ASME SA-216/SA-216M, Grade WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-216/SA-216M, Grade WCB.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	13CR.
Seat	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	N/A.
Stem Packing/Seals	N/A.
Body Gasket/Seals	Nonasbestos.
Operator	N/A.
Size	2 1/2” – 16”

SECTION 40 55 00 VALVE DATA SHEET VCNE01	
Item	**Description**
Type	Check, Wafer.
Rating	Class 150.
Standards	API Std. 594 (Note 1).
Ends	Installed Between Class 125 FF, ASME B16.1 or Class 150 FF ASME B16.5 Flanges (Note 3).
Body Material	Carbon Steel, ASTM A216 WCB. (Note 4)
Bolting	ASTM A193/A193M, Grade B7.
Disc	(Split) ASTM A216 WCB + 13% Cr Facing (Type 316 Stainless Steel Spring or equal) (Note 2).
Seat	Buna-N.
Body Gasket/Seals	Nonasbestos.
Size	3" – 48"

Notes:
1. Each manufacturer must state (when quoting) that either all valves comply with API Std. 594 dimensions or specifically list those sizes that do not comply.
2. Either stainless steel or aluminum bronze are acceptable alternates.
3. Flange drilling of NPS 26 inches and larger shall be per AWWA C207, Class D.
4. Retainerless body design with no external body penetrations eliminating the possibility of outside leakage.

SECTION 40 55 00 VALVE DATA SHEET VCQB02	
Item	**Description**
Type	Check, Swing (Y-Pattern).
Rating	Class 125, 200 psig (CWP) and 125 psig (SWP)
Standards	MSS SP-80.
Ends	Threaded, ASME B1.20.1, NPT.
Body Material	Bronze.
Bonnet Type & Material	Threaded Cap, Bronze.
Disc	Bronze, Renewable.
Seat	Bronze, Integral.
Body Gasket/Seals	Nonasbestos.
Size	1/2" – 2”

Notes:

1. Do not use in reciprocating services.

SECTION 40 55 00 VALVE DATA SHEET VCSC01	
Item	**Description**
Type	Check, Piston (Spring Actuated).
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASTM A105/A105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A105/A105M.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Hardfaced, Stellite or Approved Substitute (Fully Guided).
Seat	Integral, Hardfaced, Stellite or Approved Substitute.
Trim	13 CR (302 SS Spring).
Body Gasket	Nonasbestos.
Operator	N/A.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VCSC02	
Item	**Description**
Type	Check, Swing
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASTM A105/A105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A105/A105M.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Hardfaced, Stellite or Approved Substitute (Fully Guided).
Seat	Integral, Hardfaced, Stellite or Approved Substitute.
Trim	13 CR
Body Gasket	Nonasbestos.
Operator	N/A.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VCSC03	
Item	**Description**
Type	Check, Piston (Spring Actuated).
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASME SA-105/SA-105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-105/SA-105M.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	Hardfaced, Stellite or Approved Substitute (Fully Guided).
Seat	Integral, Hardfaced, Stellite or Approved Substitute.
Trim	13 CR (302 SS Spring).
Body Gasket	Nonasbestos.
Operator	N/A.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VCSN01	
Item	**Description**
Type	Check, Piston (Spring Actuated).
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld, ASME B16.11.
Body Material	Stainless Steel, ASTM A182/A182M, Grade F316.
Bonnet Type & Material	Bolted, Stainless Steel, ASTM A182/A182M, Grade F316.
Bolting	ASTM A193/A193M, Grade B8 or B8M.
Disc	13CR.
Seat	Integral, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	N/A.
Stem Packing/Seals	N/A.
Body Gasket	Nonasbestos, Spiral-sound 304 SS with Grafoil, or Graphite.
Operator	N/A.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VCVN01	
Item	**Description**
Type	Check, Poppet.
Rating	1500 @ 100 Degrees F, 1545 psig @ 300 Degrees F (Swagelok).
Standards	Manufacturer's Standard.
Ends	Tube Fitting.
Body Material	316 SS.
Bonnet Type & Material	N/A.
Bolting	N/A.
Body Gasket	PTFE coated 316 SS.
Operator	N/A.
Size	1/4" – 1/2"

SECTION 40 55 00 VALVE DATA SHEET VFAC01	
Item	**Description**
Type	Butterfly, Metal Seated.
Rating	ASME B16.34 Class 150.
Standards	MSS SP-67, Narrow Body Dimensions (Note 1 and 2). API Std. 609
Ends	Serrated Facing to Fit between Class 150 RF WN, ASME B16.5 Flanges.
Body	ASTM A 216 WCB
Bolting	ASTM A193 Grade B7.
Disc	ASTM A216/A216M, Grade WCB, Nickel Plated (ENP)
Stem Type/Material	ASTM A479 Gr. 410 or ASTM A564 Grade 630 (17-4PH)
Seat	Stellite CoCr Alloy Gr. 21
Stem Packing/Seals	Nonasbestos. Duplex & Graphite
Operator	Handwheel with Enclosed Gear Operator.
Size	3" – 16”

Notes:
1. For size 3 inches to 14 inches, each manufacturer must state (when quoting) that either all valves comply with the narrow body face-to-face dimensions of MSS SP-67 or specifically list those sizes that do not comply.
2. For size 16 inches, each manufacturer must state (when quoting) that either all valves comply with the wide body face-to-face dimensions of MSS SP-67 or specifically list those sizes that do not comply.
3. Valves shall provide bi-directional bubble-tight shutoff at full rated pressure.
4. Valves shall have a vertical thrust bearing to support the disc and stem, adjustable packing gland and stem bearings.

SECTION 40 55 00 VALVE DATA SHEET VFBC01	
Item	**Description**
Type	Butterfly, Metal Seated, Tripe Offset
Rating	ASME B16.34 Class 300.
Standards	MSS SP-68
Ends	Serrated Facing to Fit between Class 300 RF WN, ASME B16.5 Flanges. (Note 3)
Body	ASTM A216 WCB
Bolting	ASTM A193 Grade B7.
Disc	ASTM A216/A216M, Grade WCB, Nickel Plated (ENP)
Stem Type/Material	ASTM A479 Gr. 410 or ASTM A564 Grade 630 (17-4PH)
Seat	Stellite CoCr Alloy Gr. 21
Stem Packing/Seals	Nonasbestos. Duplex & Graphite and Live Loaded Packing
Operator	Handwheel with Enclosed Gear Operator.
Size	3" – 16”

Notes:
1. Valves shall provide bi-directional bubble-tight shutoff at full rated pressure.
2. Valves shall have a vertical thrust bearing to support the disc and stem, adjustable packing gland and stem bearings.
3. Lug type valves are an acceptable alternate and may be preferred for Contractor’s start-up and commissioning activities. Contractor and Seller to confirm end connection prior to purchase order.

SECTION 40 55 00 VALVE DATA SHEET VFBC02	
Item	**Description**
Type	Butterfly, Metal Seated, Tripe Offset
Rating	ASME B16.34 Class 300.
Standards	MSS SP-68
Ends	Serrated Facing to Fit between Class 300 RF WN, ASME B16.5 Flanges. (Note 3)
Body	ASME SA-216 WCB
Bolting	ASME SA-193 Grade B7.
Disc	ASTM A216/A216M, Grade WCB, Nickel Plated (ENP)
Stem Type/Material	ASTM A479 Gr. 410 or ASTM A564 Grade 630 (17-4PH)
Seat	Stellite CoCr Alloy Gr. 21
Stem Packing/Seals	Nonasbestos. Duplex & Graphite and Live Loaded Packing
Operator	Handwheel with Enclosed Gear Operator.
Size	3" – 16”

Notes:
1. Valves shall provide bi-directional bubble-tight shutoff at full rated pressure.
2. Valves shall have a vertical thrust bearing to support the disc and stem, adjustable packing gland and stem bearings.
3. Lug type valves are an acceptable alternate and may be preferred for Contractor’s start-up and commissioning activities. Contractor and Seller to confirm end connection prior to purchase order.

SECTION 40 55 00 VALVE DATA SHEET VFNE01	
Item	**Description**
Type	Butterfly, Resilient Seated.
Rating	ASME B16.1 Class 125.
Standards	MSS SP-67, Narrow Body Dimensions (Note 1).
Ends	Tapped Lugs ASME B1.1, UNC, to Fit Class 125 ASME B16.1 or Class 150 ASME B16.5 Flanges.
Body	Cast or Ductile Iron.
Bolting	Cap Screws, ASTM A193 Grade B7.
Disc	Nylon 11 Fusion Bonded A536 Ductile Iron, or Approved Substitute.
Stem Type/Material	Stainless Steel.
Seat	EPDM, or Approved Substitute (Note 2).
Stem Packing/Seals	Nonasbestos.
Operator	Lever with Throttling Plate.
Size	3" – 6”

Notes:
1. Each manufacturer must state (when quoting) that either all valves comply with the narrow body face-to-face dimensions of MSS SP-67 or specifically list those sizes that do not comply.
2. The seat shall fully isolate the body and stem from the line media, and shall be field replaceable. No flange gasket required. Consult valve list to determine media and confirm seat material compatibility.
3. Valves shall provide bi-directional bubble-tight shutoff at full rated pressure.
4. Valves shall have a vertical thrust bearing to support the disc and stem, adjustable packing gland and stem bearings.

SECTION 40 55 00 VALVE DATA SHEET VFNE02	
Item	**Description**
Type	Butterfly, Resilient Seated.
Rating	ASME B16.1 Class 125.
Standards	MSS SP-67, Narrow Body Dimensions (Note 1 and 2).
Ends	Tapped Lugs ASME B1.1, UNC, to Fit Class 125 ASME B16.1 or Class 150 ASME B16.5 Flanges.
Body	Cast or Ductile Iron.
Bolting	Cap Screws, ASTM A193 Grade B7.
Disc	Nylon 11 Fusion Bonded A536 Ductile Iron, or Approved Substitute.
Stem Type/Material	Stainless Steel.
Seat	EPDM, or Approved Substitute (Note 3).
Stem Packing/Seals	Nonasbestos.
Operator	Handwheel with Enclosed Gear Operator.
Size	8" – 20”

Notes:
1. For size 8 inches to 16 inches, each manufacturer must state (when quoting) that either all valves comply with the narrow body face-to-face dimensions of MSS SP-67 or specifically list those sizes that do not comply.
2. For size 18 inches to 20 inches, each manufacturer must state (when quoting) that either all valves comply with the wide body face-to-face dimensions of MSS SP-67 or specifically list those sizes that do not comply.
3. The seat shall fully isolate the body and stem from the line media and shall be field replaceable. No flange gasket required. Consult valve list to determine media and confirm seat material compatibility.
4. Valves shall provide bi-directional bubble-tight shutoff at full rated pressure.
5. Valves shall have a vertical thrust bearing to support the disc and stem, adjustable packing gland and stem bearings.

SECTION 40 55 00 VALVE DATA SHEET VGAC03	
Item	**Description**
Type	Gate.
Rating	Class 150.
Standards	ASME B16.34, API Std. 600, ASME B16.10.
Ends	Flanged, Class 150 RF, ASME B16.5
Body Material	Carbon Steel, ASTM A216/A216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Class WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Solid Wedge, 13CR.
Seat	Renewable, Seal Welded, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	2 1/2” – 8”

SECTION 40 55 00 VALVE DATA SHEET VGAC04	
Item	**Description**
Type	Gate.
Rating	Class 150.
Standards	ASME B16.34, API Std. 600, ASME B16.10.
Ends	Flanged, Class 150 RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Class WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Solid Wedge, 13CR.
Seat	Renewable, Seal Welded, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Gear Operator.
Size	10” – 24”

SECTION 40 55 00 VALVE DATA SHEET VGBC03	
Item	**Description**
Type	Gate.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10, API Std. 600.
Ends	Flanged, Class 300 RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Class WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Stem	OS&Y, 13CR.
Seat Type/ Material	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	2 1/2” – 8”

SECTION 40 55 00 VALVE DATA SHEET VGBC04	
Item	**Description**
Type	Gate.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10, API Std. 600.
Ends	Flanged, Class 300 RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Class WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Stem	OS&Y, 13CR.
Seat Type/ Material	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Gear Operator.
Size	10” – 24”

SECTION 40 55 00 VALVE DATA SHEET VGBC07	
Item	**Description**
Type	Gate.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10, API Std. 600.
Ends	Flanged, Class 300 RF, ASME B16.5.
Body Material	Carbon Steel, ASME SA-216/SA-216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-216/SA-216M, Class WCB.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Stem	OS&Y, 13CR.
Seat Type/ Material	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	2 1/2” – 8”

SECTION 40 55 00 VALVE DATA SHEET VGBC08	
Item	**Description**
Type	Gate.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10, API Std. 600.
Ends	Flanged, Class 300 RF, ASME B16.5.
Body Material	Carbon Steel, ASME SA-216/SA-216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-216/SA-216M, Class WCB.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Stem	OS&Y, 13CR.
Seat Type/ Material	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Gear Operator.
Size	10” – 24”

SECTION 40 55 00 VALVE DATA SHEET VGSC01	
Item	**Description**
Type	Gate.
Rating	Class 800
Standards	ASME B16.34, API Std. 602
Ends	Socket Weld, ASME B16.11
Body Material	Carbon Steel, ASTM A105/A105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A105/A105M.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Seat	Renewable, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VGSC02	
Item	**Description**
Type	Gate.
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Threaded, ASME B1.20.1, FNPT x Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASTM A105/A105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A105/A105M.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Seat	Renewable, Hard Faced, Stellite Or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VGSC03	
Item	**Description**
Type	Gate.
Rating	Class 800
Standards	ASME B16.34, API Std. 602
Ends	Socket Weld, ASME B16.11
Body Material	Carbon Steel, ASME SA-105/SA-105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-105/SA-105M.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Seat	Renewable, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VGSC04	
Item	**Description**
Type	Gate.
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Threaded, ASME B1.20.1, FNPT x Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASME SA-105/SA-105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-105/SA-105M.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	Flexible Wedge, 13CR.
Seat	Renewable, Hard Faced, Stellite Or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VLAC02	
Item	**Description**
Type	Globe, Plug Type.
Rating	Class 150.
Standards	ASME B16.34, ASME B16.10.
Ends	Flanged, Class 150 RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Class WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Class WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	13CR.
Seat	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	2 1/2” – 14”

SECTION 40 55 00 VALVE DATA SHEET VLBC02	
Item	**Description**
Type	Globe, Plug Type.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10.
Ends	Flanged, Class 300 RF, ASME B16.5.
Body Material	Carbon Steel, ASTM A216/A216M, Grade WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A216/A216M, Grade WCB.
Bolting	ASTM A193/A193M, Grade B7.
Disc	13CR.
Seat	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	2 1/2” – 12”

SECTION 40 55 00 VALVE DATA SHEET VLBC04	
Item	**Description**
Type	Globe, Plug Type.
Rating	Class 300.
Standards	ASME B16.34, ASME B16.10.
Ends	Flanged, Class 300 RF, ASME B16.5.
Body Material	Carbon Steel, ASME SA-216/SA-216M, Grade WCB.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-216/SA-216M, Grade WCB.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	13CR.
Seat	Renewable, Seal Welded, Hardfaced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Nonasbestos.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	2 1/2” – 12”

SECTION 40 55 00 VALVE DATA SHEET VLNB01	
Item	**Description**
Type	Globe.
Rating	Class 125.
Standards	MSS SP-85, ASME B16.10.
Ends	Flanged, Class 125 FF, ASME B16.1.
Body Material	Cast Iron, ASTM A126/A126M, Class B.
Bonnet Type & Material	Bolted, Cast Iron, ASTM A126/A126M, Class B.
Bolting	ASTM A307, Grade B.
Disc	Bronze, Renewable.
Seat	Bronze, Renewable.
Stem Type/Material	OS&Y, Bronze.
Stem Packing/Seals	Nonasbestos, TFE Impregnated.
Body Gasket/Seals	Nonasbestos.
Operator	Handwheel.
Size	3” – 6”

SECTION 40 55 00 VALVE DATA SHEET VLNB02	
Item	**Description**
Type	Globe.
Rating	Class 125.
Standards	MSS SP-85, ASME B16.10.
Ends	Flanged, Class 125 FF, ASME B16.1.
Body Material	Cast Iron, ASTM A126/A126M, Class B.
Bonnet Type & Material	Bolted, Cast Iron, ASTM A126/A126M, Class B.
Bolting	ASTM A307, Grade B.
Disc	Bronze, Renewable.
Seat	Bronze, Renewable.
Stem Type/Material	OS&Y, Bronze.
Stem Packing/Seals	Nonasbestos, TFE Impregnated.
Body Gasket/Seals	Nonasbestos.
Operator	Enclosed Gear Operator.
Size	8” – 10”

SECTION 40 55 00 VALVE DATA SHEET VLRB01	
Item	**Description**
Type	Globe.
Rating	Class 125, 200 psig (CWP) and 125 psig (SWP)
Standards	MSS SP-80.
Ends	Threaded, ASME B1.20.1, NPT.
Body Material	Bronze ASTM B62.
Bonnet Material	Bronze ASTM B62.
Disc	Renewable.
Seat	Renewable.
Stem Type/Material	Rising, Bronze.
Stem Packing/Seals	Nonasbestos.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VLSC01	
Item	**Description**
Type	Globe, Plug Type.
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASTM A105/A105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A105/A105M.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Renewable, Plug Type, 13CR.
Seat	Integral, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Graphite.
Body Gasket/Seals	Graphite.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VLSC02	
Item	**Description**
Type	Globe.
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld Inlet, ASME B16.11 x FNPT Outlet, ASME B1.20.1.
Body Material	Carbon Steel, ASTM A105/A105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASTM A105/A105M.
Bolting	ASTM A193/A193M, Grade B7.
Disc	Renewable, Plug Type, 13CR.
Seat	Integral, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Graphite.
Body Gasket/Seals	Graphite.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VLSC03	
Item	**Description**
Type	Globe, Plug Type.
Rating	Class 800.
Standards	ASME B16.34, API Std. 602.
Ends	Socket Weld, ASME B16.11.
Body Material	Carbon Steel, ASME SA-105/SA-105M.
Bonnet Type & Material	Bolted, Carbon Steel, ASME SA-105/SA-105M.
Bolting	ASME SA-193/SA-193M, Grade B7.
Disc	Renewable, Plug Type, 13CR.
Seat	Integral, Hard Faced, Stellite or Approved Substitute.
Stem Type/Material	OS&Y, 13CR.
Stem Packing/Seals	Graphite.
Body Gasket/Seals	Graphite.
Operator	Handwheel.
Size	1/2" – 2”

SECTION 40 55 00 VALVE DATA SHEET VLSN01	
Item	**Description**
Type	Globe.
Rating	Class 800.
Standards	API Std. 603.
Ends	Socket Weld, ASME B16.11.
Body Material	Stainless Steel, A182/A182M, Grade F316.
Bonnet Type & Material	Bolted, Stainless Steel, A182/A182M, Grade F316.
Bolting	ASTM A193/A193M, Grade B8.
Disc	Type 316 Stainless Steel, Renewable (Plug Type).
Seat	Type 316 Stainless Steel, Integral.
Stem Type & Material	OS & Y, Type 316 Stainless Steel with Position Indicator.
Stem Packing/Seals	Graphite.
Body Gasket/Seals	Graphite.
Operator	Handwheel.
Size	1/2" – 2”

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SECTION 40 90 00
I&C GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 PURPOSE OF DOCUMENT

A. This Document specifies the engineering and design criteria, I&C General Requirements, pertinent to the Instrumentation and Controls Discipline that are used to develop the Project Engineering design documents (Documents) for the Work.

B. Of emphasis is the principle that the Documents are functional and schematic in nature. Supplier is responsible to prepare detailed as-built drawings based on the equipment selected and provide a completely operational system that meets the requirements of the Documents. Any conflict between the design criteria and the Documents shall be brought to the notice of the Engineer. Engineer's/Owner's decision shall be final and followed by the Supplier for implementation at no extra cost to the Owner.

C. This is a multipurpose Specification that applies to equipment Suppliers and field installation teams. Certain aspects of the Specification may apply only to the field teams (i.e. startup). If questions of applicability arise, request clarification from Engineer.

1.02 APPLICABLE CODES AND STANDARDS

A. The latest edition for all codes and standards referenced in this Specification shall be the edition in effect at the time of Contract award.

B. All control systems and instruments shall be in compliance with the following Codes and Standards, where applicable:

1. American Petroleum Institute (API):
   a. RP 551, Process Measurement Instrumentation.
   b. RP 552, Transmission Systems.
2. American Society of Mechanical Engineers Standard (ASME):
   a. B16.34, Valves-Flanged, Threaded and Welding End.
   b. B16.36, Orifice Flanges.
   c. B31.1, Power Piping.
   d. MFC-3M, Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi.
   e. PTC-6, Steam Turbines.
   f. PTC-19.2, Pressure Measurement Instruments and Apparatus.

g. PTC-19.3, Temperature Measurement Instruments and Apparatus.
h. PTC-19.3 TW, Thermowells.
i. PTC-19.5, Flow Measurement.

3. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A213/213M, Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater and Heat-Exchanger Tubes.
   c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   d. E1137, Standard Specification for Industrial Platinum Resistance Thermometers.
4. Institute of Electrical and Electronics Engineers (IEEE):
   a. 1143, IEEE Guide on Shielding Practice for Low Voltage Cables.
   b. 1050, “Guide for Instrumentation and Control Equipment Grounding in Generating Stations”.
   c. C 37.1, “Standard Definition, Specification and Analysis used for Supervisory Control, Data Acquisition, and Automatic Control”.
   d. C 37.2, “Standard Electric Power System Device Function Numbers and Contact Designations”.
   e. C37.90.1, “Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems”.
5. International Society of Automation (ISA):
   a. MC 96.1, Temperature Measurement Thermocouples.
   b. RP12.4, Pressurized Enclosures.
   c. RP60.3, Human Engineering for Control Centers.
   d. RP60.6, Nameplates, Labels, and Tags for Control Centers.
   e. 7.0.01, Quality Standard for Instrument Air.
   f. 75.01.01, Industrial-Process Control Valves - Part 2-1: Flow capacity - Sizing equations for fluid flow under installed conditions.
   g. 77.70, Fossil Fuel Power Plant Instrument Piping Installation.
   h. ANSI/ISA 5.1, Instrumentation Symbols and Identification.
   i. 12.01.01, Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations.
   j. 12.12.01, Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.
   k. 20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   l. 50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   m. 51.1, Process Instrumentation Terminology.

6. National Electrical Manufacturers Association (NEMA):
   a. ICS-1, Industrial Control and Systems General Requirements.
   b. ICS-4, Terminal Blocks.
   c. ICS-6, Industrial Control and Systems Enclosures.
   d. 250, Enclosures for Electrical Equipment (1,000 Volts Max).
7. National Fire Protection Association (NFPA):
   a. NFPA 70, National Electrical Code.
   b. NFPA 85, Boiler & Combustion Systems Hazards Code.
   c. NFPA 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment.
8. UL:
   a. 508, Standard for the Construction of Industrial Control Panels.
   b. 864, Control Units and Accessories for Fire Alarm Systems.
   c. 1076, Standard for Safety Proprietary Burglar Alarm Units and Systems.
9. All electronic equipment shall conform to the requirements of FCC Regulation Part 5, Section 15, governing radio frequency electromagnetic interference, and shall be so labeled.
10. HART Communication Foundation:
    a. HART Field Communication Protocol Specifications, Revision 7.0.
    b. Wireless WiHART standard HCF_SPEC-290 Revision 1.1.

1.03 DEFINITIONS

1. FDT: Factory Demonstration Test.
2. HMI: Human-Machine Interface.
3. HVAC: Heating, Ventilating, and Air Conditioning.
4. I&C: Instrumentation and Control.
5. I/O: Input and Output.
6. O&M: Operation and Maintenance.
7. P&ID: Process and Instrument Diagram.
8. PC: Personal Computer.
9. PSS: Process SCADA System.
10. PLC: Programmable Logic Controller.
11. RTU: Remote Terminal Unit.
12. SCADA: Supervisory Control and Data Acquisition.
13. SLDC: Single Loop Digital Controller.
14. SSDT: Staging Site Demonstration Test.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

1.04 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
    a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Owner/Engineer accepted procedures, forms, and checklists.
    b. Describe each test item to be performed.
    c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Supplier.
6. Conducting Tests:
    a. Provide special testing materials and equipment.
    b. Wherever possible, perform tests using actual process variables, equipment, and data.
    c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
    d. Define simulation techniques in test procedures.
    e. Test Format: Cause and effect.
        1) Person conducting test initiates an input (cause).
        2) Specific test requirement is satisfied if correct result (effect), occurs.
    f. For PSS systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PSS to ensure it is operational, ready for FDT.
2. Location: PSS System Integrator's facility.
3. Integrated Test:
    a. Interconnect and test PSS, except for primary elements and smaller panels.
    b. Exercise and test functions.
    c. Provide stand-alone testing of smaller panels.
    d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Owner and Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
   a. Test entire PSS, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
      1) Packaged system Suppliers to provide a mockup sample of the PSS software for interface testing. Include the following systems: Gas Turbine, Gas Compression, Balance of Plant Equipment and Water Treatment.
   b. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PSS System Integrator's facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
   a. Simulate each discrete signal at terminal strip.
   b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Operation of communications between the PLC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
   a. One of each type function; for example, if there are pump control sequences for several identical pumps, demonstrate controls for one pump.
   b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
   c. All required and shown functions for 100 percent of loops.
8. Nonloop-Specific Functions:
   a. Capacity: Demonstrate that PSS systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
   b. Timing: Include tests for timing requirements.
   c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. Failed Tests:
    a. Repeat and witnessed by Engineer or Owner's designee.
    b. With approval of Engineer, certain tests may be conducted by PSS System Integrator and witnessed by Engineer as part of Functional Test.

11. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
12. Daily Schedule for FDT:
    a. Begin each day with meeting to review day's test schedule.
    b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

PART 2 EXECUTION

2.01 DESIGN CRITERIA

A. All instrumentation shall be supplied as defined in the Specifications. Only devices that are normally or commonly used in power plant type applications will be approved. Approved Suppliers are identified in Section 40 91 00, Instrumentation and Control Components.

B. Data Sheets shall be provided for all instrumentation and control valves, including items furnished with packaged equipment. These Data Sheets may be Supplier standard but shall contain all the information in ISA-style specification forms, similar to ISA –S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. Supplier shall complete the preliminary data sheets provided in the Contract Documents based on approved Supplier Shop Drawings.

C. All transmitters, switches, pressure relieving devices, and control valves shall be calibrated by the manufacturer or Supplier before the equipment is shipped. Calibration sheets shall be submitted to the Engineers for approval.

D. Transmitters are preferred over switches for most applications. However, where switches are provided because of process or code requirements, they shall be provided with epoxy-coated aluminum or stainless steel enclosure rated NEMA 4X minimum (explosion proof in Class I Div 2 Group D environments), and shall be snap action type with hermetically sealed dual Form C switch dry contacts rated 5A resistive at 120V ac, 0.5A resistive at 125V dc, or 2A resistive at 30V dc. All contacts used with interrogation voltages under 120 Volts shall have gold flashed contacts.

E. For packaged equipment:

1. The equipment supplier shall provide all instrumentation and controls prewired with wiring, raceway, and a junction box or local panel at a single location on the skid battery limit so that all supplier instrumentation and control system field wiring is terminated to one location at the skid limit. All terminations shall be brought to terminal strips including all spares.
2. If a local panel is located exterior to the package battery limit, the Engineers will locate the panel but it shall be the supplier's responsibility to furnish Interconnection Drawings for the wiring between the package unit junction boxes and this local panel.
3. The supplier shall provide instruments mounted, tubed, and wired which:
   a. Are an integral part of the equipment, such as speed governors, overspeed trips, etc.
   b. Require special provisions on the equipment depending on the specific instrument to be used, such as electronic detectors for speed, vibration and axial displacement on running equipment, and thermocouples for bearing metal and thrust pad temperatures.
   c. Are supplied as part of the equipment. This includes anti-surge controls for centrifugal compressors and burner management systems for boilers, fired heaters, flares, etc., and sequencing, monitoring, protection, and regulating control of reciprocating compressors.
   d. Are specified in the Equipment Data Sheets.
   e. Are integral inline instruments including control/regulating valves and pressure relieving devices for Package Units that comprise lube, seal or control oil systems.
   f. Are protected from additional heat input from the sun or from thermal radiation from nearby equipment, as required by the location and ambient conditions, and the instrumentation and control equipment environmental specifications.

B. Analog control instrumentation that interfaces with the main plant control equipment shall use isolated 4-20 mA dc with HART protocol. Equipment supplier shall note on the Data Sheets if an instrument is loop-powered or requires a separate power feed.

C. All process transmitters shall be of the 4 to 20 mA type with HART interface for hand-held calibrators. Transmitters shall be "SMART" electronic, microprocessor based, two-wire type equipped with LED indicators calibrated in process engineering units (pounds/hour, inches, inches H_2O, degree F, psig, etc.). The transmitters shall be custom calibrated and calibration certificates are to be furnished. Each transmitter shall be electronically encoded with the instrument tag number.

D. Local control valves shall be pneumatic unless process conditions dictate otherwise.

E. Filter regulators with output pressure gauge shall be provided for all pneumatically operated control equipment.

F. The plant instrument air supply will be 80 psig minimum and 125 psig maximum. Any pressure reduction below this range is the responsibility of the equipment supplier.

G. Control valve, pressure relief valve, and flow measuring device calculations shall be prepared using customary imperial U.S. Units.

H. All elastomers (liners, gasketing, packing, etc.) and wetted materials are to be compatible with the process service.

I. All electronic instrumentation shall be immune to Radio Frequency Interference (RFI).

J. All control systems shall be designed for safe failure positions in the event of a complete loss of electrical power and/or instrument/plant air systems. All such failures shall generate an alarm contact for use by the Process SCADA System. All valve fail positions shall be noted on P&ID's.

K. At no time shall any voltage in excess of 125V dc or 120V ac, 60-Hz be allowed in any instrument/control systems panel without express written release from the Engineers.

L. Electrical startup/shutdown systems where involved with control systems shall be energized for normal operation and de-energized for shutdown position, unless otherwise specified by the Engineers.

M. The equipment and its installation shall meet with the area electrical classification stated (created by same equipment or external factors) on the Equipment Data Sheets and the Hazardous Area Location Diagrams.

N. Alarm or shutdown actuating transmitters or switches must be separate from any devices used for normal process control.

O. All alarm circuits shall be normally energized, de-energized to trip. Emergency shutdown circuits shall be de-energized to trip where practical. Where energize to trip circuits must be used, each circuit shall be provided with an undervoltage relay. All contacts for generating alarms shall be closed during normal operation and opened on a fault condition.

P. Control switches such as pressure switches having two sets of contacts with independently adjustable settings shall not be used. In lieu of dual type controls, two separate devices shall be provided.

Q. The following voltages will be used for field interrogation and outputs in the Plant Control System:

1. MCC Inputs to the PLC: 120V ac.
2. MCC Outputs from the PLC: 120V ac.
3. Digital Inputs to the PLC: 24V dc.
4. Digital Outputs to Solenoid Valves: 24V dc.
5. Digital Inputs to relay logic systems: 24V dc.
6. Digital Outputs from the PLC: 24V dc (125V dc for electrical protection circuits).
7. Analog Inputs: 24V dc powering 4-20mA signal.
8. Analog Outputs: 24V dc powering 4-20mA signal.

R. Instruments shall not be located in areas where the ambient temperature exceeds 130 degrees F or areas exceeding manufacturers requirements.

S. Instruments shall not be supported on handrails or equipment subject to vibration.

T. Instruments subject to vibration shall be mounted to minimize the effect of vibration. An anti-vibration mount may be used.

U. Fiber optic cable shall be installed and terminated by a licensed Supplier certified in fiber optic installation.

V. Instruments shall be mounted with a clearance of at least 2 feet per 100 degrees F from equipment with surface temperatures in excess of 200 degrees F.

W. Provide minimum 18-inch clearance for worker access around an instrument installation. For specific instrument installation, refer to instrument installation detail Drawings provided. Do not install instrumentation so that it protrudes into walkways.

X. Local instruments shall be mounted no more than 30 feet from the point of measurement without Owner/Engineer’s approval.

Y. If the adjustment of one locally mounted instrument device affects the operating of another (such as local controllers and control valves), the devices shall be mounted so that both devices can be seen at the same time.

Z. Mount instruments so centerline of device is 4 feet 6 inches above the platform or grade.

AA. The connection or welding of instrument supports or brackets to structural steel shall be approved by the Engineer prior to performing the actual work.

BB. Welding on process equipment or process piping shall be approved by the Engineer prior to performing the actual work.

CC. Support and protect capillary tubing of filled and sealed instruments from damage. Do not cut or remove capillary tubing. Any extra length shall be neatly coiled at the instrument end of the tubing.

DD. Materials that are to be attached or clamped to process piping or equipment shall be selected to avoid electrolysis.

EE. Junction boxes shall be mounted in the vertical plane. Tubing and conduit penetrations shall be made in sides or bottom of junction box to prevent water entry. Unused entry holes shall be blanked. Adequate clearance must be provided for door swing.

2.02 FIELD QUALITY CONTROL

A. General:

1. Coordinate PSS testing with Owner and affected Suppliers.
2. Notify Owner/Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Owner/Engineer may actively participate in tests.
4. Owner/Engineer reserves right to test or retest specified functions.
5. Owner/Engineer’s decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PSS System Integrator to observe PSS equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PSS site representative to supervise and coordinate onsite PSS activities.
3. Require PSS site representative to be onsite while onsite work covered by this section and PSS subsystems is in progress.

C. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
3. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

D. Testing:

1. Preparation for Testing: Performed by PSS System Supplier to test and document PSS is ready for operation.
   a. Loop/Component Inspections and Tests:
      1) These inspections and tests do not require witnessing
      2) Check PSS for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
      3) Provide space on forms for signoff by PSS System Supplier.
      4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
         a) Project name.
         b) Loop number.
         c) Tag number for each component.
         d) Checkoffs/Signoffs for Each Component:
            (1) Tag/identification.
            (2) Installation.
            (3) Termination wiring.
            (4) Termination tubing.
            (5) Calibration/adjustment.
         e) Checkoffs/Signoffs for the Loop:
            (1) Panel interface terminations.
            (2) I/O interface terminations with PLCs**.**
         f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
         g) Total loop operational.
         h) Space for comments.
      5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs I/O module and include the following:
         a) Project name.
         b) Loop number.
         c) Component tag number or I/O module number.
         d) Component code number for I&C elements.
         e) Manufacturer for I&C elements.
         f) Model number/serial number for I&C elements.
         g) Summary of Functional Requirements; For Example:
            (1) Indicators and recorders, scale and chart ranges.
            (2) Transmitters/converters, input and output ranges.
            (3) Computing elements' function.
            (4) Controllers, action (direct/reverse) and control modes (P, I, D).
            (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
            (6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
(5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
d. FDT-Repeat:
1) Repeat FDT onsite with installed PSS equipment and software.
2) As listed in PSS subsections, certain portions of FDT may not require retesting.
3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
e. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.

2. Functional Test:
a. Scope: Confirm PSS, including applications software, is ready for operation.
b. Refer to PSS subsections for additional requirements.
c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
3. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Supplier except for Functional Test items signed only by Supplier.

E. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed. Performance Test on associated PSS equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and non-loop-specific tests same as required for FDT except that entire installed PSS tested using actual process variables and functions demonstrated.

3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. PSS Supplier to Equipment Supplier Interface Testing:
    a. These tests are a subset of PSS Performance Testing.
    b. This subset shall be performed to verify the interface of the following packaged control systems with the PSS:
        1) Section 48 11 23, Combustion Turbine Generator.
        2) Section 43 12 00, Fuel Gas Compressor.
    c. This subset of the PSS Performance Testing includes verification of all PSS-based monitoring of the Supplier's equipment.
    d. The PSS to Equipment Supplier Interface Testing shall not commence until after the successful completion of the functional testing of the equipment Supplier's control system, as described in the section specifying all the Supplier's equipment.
        1) Deferral of this PSS to Equipment Supplier Interface Testing to a period after the completion of the equipment's functional testing does not eliminate the PSS supplier or equipment Supplier from coordination or completion of work required to successful complete the equipment's functional testing.
        2) The Engineer, at their own discretion may consider portions of the PSS to Equipment Supplier Interface Testing as complete during the execution of the equipment's functional testing. This would require:
            a) The function associated with the portion of the PSS to Equipment Supplier Interface Testing was successfully demonstrated.
            b) PSS Performance Test procedure submittal has been approved.
            c) The Engineer opts to witness the function with the portion of the PSS to equipment Supplier interface testing.
    e. The equipment Supplier or their representative shall provide the following services related to the PSSS to Equipment Supplier Interface Testing:
        1) Assist the PSS supplier in development of the testing procedure submittal.
            a) These procedures shall include a detailed list of data being exchanged between the equipment Supplier and PSS supplier systems.
            b) Be onsite and participate in the test.
            c) Perform simulations as required to execute the tests.
            d) Troubleshoot the Supplier equipment and control system as required by test results
            e) Correct packaged control system PLC or OIU errors uncovered during testing.

5. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
6. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
7. Make O&M data available to Engineer at Site both before and during testing.
8. Follow daily schedule required for FDT.
9. Determination of Ready for Operation: When Functional Test has been completed.
10. Refer to examples of Performance Test procedures and forms in Article Supplements.

2.03 DOCUMENTATION REQUIREMENTS

A. The following types of instrument and controls documentation will be generated by the Engineer as part of the Contract Documents, to define scope of work for field installation. These documents are generic and functional in nature. The Supplier shall modify and/or add missing information based on Manufacturer's approved Shop Drawings to customize all Documents. Supplier is responsible to keep a record of changes required during construction and customizing all I&C Drawings and provide record drawings for the Project.

1. Process and Instrument Diagrams (P&IDs): Using ANSI/ISA-5.1-2009 Instrumentation and Symbols and Identification to denote instrumentation and controls, including all interfaces with other plant equipment.
2. Instrument Location drawings: Instrument locations shall be shown either on dedicated Instrument Location Drawings or may be shown on Piping Plan Drawings or Electrical Plan Drawings.
3. Instrument Index:
   a. A list of all instruments including: Tag number, service description, manufacturer, model, type, size, calibrated range and when available operating data including ranges and set points. Supplier to customize based on Manufacturer/Supplier's approved Shop Drawings.
   b. The instrument index shall also list control valves including: Tag number, service description, manufacturer, model, type, size, end connections, actuator information, min/normal/max process conditions, C_v (flow coefficient), and all other pertinent information. Any Manufacturer specific information shall be filled in by the Supplier.
   c. Will be provided in both hard copy and in Microsoft Excel electronic file format.

4. Instrument Installation and Arrangements Drawings: For all instruments and valves shipped loose that will require installation in the field.
5. Control system documents to be used by the Supplier for application programming:
    a. For all control, monitor, alarm, shutdown or interlock loops.
    b. Sequence of Operations.
    c. Logic - ladder logic or block diagram form.
6. Data Sheets:
    a. Preliminary Data Sheets will be provided in the Contract Documents for all instruments and control valves.
    b. Shall be presented in format that contains all the information in ISA-S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
    c. Based on Supplier/Manufacturer's approved Shop Drawings Supplier shall update all data sheets and fill in missing information.
7. Supplier shall provide the following additional documentation:
    a. Instrument calibration sheets.
    b. Following updated/record drawings:
        1) Instrument Index.
        2) I/O Lists.
        3) Wiring/Interconnection drawings.
        4) Ladder Logic or block diagrams.
        5) Instrument Data Sheets.
    c. Dimensional drawings.
    d. Manufacturer wiring diagrams with terminal identification, make and type.
    e. Installation and maintenance instructions.
    f. Sizing calculations for all control valves, relief valves, regulating valves, and flow elements.
    g. Thermowell wake frequency calculation per ASME PTC 19.3.
    h. Ship-Loose List: A list of instruments and valves shipped loose that will require installation in the field.
    i. Following Application Programming Related Documentation:
        1) PLC ladder listings, hard copy and electronic copies.
        2) Data exchange tables for all PLC and other data links specified and shown on the Drawings.
        3) Central computer server data base and configuration.
    j. Complete wiring and pneumatic connection drawings.

2.04 TAGGING REQUIREMENTS

A. Refer to Section 01 58 53, Project Equipment identification, for tag format.

B. Equipment Tagging:

1. All instruments and control valves shall be assigned a unique tag number per the project tagging specification.
2. All instruments and control valves shall be labeled with the instrument tag number engraved on a Type 316 stainless steel tag. The tag and wire shall be stainless steel and riveted or wired to the device. As a minimum the tag shall have the service description and instrument tag number.
3. If the tag is riveted, it shall have a character height of 0.125 inches, 90 characters maximum or permanently stamped on the instrument with 65 characters maximum.
4. If the tag is attached with wire, the wire shall be minimum 12-gauge solid or braided stainless steel wire; stranded wire is prohibited. Wire ends shall be joined with compression-type clamps; wire ends shall not be joined by twisting. The tag minimum size shall be 1-inch by 2.5 inches, with a minimum thickness of 1/16 inch.
5. The tag numbers to be used for the project are to be shown as such on the P&IDs and other documents, Data Sheets, and Drawings submitted for the Project.

C. PLC Signal Tagging (Part of Supplier's Scope of Work):

1. All hardwired and datalink signals between PLCs shall be assigned a unique tag per the project tagging philosophy.
2. All PLC hardwired and soft datapoint addresses shall be documented and submitted for approval prior to the performance of a Factory Acceptance Test (FAT).

2.05 CONTROL PANELS

A. General:

1. Large free-standing upright panels or wall mount panels shall be provided.
2. Panels shall have internal light and switch and 120-volt duplex grounding type receptacle wired to a junction box to be fed from a separate external circuit.
3. Panel power for equipment control shall be fed from a separate circuit, but not the same circuit as the lighting circuit.
4. Panels to be mounted outdoors shall be provided with strip heaters and thermostatic controls.
5. Panels in hot environments shall be provided with cooling equipment such as fans and thermoelectric coolers, as required by internal components.
6. All panels shall have 20 percent spare terminal blocks for connection of external wiring, and 20 percent spare space for future equipment.

7. All panels associated with package units shall be designed and supplied by the package Supplier. Front of panel layout drawings and electrical or tubing schematic drawings shall be submitted to the Engineers for approval prior to fabrication.
8. The location of a panel on a Supplier package shall be specified and shown on the General Arrangement Drawings submitted for review. Panel front and location of any panel doors shall be shown on the General Arrangement Drawings.
9. Panels shall be arranged so that the 5th percentile woman and the 95th percentile man, as defined by ISA RP60.3, can easily monitor and operate the instrumentation and controls mounted on the panel. No panel front equipment shall be mounted less than 30 inches above the operator platform level. No controls shall be installed greater than 56 inches above the operator platform level.
10. Panels shall be of 12-gauge minimum welded steel construction, framed, braced with angle or channel steel as necessary. All panels located outdoors shall have a rain and/or hail shield to protect equipment mounted on the front of the panel.
11. Furnish NEMA 4X panels for unconditioned indoor areas, and all outdoor areas.
12. Panels for indoor service with climate control shall be rated NEMA 12.
13. Panels in classified areas shall be explosion proof or NEMA 4X with purge air to maintain a positive internal pressure.
14. All panel doors shall be gasketed. All control panel doors shall include a locking three-point latch. Provide one key for each panel. All panels to be keyed alike. NEMA 4 panel door clips shall not be supplied without written authorization by the Engineers. Only panels in washdown areas will be allowed to be supplied with door clips.
15. Panel doors shall be full-length flush pan with full-length stainless steel piano hinges rated for 1.5 times the door plus instrument weight.
16. All panels including instrument components, electrical wiring, and devices must conform to the electrical area classification specified in the Equipment Data Sheets.
17. Wiring and panel assembly shall conform to UL 508A and all local codes.
18. Nameplates shall generally be 1 inch by 3 inches with up to four lines of 3/16-inch high engraving with 15 characters per line. Nameplates shall be engraved lamicoid, white with black core. Nameplates shall be fastened to the panel surface with stainless steel screws. Adhesive attachment of nameplates is prohibited. Nameplate abbreviations shall comply with the requirements of ISA RP60.6, Appendix B or latest revision. Abbreviations not listed in ISA RP60.6 must be approved in writing by the Engineers.
19. Wiring and terminal blocks shall be tagged with permanent markers. Adhesive markers are not permitted. Nameplates shall not be attached to removable covers or relays but to the enclosure backplane.

20. Panel and all associated equipment must be suitably secured and protected to ensure that it will not be damaged in shipment or storage at the job site. Site storage will be covered, but not necessarily ventilated, heated or cooled. The Supplier shall define storage and preservation requirements.
21. Each panel which is not permanently mounted and shipped by the Supplier of an equipment package unit shall be provided with removable lifting lugs. Lifting lugs shall be capable of supporting the panel weight.
22. Panel annunciator windows shall have a minimum size of 1 inch by 3 inches. All annunciator lamp boxes shall have 20 percent spare windows. Spares shall be evenly distributed across the lamp boxes. Each alarm point of local annunciators shall be supplied with auxiliary contacts for retransmission of alarm signals for use in the Plant Control System.
23. Annunciator sequence for shutdown alarms shall be first out, manual reset (ISA AFM sequence). Annunciator sequence for trouble alarms shall be automatic reset (ISA A sequence). A complete nameplate legend shall be supplied for the Engineers to review and approve.
24. Two alarm points representing different alarm conditions shall not appear on the same lamp box window. For example, a single alarm window indicating High/Low Lube Oil Pressure is strictly prohibited. Dedicated windows shall be provided for each alarm condition.
25. Control/instrument panel indication light colors shall be:
    a. Green: Not Running/Breaker Open/Valve Not Open.
    b. Red: Running/Breaker Closed/Valve Not Closed.
    c. Yellow: Warning, Alarm, Manual.
    d. Blue: Permissives Met, Automatic.
    e. White: Status Indication.
    f. Clear: Ground Detection.

B. Panel Wiring Requirements: See Electrical Requirements for Packaged Mechanical Equipment, Specification 26 05 04, Basic Electrical Materials and Methods.

C. Panel Tests:

1. The Supplier shall advise the Engineers when the panels are complete. A detailed inspection with functional checkout may be required. The Supplier shall coordinate such inspection and tests in the following manner.
    a. The Supplier shall energize all of the electrical circuits at least 24 hours before the tests are conducted. The panel shall remain energized throughout the test.
    b. The Supplier shall inform the Engineers when the Engineers' inspectors or designated representative(s) can arrive to witness the test and perform the inspection. A minimum of 5 days' notice is required.
    c. The Supplier shall provide the necessary labor, space, test equipment and tools to perform a complete panel functional test. Panel inputs and outputs shall be simulated with a test panel consisting of switches and lights.

2. If the Supplier fails to perform the necessary checks or is unable to present the panel for inspection when the Engineers' Inspector or designated representative(s) arrive, the Supplier shall be liable for back charges for extra time required for the Inspection Personnel Services.

2.06 CONTROL VALVES\SHUT DOWN VALVES

A. Specifications: Refer to Section 40 92 13, Process Control Valves and Regulators, for specifications Control Valves and operators.

2.07 PROGRAMMABLE LOGIC CONTROLLERS (PLC) AND COMPUTER WORKSTATIONS

A. Reference PLC Equipment List in PLC components in Section 40 91 00, Instrumentation and Control Components.

2.08 PSS MISCELLANEOUS DATA LINKS

A. The Supplier is responsible to implement all data links shown on the Drawings and specified in the individual Specification sections. These data links will allow efficient data exchanges between self-contained purpose based control package systems, the Plant Control System, computer workstations, and existing plant control systems.

2.09 INSTALLATION PRACTICES

A. Work Included:

1. Instrument and controls installation includes, but is not limited to, the following.
2. Instrumentation and controls receipt, storage and handling.
3. Protecting of all instruments, controls, PLC enclosures, and bulk instrumentation materials from the time of receipt at the jobsite until final completion. This includes temporary protection after installation until equipment is put in service (for example, protection from material falling from above, or protection from damage due to workers climbing on or near equipment).
4. Furnishing and installation of all necessary bulk instrumentation materials such as tubing, valves and manifolds, fittings, piping, instrument mounting stands, enclosures, wiring, wire markers, etc. that are required to perform the specified work. Individual instrument installation details have an abbreviated Bill of Material which references a Master Bill of Material. It is the Supplier's responsibility to do a complete and thorough material take-off using these drawings and documents.
5. Location of instrument and controls equipment based on supplied location plans, piping isometrics and other applicable drawings.

6. Installation of all instrumentation and controls. The installation will include all required wiring and tubing.
7. Installation of on skid control systems.
8. Providing all necessary supervision, labor, tools, test equipment, facilities, temporary supplies, and any other equipment required to test and calibrate the instruments and controls for the Project, including those instruments supplied and installed with skid mounted equipment or packaged mechanical equipment. All workers shall be skilled in the work to which they are assigned, and all work shall be performed under the direct supervision of an experienced and competent foreman.
9. Tagging of any instrument that does not have a factory installed nametag.
10. Maintaining a current set of marked up "Record" documents for later incorporation on "as built" Drawings.

B. Work Not Included: The Supplier shall be responsible for all installation work associated with this Project. No installation work is specifically excluded from the scope of Work.

C. Receiving, Storage, and Handling:

1. All instrumentation and control panels will be received, inspected and stored by the Supplier at the jobsite until the instruments are ready to be installed. All instrument tag numbers, and model numbers will be verified against the instrument datasheets, instrument index, and Supplier documentation. Any discrepancies will be brought to the attention of the Owner. Any item received by the Supplier without a tag number will be tagged with a stainless steel tag by the Supplier prior to placing the item into storage.
2. Store all items in a clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

D. Products:

1. Tubing:
   a. For process tubing, defined as piping running between an instrument and the block valve nearest the process. For instrument air supply tubing, defined as piping running between the control valve or instrument and the block valve on the air header or subheader.
   b. Conform to ASTM A269/A213.
   c. Type 316 stainless steel, seamless, annealed and pickled. The tubing shall be 1/2-inch OD for most applications. Supplier shall obtain Owner's permission for use of other tubing sizes on specific applications.

d. Wall thickness of the tubing is dependent on the pressure and temperature conditions of the process. Minimum wall thickness of the tubing shall comply with Table 1, but in no case shall wall thickness be less than 0.049 inch.
e. Pressure-temperature rating of tubing shall be accurately determined from tubing manufacturer's product Specifications.

Table 1
Minimum Wall Thicknesses For Tubing
(ASTM 269/A213 Type 316 Stainless Steel)

Pressure Rating (psig)	Size (OD, Inch)	Wall Thickness (Inch)
2,000 and below	3/8	0.049
	1/2	0.049
2,000 to 4,000	3/8	0.065
	1/2	0.065
4,000 to 6,000	3/8	0.065
	1/2	0.083

2. Tubing Fittings:
   a. Type 316 stainless steel, conforming to ASTM A213/A213M and ASTM A269.
   b. Fittings will be compression type with two ferrules and hex nut, Swagelok "Or-equal."
   c. Male threads shall be rolled. Nuts shall be pre-lubricated.
   d. Only one brand of tubing fittings shall be provided for entire Project.
3. Valves and Manifolds:
   a. Process tubing runs for pressure instruments shall have a manifold valve installed directly mated to (preferably), or next to, instrument. Typically, this manifold is provided by Supplier with the instrument.
   b. The body, stem, and trim of the process tubing valves shall be Type 316 stainless steel minimum. More corrosion resistant materials shall be provided if required by process service.
   c. Gauge and absolute pressure instruments shall be provided with 2-valve manifolds. Differential pressure instruments shall be provided with 5-valve manifolds.
   d. Valves/manifolds in services with pressures below 4,000 psig shall have compression type tubing connectors.
   e. Valves/manifolds in services with pressures above 4,000 psig shall have bar-stock bodies with nonrotating stems and threaded end connections.

f. PTFE packing shall be provided for services below 450 degrees F. Graphite packing shall be provided for services above 450 degrees F.
g. Packing shall be nonasbestos.
h. Packing and seat material shall be designed to withstand full process operating pressures and temperatures.
i. Support valves/manifolds independently of tubing.

4. Tubing Raceways:
   a. If required by Project Specifications, construct of either hot-dip galvanized steel in accordance with ASTM A123/A123M or heavy-duty reinforced fiberglass.
   b. Accessories such as nuts, bolts, and clamps shall be Type 316 stainless steel.
   c. Angle bracket shall be fabricated of Type 316 stainless steel or hot-dip galvanized steel. Beam clamps shall be galvanized steel.
   d. Widths: 1 inch, 1-1/2 inches, 2-1/2 inches, and 4 inches.
   e. Depths: 3/4 inch and 1 inch.
   f. Support tubing every 3 feet of running length of tubing.
   g. Slope tubing in accordance with instrument installation details. Minimum slope is 1/2 inch per foot.

E. Instrument Electrical:

1. General:
   a. Ensure that instrumentation comply with NFPA 70, as amended by the local jurisdiction.
   b. Confirm that wire and cable construction and materials are suitable for special conditions such as high temperature, intrinsically safe and corrosive or contaminated environments.
   c. Electrical enclosures, conduit, and fittings shall comply with the requirements of the Project electrical Specifications.
   d. Control signal and power supply cables shall comply with the requirements of the Project electrical Specifications.
2. Wiring Methods:
   a. Electrical wiring and equipment shall be installed in accordance with the Project electrical Specifications.
   b. Wire nuts and splices are not permitted.
   c. Instrument control signal cables and electrical power cables shall only cross at right angles.
   d. 24V dc signal wiring shall not be installed in the same tray, channel or raceway with 120V ac or higher electrical wiring.
   e. Care shall be taken in the layout of terminals and in the wiring method used to prevent contact between circuits if a wire becomes disconnected.
3. Electrical Transmission System:
   a. Signal for the electrical transmission system shall be direct current (DC). Signal current shall be 4 to 20 milliamperes (mA).

b. Terminals shall contain screw-clamp or spring clamp type terminal blocks with Phoenix Contact (“Or-equal”) terminal connectors with pre-printed terminal block markers.
c. Thermocouple signals shall be millivolt (mV).

4. Thermocouple terminals of the proper type shall be utilized for signal interface.

F. Field Junction Boxes:

1. Terminal boxes, junction boxes and field panels shall be rated NEMA 4X minimum and shall be constructed of Type 316 stainless steel with stainless steel hardware.
2. On any skid requiring connection between on-skid instrumentation and control devices and off-skid instrumentation and control devices, skid Supplier shall provide an on-skid instrumentation junction box on a structural steel support. Junction boxes are to be manufactured according to Project Drawings. A nameplate shall be installed on the face of the junction box identifying as a minimum its tag number, service description, and Project name.

G. Mounting:

1. Field instruments shall be installed and mounted as required or recommended by ISA 70.70 standard, ASME PTC 19.2, PTC 19.3, PTC 19.5, and PTC 46.
2. Field instrument installation details have been prepared by the Engineers. Should a variation of the detail be required, the Supplier shall submit a Request for Information (RFI) with a sketch of the proposed variation to the Engineers or Owner for approval prior to installation of the instrument.
3. Supplier shall determine the type and quantity of instrument stands required for the application and location based on instrument location Drawings and installation details.
4. The Supplier shall provide all mounting hardware for field instrument items.
5. Pipe for instruments to be mounted on pipe stands shall be 2-inch Schedule 40 galvanized carbon steel pipe.
   a. Sides of the baseplate of the pipe stand shall be a minimum of 8 inches and manufactured of galvanized steel with a thickness not less than 3/8 inch.
   b. The pipe stands shall be of all-welded construction. Supporting and mounting hardware shall be stainless steel.
6. Instruments shall be accessible for maintenance without the use of ladders taller than 6 feet, scaffolding, or portable man lift equipment such as a cherry picker.
7. Instruments shall be piped and/or tubed with sufficient clearance for removal of the instrument for service.

8. Where practical, the centerline of an instrument mounted at grade or on a platform shall be 4 feet 6 inches above grade or platform.
9. Instruments shall not be mounted on handrails, ladders, in pathways, or on pipe or equipment that is subject to vibration.
10. Instrument mounts shall not be welded to process lines, vessels or equipment.
11. All root valves will be furnished and located by Piping Supplier. All other hand valves required by instrument installation details shall be located by Supplier in accessible locations for operation and maintenance.
12. Thermowells shall be clear of all foreign materials prior to installation of the thermal sensitive elements.
13. If any filled temperature and/or pressure capillary systems are required, the Supplier shall support and protect the capillary with steel channel or tube tray. Excess capillary shall be coiled and protected at the instrument.
14. Capillary shall be shielded from the sun and from nearby heat sources so that the reading will not be influenced by ambient conditions.
15. If any armored cable is required, the cable shall be supported in steel channel and excess cable shall be neatly coiled and secured.
16. The following table shall be used for determining required accessibility of instruments:
    a. Type 1: Grade, platform or stairway.
    b. Type 2: Grade only.
    c. Type 3: Grade, platform, stairway, permanent ladder or portable ladder.

Type of Instrument	Access Type Required
Transmitter	1
Local indicator	1
Pressure gauge	3
Thermowells	3
Self-contained regulators	1
Local controllers	1
Process actuated switches	3
Frequently monitored or adjusted instruments	1
Emergency instruments	2
Thermocouples and RTDs	3

H. Instrument Calibration:

1. All instruments shall meet the manufacturer’s published Specifications. Instruments that do not satisfy the manufacturer’s Specifications shall be repaired or returned to the manufacturer.

2. The manufacturer's recommended calibration procedures shall be followed for all instrument calibration when needed. The Supplier shall record all calibration data on a "calibration" sheet. For instruments received with factory Certified Calibration Reports, Supplier will verify calibration of these devices. In general, instrumentation received with factory Certified Calibration Reports do not need further calibration unless instrument is to be used for performance testing (or other special purposes requiring immediate calibration) and factory calibration occurred more than 6 months prior to the performance test.
3. Test instruments shall be NIST traceable and provided by the Supplier with equal or better accuracy as noted below:

Inclined water manometer	0.1% full scale
Dead weight tester	0.1% full scale
Precision pressure gauge	0.25% full scale
Digital voltmeter	0.1% full scale
Current and/or voltage meter	0.25% full scale
Precision potentiometer	0.3% full scale
Precision temp potentiometer	0.3% full scale
Precision resistor decade box	0.1% full scale
Stopwatch	0.1 seconds

4. The Supplier shall confirm that all instruments comply with the instrument index, instrument datasheets and manufacturer documentation. Items to be checked include but are not limited to the following:
   a. Instrument tag number.
   b. Model number and serial number.
   c. Size and Connection type.
   d. Materials of Construction.
   e. Instrument ranges and setpoints.
   f. Thermowell lengths.
   g. Thermocouple and RTD types.
5. Control Valves and self-contained pressure regulators shall be inspected to verify against the Datasheets the following as a minimum:
   a. Valve body and trim materials of construction.
   b. Valve body size and type.
   c. Valve end connection size and type.
   d. Valve action and fail position.
   e. Valve stroke time (for fast operating valves).
   f. Valve actuator, accessories and position switches or transmitter (when supplied).
   g. Valve shall be checked to ensure that it seats properly when the appropriate bench set pressure is applied to the actuator.

I. Instrument Locations:

1. Field instrument location plan Drawings have been prepared by the Engineers. These Drawings have been provided for the Supplier to use as a guideline for locating instruments. It is the Supplier's responsibility to determine the most appropriate location for the instruments based on the final configuration and location of equipment.
2. Instruments are to be located with attention given to instrument accessibility for maintenance purposes and personnel safety.
3. The final installed locations of the instruments shall be documented by the Supplier with the Supplier providing final marked up "record" location plans to the Engineers or Owner.

J. Instrument Installation:

1. Field instruments shall be installed as required or recommended by ISA-70.70 standard, ASME PTC-19.2, PTC-9.3, PTC-19.5, and PTC-46.
2. Instruments shall be accessible for maintenance without the use of ladders taller than 6 feet, scaffolding, or portable man lift equipment such as a cherry picker. Tubing run from the tubing supply valve to the instrument shall be as short as possible. Instruments shall be line-mounted, rack-mounted or stand-mounted. No instruments shall be mounted on handrails. Instrument racks and stands shall be mounted directly on structural steel or on concrete.
3. Pipe-mounted pressure gauges shall be provided with siphons, as required, for steam service, pulsation dampeners for pulsating flow, and diaphragm seals for corrosive or severe service.
4. Pressure type instruments shall have associated isolation and test valves or combination two valve insulation/test manifolds. Differential pressure type instruments shall have associated pairs of isolation and equalizing valves or a five-valve isolation/equalizing manifold. Pressure transmitters and differential pressure transmitters shall be directly mounted to the manifold. Diaphragm seals shall be provided for corrosive or severe service.
5. Sensing elements shall be located with adequate clearance for removal and replacement. Taps on process lines shall take into account requirements for venting and draining. In order to prevent plugging, no taps shall be located on the bottom of pipes. Instrument taps shall be mounted either on the side or top of pipes as required. Installation and routing of sensing lines shall take into account requirements for blowdown or back flushing of lines.
6. Typical instrument installation detail drawings will be provided by the Engineers to define how the instruments will be installed by Supplier.
7. Installation and routing of sensing lines shall take into account requirements for thermal expansion of the tubing under normal process conditions.
8. Instrument tubing shall be insulated as required, in accordance with Project piping insulation Specifications.

K. Installation Check-Out:

1. All instruments and accessories shall be visually inspected for damage after installation. If damage is observed, corrective action shall be initiated.
2. All instruments shall be free of shipping restraints and stops. Glass shall be clean. Temporary protective devices shall be removed prior to placing instruments in service.
3. Verify that all instruments and instrument tubing are correctly tagged, labeled, and installed at the correct location and orientation.
4. All primary elements shall be checked for proper installation with respect to direction of flow, elevation, orientation, insertion depth of thermowells, or any other applicable considerations.
5. Instrument electrical wiring shall be checked for proper termination and labels.
6. Instrument piping and/or tubing which is process-connected shall be checked for fitting type materials, connection sizes and rating. Verify that adequate brackets and supports have been used to maintain continuity of rigid construction.
7. On installations which involve instrument seal pots or reference (wet) legs, the system shall be filled. All seal/fill fluids will be supplied by the Supplier.
8. Verify that the air supply for each instrument is correctly installed.
9. All tubing connections shall be checked per manufacturer's recommendation. Over-tightened connections shall be replaced. Tubing with scars from a tube cutter or knife used to remove the sheathing shall be replaced.
10. Do not install primary in-line elements until the process line has been flushed clean.
11. In general, for in-line elements in piping subject to steam blows, do not install the element until after steam blows. If the in-line instrument must be installed before steam blows, such as for welded thermowells in critical pipe spools, then the instrument must be designed to withstand the highest expected velocity without damage or fatigue, even if such velocities are infrequent or of short duration. If the in-line instrument is removable, such as orifice plate or threaded/flanged thermowell, it may be installed before steam blows as long as it is removed for steam blows and associated pipe taps are capped or plugged.
    a. All transmitters shall be isolated from the process lines and vented to atmosphere for overpressure protection during flushing and steam blows.

L. Rotameters:

1. Mount rotameters vertically. Vertical alignment shall be verified.
2. Verify that rotameter float and follower can travel full range.

M. Orifice Meters:

1. Inspect orifice plate for correct tag number, line size, bore size, plate thickness and material, inlet side correctly identified, and when applicable, drain and vent holes size and location and eccentric bore orientation.
2. Inspect for nicks, burrs, wire edges, or other defects that would affect measurement accuracy.
3. Orifice plates in pipes subject to steam blows, compressed air cleaning, or other high velocity cleaning are removed prior to steam blows/cleaning to ensure orifice plates are not damaged.
4. Install orifice plate in the correct orientation in accordance with ASME PTC 19.5 paragraph 4-5.5 and manufacturer labelling. Typically, this will be with the beveled side facing downstream and square edge facing upstream.
5. Orifice plates on horizontal runs of pipe are installed so that the orifice plate can be removed vertically.
6. Locate differential pressure flowmeters for liquid or steam and condensable vapor service below orifice flanges. Verify that associated impulse piping/tubing is sloped continuously downward from flange taps to flowmeter. Verify correct installation of condensate pots or wet leg fill connections. Verify wet legs are filled.
7. Locate flowmeters in gas service above the orifice flanges. Verify that associated impulse piping/tubing is sloped continuously upward from flange taps to flowmeter.
8. Instrument Supplier (Supplier) and Piping Supplier shall verify that the proper straight runs of pipe both upstream and downstream of the orifice have been correctly installed.
9. Verify that associated piping/tubing is sloped in proper direction. Minimum slope is 1/2 inch per foot.
10. Differential pressure instrument shall be located as close as possible to the sensing point. Verify that the instrument is installed correctly.
11. Verify high and low pressure connections are piped correctly for direction of flow.

N. In-Line and Insertion type flowmeters:

1. Verify that the flowmeter is installed and grounded in accordance to manufacturer’s instructions.
2. A startup strainer shall be provided for all insertion type meters (vortex, turbine, positive displacement, etc.) to prevent fouling the meter during startup and commissioning. Strainer shall be removed before normal plant operations begin.
3. Flow transmitters that are not integral to the element shall be mounted as close as possible to the flow element.

4. In-line and insertion type flowmeters in pipes subject to steam blow shall not be installed until after steam blow.
5. Follow installation detail for the instrument.

O. Magnetic Flowmeters:

1. Verify that the flow direction through the meter is compatible with the orientation of the sensing element and that the meter will always be full of liquid.
2. Verify that the wiring connection and grounds are correct.

P. Temperature Instruments:

1. Thermowells shall be of the welded, threaded or flanged type as shown on the Piping ISO's and instrument datasheets. Verify that thermowell material type and material match instrument datasheets and comply with the Project piping Specifications.
2. Verify thermocouple or RTD type against instrument index and datasheets.
3. For weld-in and socket weld style thermowells, ensure temperature sensor is removed before welding the well into the pipe or socket.
4. Thermowells shall be installed prior to hydrotesting or leak testing, except for welded thermowells in lines subject to steam blows.
5. In general, welded thermowells in pipes subject to steam blows, compressed air blows, or other high velocity cleaning shall not be installed until after steam blows/cleaning, so that well and weld is not damaged by flows exceeding wake frequency. If thermowells must be installed before steam blows, such as for welded thermowells in critical pipe spools, then the Supplier shall verify that the thermowell has been designed to withstand the highest expected velocity without damage or fatigue.
6. Threaded or flanged thermowells in pipes subject to steam blows, compressed air blows, or other high velocity cleaning may be installed before steam blows/cleaning, but must be removed for steam blows/cleaning to prevent damage from flows exceeding wake frequency.
7. Ensure temperature sensors such as thermometers, thermocouples and resistance temperature detectors are installed in their respective thermowells. Ensure thermowell bore is clean and dry before inserting the sensor.
8. Verify that the temperature sensor is in proper contact with the bottom of the thermowell.
9. Hermetically sealed, bimetallic thermometers shall be located to be readable from grade or from a working platform.
10. Bulb and capillary style temperature instruments shall have capillary supported and protected with steel channel or tube tray. Excess capillary shall be coiled and protected at the instrument. Capillary shall be shielded from the sun and from nearby heat sources so that the reading will not be influenced by ambient conditions.

Q. Level Instruments:

1. Level instrument installations shall be designed and installed to be readable and to permit maintenance from grade or platform. Block and drain valves shall be accessible.
2. All gauge glasses in process and utility service shall be reflex or transparent. Gauge glasses shall be installed on vessels on connections separate from any other instrumentation. Transparent gauges shall be provided with illumination.
3. All differential pressure type level instruments shall be installed with isolating gauge valves. Vents and drains shall be provided according to service.
4. Differential pressure type level instruments shall be located as close as possible to the sensing point. Supplier shall check to verify that each leg of the transmitter is filled with the proper fluid, if applicable, and that high- and low-pressure connections are connected correctly.
5. Float or Displacement Type Level Switches:
    a. Verify that the specific gravity setting is correct.
    b. Verify that the displacer is plumb and manually check for freedom of movement.
6. Magnetic Level Gauges:
    a. Examine for orientation and visibility.
    b. If gauge cocks, vent valves or drain valves have been specified, verify that they are properly installed.
    c. Note proper orientation of horizontal ball check block valves, if applicable.
    d. Verify and adjust the flag assembly and gauge board to provide the best possible visibility.
7. Guided Wave Radar Type Level Transmitters:
    a. Verify that the level probe is installed correctly per the manufacturer’s instructions and installation details provided by the Engineers.
    b. Verify proper alignment with the guides or stilling well and that “swinging” is not possible.
    c. Verify that a sufficient number of holes have been correctly made in the stilling wells to allow for air to escape and not block the fluid from traveling up the stilling well.

R. Pressure Instruments:

1. Pressure gauges shall be installed directly on the line or equipment they are servicing except where vibration will impair operation, or where process conditions will exceed gauge ratings, and then they shall be mounted remotely. All other types of pressure instruments shall be mounted on separate brackets in the vicinity of the root valve.

2. Pressure gauges in condensing vapor service shall be mounted above the process taps and installed with siphons or pigtails.
3. Pressure gauges or liquid filled gauges on services that surge shall have pulsation dampeners.
4. Pressure gauges shall be readable from grade or from a platform.
5. Verify piping/tubing is sloped in proper direction. Minimum slope is 1/2 inch per foot.
6. Verify instrument and valve manifold have been installed properly (no ball checks).

S. Control Valves:

1. Supplier shall inspect each valve prior to installation and notify the Engineers or Owner if any suspected damage is evident. Supplier shall verify the following: that the valves were shipped upright to prevent damage to the internal parts; that there is no damage to the inlet/outlet flanges; that inlet/outlet ports and other openings were covered during shipment and storage to keep the internals clean; and that the bonnet vents are clear of obstruction.
2. Solenoid valves, where required, shall be installed between the positioner and actuator.
3. All control valves shall be accessible from grade or platform. Sufficient space shall be provided to permit actuator removal and valve assembly removal for maintenance.
4. Verify that all control valves are installed correctly with respect to direction of flow.
5. Verify that all accessories have been included and are functional.
6. During hydrostatic testing and line flushing, control valves shall be removed or “blinded off” from the line during testing and flushing. Block valves may be left in the line, but precautions shall be taken to ensure that the block valve trim is not damaged by foreign material in the line.
7. On self-contained pressure regulators, verify that external pressure sensing piping, when required, is correctly installed.
8. All new control valves data sheets specify each control valve complete with actuator, positioner, I/P converter and filter/regulator completely assembled requiring only interconnecting electrical signals and air supply for operation. Provide and install all required components and interconnecting wiring and pneumatic tubing.

T. Pressure Safety/Relief Valves: Supplier shall inspect each relief valve prior to installation and notify the Engineers or Owner if any suspected damage is evident. Supplier shall verify the following: that the valves were shipped upright to prevent damage to the internal parts; that there is no damage to the inlet/outlet flanges; that inlet/outlet ports and other openings were covered during shipment and storage to keep the internals clean; and that the bonnet vents are clear of obstruction.

U. Instrument Air Supply:

1. Route, install, support, connect and test all instrument air piping and tubing from the instrument air piping header block valve to all instruments and control valves that require an air source.
2. The instrument air tubing shall be installed with as few joints or connections as possible. Tubing shall be reamed of burrs and cleaned of scale, dirt, oil and chips. Unions shall be provided as required. Keep threaded connections to a minimum by using bends on process tubing.
3. Each instrument air user shall have a shut-off valve installed at the end-user in such a manner as to allow the instrument to be removed without removing the valve. Each secondary branch header shall be supplied with a block valve located at its take-off point from the main header. Secondary branch headers, not supplied by piping, shall be supplied by the Supplier if the Engineers determine they are required for proper air distribution.
4. Instrument air supply, main headers and air stations shall be fabricated such that subheader branches shall come from the top of the pipe, wherever possible.
5. All headers, subheaders, branch headers and air station piping shall be sloped to a 1/2-inch drain valve located at the low points and at the end of the header.
6. The Supplier is responsible for routing air supply lines in such as manner as to avoid obstruction of the operation, maintenance or removal of equipment, instruments, panels, and overhead cranes. Walkways, platforms, ladders and stairs shall not be obstructed in any manner.
7. Instrument Air Piping and Tubing Testing:
    a. Clean and pressure test all instrument air tubing and piping.
    b. Blow all instrument air piping or tubing clean and test for leaks using clean dry instrument air or nitrogen. No water shall be used. Test pressure shall be 75 psig or 1.5 times working pressure (whichever is greater), and care shall be taken to make certain no instruments, controls or miscellaneous devices are connected. Systems will only be acceptable that exhibit a zero-leakage test using a bubbler or test gauge. Where leaks do exist, location shall be determined using commercially compounded solutions specifically for the test medium used. The Supplier shall correct all problems discovered during testing and then shall retest the section in question to verify that the problem has been corrected.
    c. Maintain an accurate log and documentation of all cleaning and acceptable pressure tests. Turn over log and test documentation to Owner upon completion.

d. After testing, the Supplier shall be certain all root valves are closed. All instrument shutoff valves and manifolds shall be shut, and bypass valves opened. Blowdown valves shall be open. Instrument air supply valves shall be closed and the vents on the filter/regulators opened. With this complete, all connections shall be made to instruments, controls, and miscellaneous devices.
e. The air supply from the valve station to each individual instrument shall be disconnected and blown down before initial admission of instrument air to any instrument.

V. Instrument Process, Control, and Air Piping and Tubing:

1. Tubing, valves and fittings shall be installed by the Supplier in accordance with the instrument installation details.
2. Supplier shall furnish, route, install, support, connect and test all tubing, piping, fittings, and isolation valves from the root valves to the locally mounted instruments.
3. Tubing, valves and fittings shall conform to applicable piping material Specifications.
4. Valves and Manifolds:
   a. Install instrument with manifold directly mated to it (typically instrument is provided factory-installed on the manifold). If manifold cannot be directly mated to instrument, install adjacent to instrument as close as possible.
   b. Support manifolds and valves in tubing runs independently of the tubing.
5. Pneumatic and Process Signal Tubing Installation.
6. Tubing shall be straight, securely fastened, and neatly arranged to facilitate insulation and troubleshooting.
7. Relieve strain on all connections by properly supporting all tubing, piping, pots, leads and instruments.
8. Process and pneumatic single tubing runs of less than 20 feet may be strapped to adjacent pipe or clamped to structural beams. No more than two tubing runs shall be run on a pipe. Tubing runs of less than 20 feet shall be supported every 3 feet of running length.
9. All other tubing and tubing bundles shall be run neatly in tube trays, steel channel, or raceways, and shall be securely fastened. Tray, channel and raceway shall be supported from structural members at intervals not more than 10 feet.
10. Commercial one-tube and two-tube tubing clips and 2-piece tube clamps may be used. All tube clips, supports, or clamps shall be removable and replaceable without cutting or burning. Tube clip supports and clamps shall be cadmium plated steel, insulated to prevent galvanic action.

11. No clip or support shall be within 12 inches of the final connection and the final connection shall be piped or tubed so that it can be disconnected from the instrument without bending the tubing or without removing or slackening the clips or supports. On high pressure systems, a clip or support shall be located within 6 inches of the final connection to prevent excessive tube “whiplash” should a connection fail.
12. Instrument process and air tubing shall not be run in electrical cable trays.
13. Raceway, tube-tray, or tubing may be strapped from the process piping, if free of vibration and if no interferences or excessive heating would be caused. Straps shall not damage or interfere with process piping insulation or heat tracing.
14. Do not route tubing through areas where a high risk of fire or mechanical damage exists (such as over vessels, compressors, or pumps).
15. Route tubing to avoid removal of the tubing when maintenance or repair of equipment is required.
16. Tubing shall be square cut using tube cutters. All ends shall be reamed to full tube inside diameter. Burrs shall be removed from each cut.
17. Tubing bends, if required, shall be 90 degrees.
18. All single metal tube bends shall be made with a tube bender. Manufacturer’s recommendations for bend radius and installation of tubing bundles and traced tubing shall be followed.
19. All tubing bends and straight sections shall be free of wrinkles, creases, flattening, sags and bows.
20. The number of tubing connections and bends shall be minimized.
21. Keep threaded connections to a minimum by using bends on tubing. If threads must be used, they shall be cut with the proper die for the particular application according to the manufacturer’s instructions.
22. Instrument piping shall be arranged to avoid measurement error caused by condensate build-up in gas service, air entrapment in liquid service, or overheating of the instrument in hot fluid service. To this end, the process signal tubing of pressure and differential pressure instruments shall be sloped in accordance with the instrument installation details and free of pockets. Minimum slope is 1/2 inch per foot.
23. Tubing runs requiring the use of unions shall have the tubing bent to lift the union from the tray for ease of inspection and maintenance.
24. Stagger offsets for unions and tees on parallel tubing runs.
25. Use elbow fittings instead of straight fittings for tubing bends; branch or street tees instead of connectors with all tube tees; and properly sized tubing fittings to match pipe connections instead of bushings or swages.
26. Changes of direction in tubing installations shall be accomplished by forming radius bends in the tubing, whereas changes in direction in piping installations shall be accomplished by fittings (90-degree elbows, etc.).
27. Instrument piping that requires periodic cleaning to prevent plugging shall be reviewed by the Engineers before installation begins.

28. No tubing runs shall be laid one on top of another. Wherever possible, tube runs shall be laid out avoiding crossing one tube over another. Where this is unavoidable, clearance shall be provided to prevent chafing and allow for maintenance.
29. Process tubing runs between the instrument and the block valve to the process shall be as short as possible.
30. Routing of tubing in potentially hot areas must be avoided.
31. Make tubing runs 20 feet or shorter with stick tubing.
32. Multi-tube bundles shall not be buried, but may be run through conduit, laid in trays, or strapped to Unistrut parallel to electrical conduit.
33. Tubing Fittings:
    a. Do not install fittings with galled or deformed threads.
    b. The sealer/lubricant for stainless steel to stainless steel National Pipe Thread (NPT) fittings shall be tetrafluoroethylene (TFE) paste. The sealer/lubricant for all other combinations of material shall be TFE paste or TFE tape.
    c. Use anti-gall compounds approved by the tubing manufacturer on threads of tube fittings.
    d. Do not exceed temperature rating of anti-gall compound.
    e. Tighten tube fittings in accordance with manufacturer's instructions.
34. Tubing Trays or Channels:
    a. Ensure installed tubing trays will not present a hazard to personnel, block access ways, or prevent passage of equipment.
    b. Support horizontal and vertical runs of tubing trays at intervals not exceeding 10 feet.
    c. Support three or more tubing lines with tubing trays or channels.
35. Tubing Labeling:
    a. Each entry or exit of tubing from a panel or junction box shall be identified at the bulkhead with a label stating the instrument to which it connects.
    b. Differential pressure instrument tubing shall be identified by "H" for "high" or "L" for low.

W. Instrument Enclosures: Instruments with housings that are not appropriately NEMA rated (for example, a pressure switch with exposed wiring terminals) shall be installed in an enclosure of the required NEMA rating for the location. The enclosure shall have a nameplate with the instrument tag name.

X. SCADA Workstations, Network cabinets and Miscellaneous Data Links:

1. Install all workstations as shown on block diagrams and location plans.
2. Install, terminate, and test all supervisory network and other data links as shown on the block diagrams. Any data links going outside the buildings and greater than 100 meters in lengths shall be fiber optic links furnished with all required media converters, patch panels and connectors.

3. Install all dedicated data links between the SCADA network and miscellaneous existing equipment as shown on the block diagrams and specified in the following Specification sections: LATER.

Y. Instrument Electrical:

1. General:
   a. Electrical wiring and equipment shall be installed in accordance with the Project electrical Specifications.
   b. Instrument control signal cables and electrical power cables shall only cross at right angles.
   c. Care shall be taken in the layout of terminals and in the wiring method used to prevent contact between circuits if a wire becomes disconnected.
   d. 24V dc control wiring shall not be installed in the same tray, channel or raceway with 120V ac or higher electrical power wiring.
   e. Separate parallel runs of 24V dc control signal cables and electrical power cables by a minimum space equal to 1 percent of the length of the run. The separation shall be limited to a minimum of 2 feet.
   f. No splices or wire nuts are permitted in the control wiring.
2. Enclosures:
   a. Instrument enclosures in hazardous areas shall be provided with electrical hazardous area reduction (purging) that follows the requirements of NFPA 496.
   b. Bottom entry is preferred. Side entry is permitted if bottom entry is impractical. No top entry is permitted under any circumstances.

Z. Loop Checkout:

1. Loop checks (checking for wiring continuity, polarity, and instrument functionality) shall be performed by Supplier on all instrumentation and wiring, including skid-mounted equipment.
2. A complete checkout report for the complete loop as opposed to individual loop segments shall be submitted to Owner.

2.10 I&C Components:

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for Specifications for I&C components.

2.11 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this Specification.

1. Supplement 1, Instrument List.
2. Supplement 2, Instrument List.
3. Supplement 3, Control Valve Data Sheet.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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FORM: 601	#	Rev	Temperature Transmitter, Element, and Thermowell					
GENERAL	1		Instrument Tag Number					
	2		Instrument Type					
	3		Service / CIP and/or SIP					
	4		P&ID Number					
	5		Line Number / Equipment Number			/		
	6		Line Size / Schedule / Material / Insulated		/	/	/	
	7		Area Classification					
	8		Electrical Cert: Transmitter / Sensor			/		
	9		Ambient Temperature: Min / Max			/		
PROCESS CONDITIONS	10		Fluid: Type / State / Phase		/		/	
	11			UOM	MIN	NORM	MAX	DESIGN
	12		Temperature					
	13		Pressure					
	14		Flow					
	15		Corrosive / Erosive / NACE Compliance		/		/	
	16		Specific Heat Ratio / Viscosity			/		
	17		Compressibility / Molecular Weight			/		
ELEMENT	18		Tag No. / Thermocouple or RTD Type			/		
	19		Number of:Elements(Single/Dual) / Wires			/		
	20		Grounded					
	21		Diameter / Insertion Length			/		
	22		Sensor Head Type					
	23		Sheath / Element Material			/		
	24		Head: Material / Spring Loaded / Class		/		/	
	25		Connection Type / Material			/		
	26		Calibration Standard					
TRANSMITTER	27		Mounting (Integral / Remote)					
	28		Calibrated Range (UOM)		To			
	29		Span: Min / Max			/		
	30		Housing: Material / Coating / Encl Rating		/		/	
	31		Conduit Entry / Transient Protection			/		
	32		Supply Voltage / Output Signal			/		
	33		Accuracy / Repeatabilty			/		
	34		Ambient Temp. Limits / Failure State			/		
THERMOWELL	35		Tag Number					
	36		Process Connection: Size / Type / Rating		/		/	
	37		Instrument Connection Size					
	38		Construction: Type / Material			/		
	39		Immersion Length / Bore			/		
	40		Length: Head / Overall			/		
	41		Manufacturer / Model No.			/		
OPTIONS	42		Mounting Kit: Type					
	43		Bracket Material / Finish			/		
	44		Bolt Material / Finish			/		
	45		Indicator (Integral / Remote)					
	46		Thread Size / Nipple Union Length			/		
PURCHASE	47		Manufacturer					
	48		Model Number					
	49							
	50							
	51		Package Number					
NOTES								

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FORM: 502	#	Rev	PRESSURE TRANSMITTER					
GENERAL	1		Instrument Tag Number					
	2		Instrument Type					
	3		Service / CIP and /or SIP					
	4		P&ID Number					
	5		Line Number / Equipment Number			/		
	6		Line Size / Schedule / Material / Insulated		/	/	/	
	7		Area Classification					
	8		Electrical Certificate					
	9		Ambient Temperature: Min / Max			/		
	10							
PROCESS CONDITIONS	11		Process Fluid: Type / State / Phase		/		/	
	12			UOM	MIN	NORM	MAX	DESIGN
	13		Temperature					
	14		Pressure					
	15		Corrosive / Erosive / NACE Cmplnce Rqd		/		/	
ELEMENT	16		Type					
	17		Diaphragm Material / O-Ring Material			/		
	18		Process Connection: Size / Type / Rating		/		/	
	19		Overpressure Limit					
	20		Fill Fluid					
	21		Measurement Range (UOM)		To			
TRANSMITTER	22		Calibrated Range (UOM)		To			
	23		Supply Voltage / Output Signal			/		
	24		Housing: Material / Finish / Encl Rating		/		/	
	25		Conduit Entry / Transient Protection			/		
	26		Mounting (Close Couple / Remote)					
	27		Zero Elevation & Suppression					
	28		Accuracy / Repeatability			/		
	29		Ambient Temp. Limits / Failure State			/		
DIAPHRAGM SEAL	30		Process Connection: Size / Type / Rating		/		/	
	31		Diaphragm Material / Finish			/		
	32		Housing Material: Top / Bottom / Gasket		/		/	
	33		Flushing Connection: Qty / Size			/		
	34		Flushing Plug or Vent Drain Valve / Matl			/		
	35		Capillary Material / Fill Fluid			/		
	36		Capillary Length / I.D.			/		
	37		Capillary Connection / Repairable			/		
	38							
OPTIONS	39		Indicator (Integral / Remote)					
	40		MANIFOLD: Type (Pressure Testing Rqd)					
	41		Manufacturer / Model Number			/		
	42		Body Matl / Packing Matl			/		
	43		MOUNTING KIT: Type					
	44		Bracket Material / Finish			/		
	45		Bolts Material / Finish			/		
	46							
PURCHASE	47		Manufacturer					
	48		Model Number					
	49							
	50		Package Number					
NOTES								

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FORM: 200	#	Rev	Control Valve - Modulating					
GENERAL	1		Instrument Tag Number					
	2		Instrument Type					
	3		Service / CIP and/or SIP					
	4		P&ID Number					
	5		Line Number / Equipment Number			/		
	6		Line Size / Schedule / Material / Insulated		/	/	/	
	7		Area Classification/ Electrical Certificate				/	
	8		Instrument Air Pressure Range					
PROCESS CONDITIONS	9		Process Fluid: Type / State / Phase			/	/	
	10			UOM	MIN	NORM	MAX	DESIGN
	11		Flow Rate					
	12		Inlet Pressure @ Flow Rate					
	13		Inlet Vapor Pressure @ Flow Rate					
	14		Differential Pressure @ Flow Rate					
	15		Temperature @ Flow Rate					
	16		Travel %					
	17		Calculated Cv					
	18		Specific Gravity / Viscosity / Molec. Wt.			/	/	
	19		Gas: Density / Compressibility				/	
	20		Shut Off dP / Leakage Class				/	
	21		Corrosive / Erosive / NACE Cmplnce Rqd			/	/	
	22		dB Max: Allowed / Calculated			dBA	/	dBA
	23		Fail Position					
VALVE	24		Valve Type / Body Style / Port Size			/	/	
	25		Process Connection: Size / Type / Rating			/	/	
	26		Rated Cv / CV Note				/	
	27		Flashing / Cavitation				/	
	28		F-F Dimension / Weight				/	
	29		Material: Body / Cage / Bolts			/	/	
	30		Material: Bearing / Liner / Seat			/	/	
	31		Material: Stem / Packing				/	
	32		Trim: Type / Form / Balanced / Matl		/		/	/
	33		Bonnet: Type / Material				/	
	34		Flow Direction / Valve Travel				/	
	35							
ACTUATOR	36		Type / Manufacturer				/	
	37		Size / Weight / Material / Orientation		/		/	/
	38		Bench Range / Travel Time: Open/Closed				/	
	39		Tubing: Material / Size				/	
	40		Position Indicator: Manuf. / Model No.				/	
POSITIONER	41		Type / Manufacturer / Model No.			/	/	
	42		Enclosure Rating / Signal Type				/	
	43		Valve Action On Increasing Signal					
	44		Gauges / Bypass				/	
	45		Mounting Kit: Type					
	46		Bracket Matl / Finish				/	
	47		Bolt Matl / Finish				/	
OPTIONS	48		Air Supply / Air Set				/	
	49		Mechanical Override / Lube Valve				/	
	50		Vol Tank Capacity / Air Fail Vlv / Set At			/	/	
	51		Solenoid: Manufacturer / Model / Tag No			/	/	
	52		Solenoid Electrical Supply: Voltage / Freq				/	
	53							
PURCHASE	54		Manufacturer					
	55		Model Number					
	56							
	57		Package Number					
NOTES								

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SECTION 40 90 10
INSTRUMENTATION AND CONTROL SUMMARY OF WORK
TURBINE 7 PROCUREMENT PACKAGE

PART 1 GENERAL

1.01 INSTRUMENTATION AND CONTROLS

A. The Turbine 7 Project, Instrumentation and Controls scope of work includes the components associated with the new combustion turbine generator, the fuel gas compressor and the fuel gas and fuel oil conditioning equipment. The intent of the Project is to augment existing aging SWBNO generation sources with new reliable power.

B. The design and supply of equipment unique to the T7 and Compressor system or that which logically/materially impacts the T7 system design will be provided by the turbine Supplier. Reference Sections 43 12 00, Gas Compressor and 48 11 23, Combustion Turbine Generator for specific requirements. The various principle elements of the I&C Work by the turbine supplier include the following items:

1. Combustion Turbine Generator Instrumentation and Control System.
2. Fuel Gas Compressor Instrumentation and Control System.
3. Fuel Gas and Fuel Oil Conditioning Equipment Controls System.
4. On Skid interconnecting instrumentation and controls cables.

C. For information only, a separate contract will be awarded for the T7 Installation and Interconnection Work, where the installation and balance of interface design and equipment not unique to, nor supplied with the T7 system, will be completed.

D. Several specifications in the Instrument and Controls Section are multipurpose and apply to both equipment Suppliers and field installation teams. However, certain aspects of the documents may only apply to the field teams (i.e. startup). If questions of applicability arise, request clarification from the Engineer.

1.02 T7 AND COMPRESSOR I&C SYSTEM GENERAL REQUIREMENTS

A. The T7 Project is to augment and modernize the Sewerage and Water Board of New Orleans (SWBNO) electrical capacity.

B. The T7 Project is to be utility industrial grade equipment and must integrate into the overall SWBNO Process SCADA System (PSS) and the overall Power Distribution Control System (PDCS).A conceptual network architecture Drawing 1419-I-SK01 is included showing the proposed interconnections to the Supplier control systems.

C. The T7 System is, one of multiple blocks of generation integrated into the PSS and to be managed by the existing SWBNO grid control system, within the existing Power Distribution Control System (PDCS), independently or dependently.

D. The equipment supplied under the Work is to be modularized in outdoor enclosures designed for all-weather access to operate and maintain the equipment in the extreme site operating conditions, essential systems that must be able to operate reliably during extreme weather, such as hurricane, events for life critical SWBNO municipal system operation.

E. The equipment will be installed on a new concrete foundation(s) in an arrangement that facilitates coordination and integration with existing utilities.

1.03 T7 AND COMPRESSOR I&C SYSTEM(S)

A. The T7 I&C System(s) is defined as the focused equipment design and supply of the system elements that are unique to the combustion turbine generator, compressor and fuel conditioning as specified in Sections 43 12 00, Fuel Gas Compressor and 48 11 23, Combustion Turbine Generator. The T7 scope of supply shall be as self-contained as practical to reduce external material supply / quantity uncertainty risk.

B. The combustion turbine generator and compressor require miscellaneous instrumentation and control system elements for a safe, complete, and operable control system is a generalization for instrumentation and control system elements that are not otherwise explicitly specified and could be reasonably known to be required and included by a specialty system supplier.

1.04 T7 AND COMPRESSOR I&C INTERFACE WITH SITE PLANT CONTROL SYSTEMS

A. Develop a redundant combustion turbine generator control system programming based on industry standards good practices for automation systems.

B. Develop a redundant compressor control system programming based on industry standards good practices for automation systems.

C. Provide a data link (Ethernet TCP/IP, EtherNet IP, Profinet etc.) for interfacing to the plant PSS and PDCS as well as critical hardwired signals as defined in the Specifications.

D. Supplier shall coordinate with Owner and Engineer to obtain any additional information required to complete the configuration of the equipment control systems and interface/integrate with the site PSS and PDCS.

E. Develop the control system configuration and network with cyber security protection infrastructure to ensure ability to deploy essential hardware and software patches in a safe and cybersecure manor to prevent cyber breaches.

F. Develop operator graphic screens using a hierarchical scheme that include overview, subsystem, alarms, trends (real time and historical), data reports, help and diagnostics.

G. Displays shall present information in a format and size to the operators in a clear and consistent manner that meets human factors principles. Display color scheme, equipment symbols and data orientation are subject to Owner approval.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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SECTION 40 90 13
CONCEPT OF OPERATIONS FRAMEWORK

PART 1 GENERAL

1.01 SUMMARY

A. Introduction:

1. For complex systems control and operation, a shared understanding of the Stakeholders needs and expectations can help increase safety, efficiency, and satisfaction with the end-product. An industry standard approach to help document a shared system control and operation understanding, is to develop a Concept of Operations (ConOps). A ConOps is typically designed to describe how a system will function from the operator's perspective; therefore, it provides high-level description of the system and documents "use cases" which are based on key system functions. This Specification section will outline a framework for consistent development and maintenance of ConOps documents.
2. A ConOps is a living document that will evolve. As the available data changes, additional needs and functionality may be necessary. It is critical that all potential users of a system review the ConOps as changes are made to ensure that the intent of the system is being met.
3. In order to accommodate system updates, like new equipment, other system modifications, or interrelated system modifications, the affected systems may be modified too.
4. The wide range of systems and their associated control and operation are loosely divided into two supergroups for consistency in description and differentiation in approach as briefly described below and further detailed in this Specification section.
    a. Power Distribution Control System (PDCS): The PDCS primary function is to monitor and control the SWBNO managed electrical distribution network, associated generation assets, and large loads that may affect the stability of the SWBNO managed electrical distribution network or dispatch of generation assets - loosely any medium voltage (>1000V) electrical infrastructure.
    b. Process SCADA System (PSS): The PSS primary function is the monitor and control SWBNO 'process' systems.
5. Additionally, modifying and/or upgrading system(s) provides the opportunity to integrate the controls systems into a modern, network, cybersecure configurations generally grouped into the two above control systems.

B. Overview:

1. Control systems are an important component for the operation of critical infrastructure in the SWBNO service territory. This ConOps Framework includes the overarching definition and structure of key documents to achieve a uniform approach and execution of systems control and operation. The ConOps Framework deliberately describes the aggregation of control and operation documentation as discrete independent documents such that these discrete independent documents can be developed independently by different entities and ultimately organized/aggregated for the purpose of establishing a system ConOps - reference documents are an important part of a system ConOps. Key elements of the ConOps Framework include:
    a. Common Control and Operation Themes:
        1) Industrial Control System Network Architecture.
        2) Industrial Controllers.
        3) Centralized HMIs.
        4) External Interfaces.
    b. Foundational Control and Operation Nomenclature.
    c. System Specific Baseline Documentation:
        1) System Diagram (P&ID, One Line).
        2) System Description.
        3) System Sequency of Operations.
        4) System Lists.
        5) System O&M Manual.
2. Figure 1: SWBNO Overview includes an overview of the SWBNO control and operations infrastructure.

C. Purpose:

1. The purpose of a ConOps Framework is to establish a basic set of minimum requirements for system control and operation documentation to improve system control and operation safety and efficiency through consistency. While the primary purpose of a system ConOps document is to describe how systems should work from the user's perspective, the development of the document also helps to build consensus among the stakeholders.
2. To help document the user's expectations of system ConOps end product, high-level system description, use case rubric/prompt, and sample HMI screens are part of the suite of referenced documents. The purpose of use cases are to capture key functions that a system must be capable of performing, with the expectation that additional functions may be identified during the detailed design workshops/meetings. Sample HMI screens are provided to help users visualize the use cases and to help improve familiarity with the look and feel of the screens.

3. Very often the execution of system modification, additions, or other changes is by an entity outside of the day-to-day system owner(s), generally described as a 'System Integrator', with information contributions from multiple parties. The operating life of systems is also often of sufficient duration that there is a strong likelihood of system modifications, additions, or other changes by dissimilar entities where a well-documented consistent approach reduces overall effort and increases successful execution. While the System Integrator will use this document as a basis of the system development and interface design, design workshops/meetings will be required with all stakeholders as described herein to facilitate the comprehensive system ConOps as outlined in this ConOps Framework

1.02 REFERENCES

1. Related Sections: This Specification section does not stand alone and is a part of the entire Specification which is the sum-total of all the sections. Related sections listed below are listed for emphasis and do not preclude the applicability of any part of the entire Specification requirements. Related sections of particular emphasis are as follows:
   a. Section 01 33 00, Submittal Procedures.
   b. Section 01 58 53, Project Equipment Identification.
   c. Section 01 61 00, Common Product Requirements.
   d. Section 25 05 11, Cybersecurity for Industrial Control Systems.
   e. Section 40 90 00, Instrumentation and Control General Requirements.
   f. Section 40 90 10, Instrumentation and Control Summary of Work.
   g. Section 40 94 23.PDCS, PDCS ECS.
   h. Section 40 94 24.PDCS, PDCS HMI.
   i. Section 40 94 25.PDCS, PDCS Interface Specification.

B. Definitions:

1. Control System: Control System used in this Specification section is a generic designation for any control system that governs the System ConOps under the ConOps Framework.
2. System ConOps: System ConOps is the system specific Concept of Operation developed within the ConOps Framework.

ACRONYMS

AHJ	Authority Having Jurisdiction
BMCS	Building Management Control System
CR	Control Room
ConOps	Concept of Operations

DCS	Delta Control System
EMCP	Electronic Modular Control Panel
EMCS	Energy Management Control System
FPR	Feeder Protection Relay
GPR	Generator Protection Relay
HMI	Human Machine Interface
HVAC	Heating, Ventilation and Air Conditioning
OT	Operational Technology
PLC	Programmable Logic Controller
PMS	Power Monitoring System
RTAC	Real-Time Automation Controller
SCADA	Supervisory Control and Data Acquisition
UPS	Uninterruptable Power Supply
VFD	Variable Frequency Drive

1.03 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data including, but not limited to, the information listed in this Specification section where not specifically part of another submittal requirement.

1.04 QUALITY ASSURANCE

1. Risks:
   a. While all projects involve risk, complex control and operations projects have inherent risks that are different than those associated with typical construction projects. Some of the primary risks that are associated with complex control and operations projects include:
      1) Coordination between systems.
      2) Potential for changing requirements.
      3) Coordination between old and new systems during construction.
   b. The primary means of mitigating these risks start with developing the ConOps. Having key stakeholders involved in the design process helps to reduce costly design changes during the construction and increases overall satisfaction. By identifying the user needs, critical functions are included in the system ConOps. Changes made to the system during the design phase of a project cost significantly less money and less time than making changes during development and implementation phases.
2. Stakeholders: The stakeholders include personnel from several different departments and, potentially, different entities. These groups represent the major participants in developing ConOps for each system. The role

of a stakeholder and willingness to engage all potential stakeholders is critical to the sound development and vetting of system ConOps through the use of the ConOps Framework. These stakeholders broadly include:

a. Sewerage and Water Board of New Orleans (SWBNO) SWBNO is the owner, operator, and maintainer of all SWBNO utility services. SWBNO utilizes many different forms of operations and control across their varying processes. The SWBNO is organized into several different operations and maintenance groups, organized in the following high level departments.
    1) Operations: SWBNO Operations is the broad team who operate the wide variety of systems servicing each of the primary utilities operated by SWBNO; drainage, potable water, and sewerage. Within the primary operations divisions there are further focused groups within the operations groups. Operations' stake in the ConOps Framework is the definition of essential system ConOps elements necessary to operate, monitor, and manage SWBNO systems safely, reliably, efficiently, and effectively through all manner of events.
    2) Maintenance: SWBNO Maintenance is organized by skill set than operational groups. SWBNO Maintenance serves all operations groups. Maintenance's stake in the ConOps Framework is the definition of essential system ConOps elements necessary to monitor, troubleshoot, and trend system data in support of effective system maintenance.
    3) Engineering: SWBNO Engineering is organized more in-line with primary Operations groups with engineers and scientists specializing in the associated operations systems. Engineering's stake in the ConOps Framework is fundamentally overseeing the consistent implementation of the ConOps Framework objectives in support of the interests of SWBNO.
    4) Business Services: SWBNO Business Services is organized more in-line with primary Operations groups managing the business aspects in the associated operation. Business Services stake in the ConOps Framework is principally assuring identification and reporting of business necessary data within the system ConOps development.
b. Contractor: SWBNO, when not executing a project internally, will utilize a Contractor to design, supply, and/or install the Project scope of work. The scope of work is highly dependent on the Project and is defined by the Contract. Contractor stake in the ConOps Framework is principally from the equipment supplier, system commissioning, and system as-built system ConOps contributions.

c. Owner's Engineer: SWBNO, when not designing a project internally nor scoping full design to the Contractor, will utilize an Owner's Engineer to perform the Project design, engineering support during construction, and/or other services as required by the Engineering Services Agreement. Owner's Engineer stake in the ConOps Framework is often as a contributor system ConOps development, review, and approval.

d. Other: SWBNO may involve other entities not categorized in any of the above groups to support execution of a project. Other's stake in the ConOps Framework will be unique to the specific engagement of that particular entity.

PART 2 PRODUCTS

2.01 GENERAL BACKGROUND

A. This ConOps Framework discusses the System ConOps development and maintenance process as well as establishing some common guidelines for key elements applicable to System ConOps.

2.02 TYPICAL CONTROL SYSTEM OVERVIEW

A. Most Control Systems, certainly those compliant with the related sections requirements, consist of primary components that work together to provide the capability to monitor and control components of the Project or application infrastructure. These components are:

1. Industrial Control System Network.
2. Industrial Controllers.
3. Central HMI.

B. Typical Operational Concept: The ConOps Framework assumes the Control System provides a central system that monitors and controls the Project or application infrastructure. The Typical Control System monitors system elements as required to support the technical design requirements and operational Use Cases. The Typical Control System provides an HMI that allows Control System users to monitor and control analog and discrete points in the controlled System. A list of the primary system functions that need to be performed through the Control System are included in the System ConOps Use Cases.

C. External Interfaces: The ConOps Framework assumes as a starting point that Typical Control Systems include external interfaces, therefore the System ConOps development should be inclusive of external interfaces as per the specific Project or application requirements.

2.03 OPERATIONAL ENVIRONMENT

A. The ConOps Framework is intentionally broad to enable specific Project or application adaptation flexibility such as a Control System controlling single or multiple systems potentially accessible from multiple user interfaces. The ConOps Framework and System ConOps should be cognizant of the operational environment accounting for differing User Roles, HMI locations, and Remote/Local considerations.

1. User Roles: User Roles as described in relevant related sections are generally repeated here for context and application in the ConOps Framework and System ConOps. The Control System, where applicable or as defined otherwise elsewhere, will conform to the cybersecurity requirements defined in the relevant related sections influencing User Roles as described herein and in Use Cases. RMS level 0 or 1 User Roles will generally follow the same cybersecurity controls as for networked Domain Controlled User Roles.
    a. Control System Administrator: Control System Administrator Use Cases, unless defined otherwise elsewhere, will have a high level of security access and will be the only user level capable of adding and removing users and user groups from the domain. They will have access to all the Control System HMI related client and server machines. Control System Administrators will function on the domain level and they will not have access to the Control System HMI/application, unless they are also members of a Control System user group.
    b. Control System Operator: Control System Operator Use Cases, unless defined otherwise elsewhere, is the day-to-day user of the Control System responsible for monitoring and controlling equipment in a system. Access privileges are defined to enable monitoring and control of equipment located within specific area(s) to which the role is associated. Monitoring of other areas without the ability to control those areas is permissible. A Control System Operator is responsible for the safe, efficient, and reliable operation of the system(s) they are operating. The Control System Operator may need to identify the root causes of system alarms, potentially utilizing detailed system status reports and/or dedicated maintenance screens to view alarms and system parameters, in order to troubleshoot issues. This user role shall provide access to system and instrument diagnostic and troubleshooting tools. Access to utilities required for backup and restore of system information shall also be granted. This role shall have a restricted user profile so that a user will not be able to install programs or change software configuration or access any removable media.

c. Control System Engineer: Control System Engineer Use Cases, unless defined otherwise elsewhere, will have high-level access to all Control System servers, clients and workstations. The Engineer has high domain level security access and is able to add and remove software, delete files and reconfigure system and Control System related applications. The Engineer group is also provided complete access to the HMI applications for operation as well as design.

d. Management (View Only): Management Use Cases, unless defined otherwise elsewhere, will be allowed login to the Control System HMI client sessions. The Observer group can monitor the system, but all control functions will be inhibited. This will be the default state for a new user.

2. Facilities: Access to a Control System, as specified in relevant related sections, could be provided at multiple locations throughout the SWBNO infrastructure. Access to Control Systems shall be incorporated into the Use Case analysis.

3. Remote / Local Control: In general, control functions can be performed locally and, in some cases, remotely via the Control System. For the purposes of ConOps Framework and System ConOps context, the following terminology, as defined in the applicable related sections, can be used in System ConOps Use Cases, unless defined otherwise elsewhere.

   a. Remote Control: System ConOps Use Cases shall take into account remote control of the system is provided through the Control System. The Control System can control the system through automatic control, a pre-programmed sequence, or through manual HMI control. Remote control via the Control System can be provided from the following location types:

      1) Control System CR HMI: The Control System CR HMI includes the Control System Operator Workstation(s) and provides the capability to monitor status of the system, initiate a pre-programmed sequence, and remotely control devices. When the system is in remote control, the operators at the Control System CR HMI are managing the Control System.

      2) Control System Remote HMI: Control System Remote HMI panel that is installed local to a particular system can only control the devices that are in eyesight of the Remote HMI. These devices are being controlled through the Control System. Through the Control System Remote HMI the operator is able to monitor the status of the system, initiate a pre-programmed sequence, remotely control devices; however, the Control System Remote HMI control will be limited to controlling the devices within the local area in which the Remote HMI is housed. In order for the system to

be controlled through the Control System Remote HMI, an operator at the Control System CR HMI must grant control to the Control System Remote HMI. When this happens, the operator at the Control System CR HMI does not have the ability to make changes to the system. This is intended to help protect any Control System operators or maintainers who may be working on the system locally.

b. Local Control: System ConOps Use Cases shall take into account local control of a device is provided by the local operator interface that is in close proximity to the device or from the device itself. When the system is in local control, or being controlled in one of these methods, the Control System is not actively controlling the device. An Operator or Maintainer will physically toggle a switch to put the device into local control. The types of local control are defined as:
   1) Local HMI: A local HMI panel that is local to the device and can only control a particular device. Since the local HMI panel is external to the CR HMI; when the device is in local and being controlled from the local HMI, the Control System cannot change the local system. The device can still provide status information to the Control System.
   2) Local Manual: Hardwired Controls or physical manipulation of a device, such as opening / closing a valve. The device can still provide status information to the Control System.

4. Control Methods: System ConOps shall take into account, unless defined otherwise elsewhere, the control methods will indicate how the actions will be initiated. The control methods for the Control System include:
   a. Automatic: In the automatic control, the Control System will run based on pre-programmed sequences which are triggered through system setpoints.
   b. Pre-Programmed: The Control System shall provide the user the capability to initiate a pre-programmed sequence. This would enable the user to activate a sequence on demand by selecting a button on the Control System HMI.
   c. Manual HMI Control: The Control System shall provide the user the capability to remotely control certain devices or systems by selecting the device and changing the status. Manual control through the Control System shall be provided at:
      1) Control System CR HMI.
      2) Control System Remote HMI.
   d. Manual Device Control: Some devices can also be controlled through a local HMI panel or from a physical switch at the device.
      1) Local HMI - Local to equipment.
      2) Local Manual - Hardwired Controls.

PART 3 EXECUTION

3.01 SYSTEMS

A. The SWBNO operations consist of many ‘systems’, whether they be civil, structural, mechanical, electrical, instrumentation, or controls, that working together or independently result in the delivery of SWBNO services. A ‘systems’ approach organizes a logical set of objects, be it equipment, materials, products, etcetera, by their function. The ConOps Framework establishes the broad consistent purpose, organization, and content of a System ConOps. The System ConOps is ‘system’ specific and unique to a specific ‘system’.

B. Systems are Project and application specific and are defined in many places but are generally referenced in the ConOps Framework as listed in the Master System Index. The Master System Index can be more specifically limited in a Project or application specific set of Drawings. The Master System Index provides a SWBNO wide aggregation of Project or application defined ‘systems’, yet it may not always agree with a Project or application specific set of Drawings, although that is the ultimate objective of the Master System Index.

3.02 USE CASES

A. Use Cases provide insight into how an Operator will interact with the Use Case defined Control System. The Use Case in combination with any or all of Sample Screens, Sequence of Operations, the Flow Diagrams, or the Control System Input/Output List provide the intended content of the System ConOps.

B. A Use Case defines the interactions between external actors and the system under consideration to accomplish a goal. While Operations can modify how tasks are accomplished, it is critical that key tasks are identified as early in the System ConOps development process as practical. Understanding of system key tasks may reveal or drive changes in functionality or system requirements, which may also necessitate changes to the physical design of the system; such changes can be accommodated with a lower incremental cost at the earlier they are discovered in the project. Therefore, emerging functionality needs to be captured early in the design, because as the project progresses the cost of changing the design increases dramatically.

C. In order to organize and capture that Use Case information in a consistent manor, the ConOps Framework provides a Use Case Template with the below listed components. Further, as the System ConOps development process may be iterative, a System ConOps Value Rubric and System ConOps Development Flow Chart are also supplements to the ConOps Framework.

1. Use Case ID: A numbered identifier, shall include <AREA> and <SYS>

2. Use Case Control System: Control System in which Use Case is executed.
3. Use Case Name: A brief title for easy reference.
4. Description: A one or two sentence description, of the primary goals of this use case.
5. Actors: Identify who (the System or specific user groups) who are responsible for the actions in the use case.
6. Preconditions: Identify the state the system must be in prior to this activity taking place (i.e., a user with sufficient privileges is logged into the system).
7. Normal Course: The sequence of tasks, which the operator undertakes to complete the required action.
8. Alternative Course: If applicable, extend the normal course to show alternate means of accomplishing the goal.
9. Screen(s): Sample Screens, if any apply to the Use Case, will be indicated here and included with System ConOps.

D. Operational Modes: The Control System identified in the Use Case will operate in different modes. To help identify all conditions of the system, the Use Cases will be organized based on the Control System modes. The following Operational Modes are commonly utilized but are not intended to be all inclusive nor exclusive for the System ConOps application, therefore application specific Operational Modes may be utilized as prudent and required where those listed below are insufficient for the specific application.

1. Normal Mode: The system operates with no hardware or software failures. The Control System should operate automatically and adjust to any changing system conditions. Also, users can perform functions using preprogrammed sequences or standard operating procedures. These Use Cases may include alternative courses or steps, which are options Users can take to complete certain steps. These alternative courses are still considered standard operating methods.
2. Degraded Mode: An error occurs in the system that affects the Control System functionality and causes the user to deviate from standard operating procedures. Since the system has not completely failed, it is still operational, but it operates with reduced capabilities. When there is a device failure or a software bug, the degraded modes are handled as alternatives in the Use Cases.
3. Maintenance Mode: Periodically the Control System will need preventative or emergency maintenance. The system can be put into a maintenance mode to perform this work. The system operates with certain devices or components that are isolated. The user follows modified procedures.
4. Testing Mode: Procedures followed to test the system’s functionality without affecting normal operating procedures.

5. User Access:
    1) Control Systems often have User Account controlled varying levels of access to different functions, providing intentional ‘role’ based User functionality.
    2) Standard User access rights are identified as:
        a) Monitor and Reporting Only: Users will be able to view the status and generate reports.
        b) Monitor and Control: Users will be able to view status of the systems, activate pre-programmed sequences, and manipulate devices.
        c) System Configuration: Users will be able to configure or adjust settings.
        d) N/A: Use group does not have access to the function.

3.03 SAMPLE SCREENS

A. Sample Screens provide a general look and feel of the HMI screen for the Use Case.

B. To help design and implement a Control System that meets all of the stakeholder requirements and is intuitive to the end users, Sample Screens are included, where applicable/available to augment Use Cases. Sample Screens are designed in accordance with the appropriate HMI Specification section and/or Graphics Standard. The intention of the Sample Screens in Use Cases are to help Users visualize the overall look and feel of the system.

3.04 SEQUENCE OF OPERATIONS

A. Sequence of Operations’ provide step-by-step procedures for how the Control System shall operate under certain conditions to achieve a desired predictable outcome. A Sequence of Operations are intended to be in outline form to convey an operational sequence simply and logically. Sequence of Operations are driven by Use Cases and include both Operator driven decisions and automated Control System decisions/actions. Sequence of Operations are often supported by a corresponding System Logic Flow Diagram.

1. Mechanical Sequence of Operations: In mechanical sequences, the first column lists an action that is performed by the system or a Control System operator. When specific valves, pumps, or other devices are impacted, the device and status is listed. Additionally, in the columns to the left, which list the devices, the device status will be indicated. For example, if that step in the sequence involves a valve opening, then the status of the valve is listed as “Open” in the corresponding column.

2. Electrical Sequence of Operations: In electrical sequences, the first column lists an action that is performed by the system or a Control System operator. When specific breakers or devices are impacted, the device and status is listed. The columns to the left list the electrical switchgear, motor control center, or relevant electrical equipment. An asterisk is used to indicate which electrical equipment the controlled electrical device is associated with.

3.05 SYSTEM LOGIC FLOW DIAGRAM

A. System Logic Flow Diagrams display the Sequence of Operations utilizing several basic logic operators.

1. Operator Selection.
2. Automated Process.
3. Operator Physically Completed Process.
4. Automated Decision.
5. Collected Data.
6. Alarm/Signal/Light.
7. Task Outside System.
8. State.

3.06 CONTROL SYSTEM INPUT/OUTPUT LIST

A. The Control System Input/Output List provides a detailed list of the points in the particular Control System.

3.07 WORKSHOPS

A. Workshops are structured working meetings to facilitate a desired outcome. ConOps Workshops are intended to enhance the collaboration of key system stakeholders during the development of System ConOps'. During a ConOps Workshop the System ConOps facilitator will manage the Workshop to drive the desired outcome. Some basic principles and objectives of a ConOps Workshop are outlined below; these principles and objective are guides only and are substantially influenced by the nature of the Project and Project phase driven purpose of the workshop. The most comprehensive workshop regimen would include as many as five workshops at progressively advanced stages of system design.

1. 40 percent System Design: 'system'(s) to be reviewed in workshop are sufficiently technically mature to have most system elements identified.
2. 75 percent System Design: 'system'(s) to be reviewed in workshop have been further refined and Use Cases are solid (80 percent).

3. 90 percent System Design: ‘system’(s) to be reviewed in workshop are past system design freeze and majority of System ConOps documentation has been developed and are ready to release to Control System Integrator.
4. Pre-FAT: ‘System’(s) to be reviewed in workshop have been configured by Control System Integrator and ready for review with expectation that review comments will be incorporated for witness in FAT.
5. Post-FAT: ‘System’(s) to be reviewed have been through FAT and FAT punch list items have been resolved with expectation that Control System will be released for shipment at conclusion of workshop.

B. Requirements Walkthrough:

1. A requirements walk-through will be hosted by the workshop facilitator with system stakeholders to step through the ConOps Framework requirements documentation in detail as driven by the workshop purpose. This ensures that the workshop results and documentation represent everyone’s complete understanding of what is to be accomplished in the workshop. This is critical for the following reasons:
   a. The stakeholders can ask questions and have responsible party(ies) provide comments about how to meet the requirements.
   b. At the workshop conclusion, the facilitator will identify actions with responsible party identified with acknowledgement from the responsible party that they accept the action.

C. Use Case Review: Use Case review is an opportunity for the Use Case author to present the Use Case to stakeholders and engage stakeholders in a Use Case validation discussion. The Use Case validation discussion will be moderated by the workshop facilitator to ensure productive time management. It is expected that, depending on stage of System ConOps development, Use Cases will require modification based on workshop.

D. Sample Screen Review: In addition to reviewing the use cases and requirements, the selected vendor shall be required to host monthly meetings, at a minimum, to review the sample screens with the system users. During these meetings, the selected vendor shall provide HMI screens that will simulate the system functionality and provide the user the ability to navigate through the screens. The purpose of these meetings is to help the users visualize the basic course of action for each use case and to help ensure that all required functionality is captured. Additionally, these meetings provide the users the opportunity to provide comments on the look and feel of the screens, make suggestions for enhancements, and possibly identify any functionality that should be added.

E. Sequence of Operations Review

F. System Flow Diagram Review

G. Control System Input/Output List Review

H. Baseline Documentation Review

3.08 SUPPLEMENTS [TO BE PROVIDED TO SUCCESSFUL BIDDER]

A. The following Supplements are intended to be informative guides within the ConOps Framework:

1. System ConOps Table of Contents (broad form).
2. System ConOps Value Rubric.
3. System ConOps Development Flow Chart.
4. Use Case Template.
5. Example Sample Screens.
6. Sequence of Operations Template.
7. Example System Flow Diagram.

3.09 REFERENCES [TO BE PROVIDED TO SUCCESSFUL BIDDER]

A. The following References are expected to be living indices pointed to individually developed discrete documents that form a part of the ConOps Framework and/or a System ConOps.

1. Master Document List/Index.
2. Master System Index.
3. Master Equipment Index.
4. Master Control System Input/Output Index.
5. Master Network IP Address Index (controlled document).

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SECTION 40 90 40
INSTRUMENTATION AND CONTROL
FOR PACKAGED MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 OVERVIEW

A. This Document specifies technical requirements associated with Instrumentation and Controls for Packaged Mechanical Equipment.

1.02 SCOPE

A. This Specification covers the basic requirements for utility industrial grade products and methods for system instrumentation and controls to ensure that the instrumentation supplied, and its installation meet the Project requirements.

B. All instruments, control valves and control systems shall comply with the requirements of this Specification. Deviations shall be allowed only after written approval for each deviation has been received from the Owner.

C. The selection of all accessories, materials, and methods of fabrication not specifically covered in this Specification, but which are necessary to complete the fabrication of control systems and equipment, shall be carried out in accordance with good engineering practices subject to written approval from the Owner.

D. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 40 90 00, I&C General Requirements.
5. Section 40 90 10, Instrumentation and Controls Summary of Work.

1.03 CODES AND STANDARDS

A. The latest edition for all codes and standards referenced in this Specification shall be the edition in effect at the time of Contract award.

B. All control systems and instruments shall be in compliance with the following Codes and Standards, where applicable:

1. American Society of Mechanical Engineers Standard (ASME):
   a. B16.34, Valves-Flanged, Threaded and Welding End.

b. B31.1, Power Piping.
c. PTC-19.2, Pressure Measurement Instruments and Apparatus.
d. PTC-19.3, Temperature Measurement Instruments and Apparatus.
e. PTC-19.3 TW, Thermowells.
f. PTC-19.5, Flow Measurement.

2. ASTM International (ASTM):
   a. E1137, Standard Specification for Industrial Platinum Resistance Thermometers.
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 1143, IEEE Guide on Shielding Practice for Low Voltage Cables.
   b. 1050, "Guide for Instrumentation and Control Equipment Grounding in Generating Stations".
   c. C 37.1, "Standard Definition, Specification and Analysis used for Supervisory Control, Data Acquisition, and Automatic Control".
   d. C 37.2, "Standard Electric Power System Device Function Numbers and Contact Designations".
   e. C37.90.1, "Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems".
4. International Society of Automation (ISA):
   a. MC 96.1, Temperature Measurement Thermocouples.
   b. RP60.6, Nameplates, Labels, and Tags for Control Centers.
   c. 75.01.01, Industrial-Process Control Valves - Part 2-1: Flow capacity - Sizing equations for fluid flow under installed conditions.
   d. 77.70, Fossil Fuel Power Plant Instrument Piping Installation.
   e. ANSI/ISA-5.1, Instrumentation Symbols and Identification.
   f. 20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   g. 50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   h. 51.1, Process Instrumentation Terminology.
5. National Electrical Manufacturers Association (NEMA):
   a. ICS-1, Industrial Control and Systems General Requirements.
   b. ICS-4, Terminal Blocks.
   c. ICS-6, Industrial Control and Systems Enclosures.
   d. 250, Enclosures for Electrical Equipment (1,000 Volts Max).
6. National Fire Protection Association (NFPA): NFPA 70, National Electrical Code.
7. All electronic equipment shall conform to the requirements of FCC Regulation Part 5, Section 15, governing radio frequency electromagnetic interference, and shall be so labeled.
8. HART Communication Foundation:
   a. HART Field Communication Protocol Specifications, Revision 7.0.

1.04 FORBIDDEN MATERIALS

A. No instrumentation or control equipment shall contain mercury or asbestos.

1.05 SUBMITTALS

A. The following types of instrument and controls documentation shall be generated:

1. Process and Instrument Diagrams (P&IDs): Using ANSI/ISA Std. 5.1-2009 symbols and tag numbering to denote instrumentation and controls, including all interfaces with rest of plant equipment.
2. Instrument Location Drawings: Instrument locations shall be shown either on dedicated Instrument Location Drawings or may be shown on Piping Plan Drawings or Electrical Plan Drawings.
3. Instrument Index:
    a. A list of all instruments including tag number, service description, manufacturer, model, type, size, and detailed operating data including ranges and set points.
    b. The instrument index shall also list control valves including tag number, service description, manufacturer, model, type, size, end connections, actuator information, min/normal/max process conditions, C (flow coefficient), and all other pertinent information.
    c. Shall be provided in both hard copy and in Microsoft Excel electronic file format.
4. I/O Lists:
    a. A list of all hardwired inputs and outputs, including: tag number, service description, signal type (AI, AO, DI, DO, TC, RTD, etc.), point characteristics (24V dc, 4-20mA, Type K, 100-Ohm PT, etc.), range (for analog points), signal power source (internal or external), PLC address, alarm setpoints, state descriptors, and other pertinent signal characteristics as required.
    b. For each PLC datalink, a list of soft points (includes calculated values and data comm links) including: tag number, service description, signal type, range, address, alarm setpoints, state descriptors, and other pertinent signal characteristics as required. The list format shall include the array name and point within the array where the datalink point is packed.
    c. Equipment Suppliers shall include in the data exchange arrays any PLC I/O points requested by other parties and shall request of other parties any PLC I/O points required in the data exchange arrays for completion of their programming.

5. Instrument Installation Drawings: For all instruments and valves shipped loose that will require installation in the field.
6. Complete wiring connection drawings.
7. Control system programming documents:
    a. For all control, monitor, alarm, shutdown or interlock loops.
    b. Logic can be in ladder logic or block diagram form.
    c. Control system logic description shall be used for monitoring and alarm functions.
8. Data Sheets:
    a. Data Sheets shall be provided for all instruments and control valves in ISA-style format, similar to those in ISA-S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
9. Provide both the native file and pdf version for each document submitted. Native files are Word, Excel, or AutoCad.

B. PLC Signal Tagging:

1. All hardwired and datalink signals between PLCs shall be assigned a unique tag per the project tagging philosophy.
2. All PLC hardwired and soft datapoint addresses (including array points) shall be documented and submitted for approval prior to the performance of a Factory Acceptance Test (FAT).
    a. Tagging must comply with Section 01 58 53, Project Equipment Identification.

C. For general Instrumentation and control requirements, see Section 40 90 00, Instrumentation and Controls General Requirements.

1.06 QUALITY ASSURANCE

A. The Supplier shall maintain a quality manual/system which meets the requirements of the applicable international quality system standard appropriate to the contracted Scope of Work throughout the duration of this Contract as well as ISO 9000 requirements.

B. The Supplier quality plan shall be issued for review and for monitoring during the Project. Reporting requirements must include the Owner/Engineer requirements and additional requirements as stated below.

C. Requirements covered by this Specification shall apply to lower tier Suppliers, including Owner/Engineer’s access (accompanied by Supplier) to facilities and records.

D. All materials and hardware to be furnished and all Work to be performed under this Specification shall be subject to review, inspection, and testing as described below.

1.07 WARRANTY AND GUARANTEES

A. Furnish Manufacturer's guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after system is operational and acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative.

PART 2 PRODUCTS

2.01 CONTROL PANELS

A. General: See control panel paragraph, in Section 40 90 00, Instrumentation and Control General Requirements.

2.02 CONTROL VALVES/SHUTDOWN VALVES

A. For control valves and shutdown valves requirements see Section 40 92 13, Process Control Valves and Regulators.

2.03 FLOW INSTRUMENTS

A. For Flow instrument requirements see Section 40 91 00, Instrumentation and Control Components.

2.04 LEVEL INSTRUMENTS

A. For Level instrument requirements see Section 40 91 00, Instrumentation and Control Components.

2.05 PRESSURE INSTRUMENTS

A. For Pressure instrument requirements see Section 40 91 00, Instrumentation and Control Components.

2.06 PRESSURE RELIEVING DEVICES

A. For Pressure Relieving Devices requirements, see Section 40 92 13, Process Control Valves.

2.07 TEMPERATURE INSTRUMENTS

A. For Temperature Instruments requirements, see Section 40 91 00, Instruments and Control Components.

2.08 PROGRAMMABLE LOGIC CONTROLLERS (PLC)

A. For PLC requirements see Section 40 91 00, Instrumentation and Controls Components.

PART 3 EXECUTION

3.01 INSTALLATION PRACTICES

A. For installation practices see Section 40 90 00, Instrumentation and Controls General Requirements.

3.02 APPROVED I&C EQUIPMENT SUPPLIERS

A. For approved I&C Equipment suppliers, see Section 40 91 00, Instrumentation and Control Components.

3.03 TESTING AND INSPECTION – GENERAL

A. The Owner reserves the right to witness tests and shall be notified at least 21 days in advance of the tests.

B. Control panels and enclosures shall be tested for proper wiring and operation before shipping.

C. The system shall be subject to Owner witnessed factory and Site acceptance tests. The system shall not be shipped from the place of assembly and configuration until the factory acceptance tests have been deemed to have been passed by the Owner.

D. Certified test reports for the tests performed shall be transmitted to the Owner prior to shipment of the system. When requested by the Owner, the Equipment Supplier shall review the test results with them and obtain approval for shipping.

E. Should the system fail a specified factory test or show abnormal results, the Equipment Supplier shall immediately inform the Owner. The cause of the problem and the proposed corrective action shall be discussed with the Owner prior to the implementation of corrective actions. After the problem is corrected, the specific system function shall be re-tested. All repair details shall be documented and included in the Test Report.

F. The Equipment Supplier shall provide to the Owner, full cooperation and assistance in any factory inspection at the Equipment Supplier's premises provided reasonable written advance notice has been given to Equipment Supplier.

G. A test procedure shall be prepared for each test which shall describe the test to be performed, the applicable item of equipment being tested, the standards and method of testing, and the testing facility's capabilities and shall state a proposed test date.

H. Owner representatives shall participate in formal design reviews at Project kickoff, and at approximately 25 percent and 75 percent completion of control logic and operator graphic development.

3.04 FACTORY DEMONSTRATION TESTS

A. For Factory Demonstration tests, see Sections 40 90 00, Instrumentation and Control General Requirements, 43 12 00, Gas Compressor and 48 11 23, Combustion Turbine Generator.

3.05 SITE ACCEPTANCE TESTING

A. For Site Acceptance Test, see Sections 01 91 14, Equipment Facility Testing and Startup, 40 90 00, Instrumentation and Control General Requirements, 43 12 00, Gas Compressor, and 48 11 23, Combustion Turbine Generator.

3.06 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer's recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be supplied new and unused, packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

3.07 PROTECTION

A. Protect equipment from construction or accidental damage during the installation period prior to system commissioning and turnover to the Owner.

END OF SECTION

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

A. The design, equipment, material and installation of the Work shall conform to requirements of the latest edition of the following codes and standards:

1. American National Standard Institute (ANSI).
2. API (American Petroleum Institute):
   a. 505, Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2.
   b. RP 551, Process Measurement Instrumentation.
   c. RP 555, Process Analysers.
   d. STD 607, Fire Test of Soft Seated 1/4 Turn Valves.
   e. SPEC 6FA, Fire Test for Valves.
3. ASME (American Society for Mechanical Engineers):
   a. B16.36, Orifice Flanges.
   b. PTC 19.3, Temperature Measurement.
   c. B1.20.1, Pipe Threads, General Purpose (Inch).
   d. MFC-3M, Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi.
4. Institute of Electrical and Electronics Engineers (IEEE).
5. The Instrumentation, Systems, and Automation Society (ISA):
   a. S5.1, Instrument Symbols and Identification.
   b. S5.2, Binary Logic Diagrams for Process Operations.
   c. S5.3, Graphic Symbols for Distributed Controls.
   d. S5.4, Instrument Loop Diagrams.
   e. S5.5, Graphic Symbols for Process Displays.
   f. S18.1, Annunciator Sequences and Specifications.
   g. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   h. S51.1, Process Instrumentation Terminology.
   i. S75.01, Flow Equations for Sizing Control Valves.
   j. S75.03, Face-to-Face Dimensions for Integral Flanged Globe-Style Control Valve Bodies (ANSI Classes 125, 150, 250, 300, and 600).

k. ANSI/ISA S75.19.01, Hydrostatic Testing of Control Valves.

6. International Organization for Standardization (ISO):
   a. 5167, Measurement of Fluid Flow by Means of Pressure Differential Devices Inserted in Circular Cross-section Conduits Running Full.
   b. TR 15377, Measurement of fluid flow by means of pressure-differential devices – Guidelines for specification of nozzles and orifice plates beyond the scope of ISO 5167-1.
7. National Electrical Code (NFPA 70 with State amendments).
8. National Electric Safety Code (NESC).
9. National Electric Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA):
    a. 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG).
    b. 72, National Fire Alarm Code.
    c. 85, Boiler and Combustion Systems Hazards Code.
    d. 86, Standard for Ovens and Furnaces.
11. FCI (Fluid Control Institute): ANSI/FCI 70-2, Control Valve Seat Leakage.
12. UL Rated Components.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.

3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral differential pressure regulators:
    a. For water service.
    b. For air service for level ranges greater than 10 feet of water.
7. Rotameters for water service.
8. Manufacturers and Products:
    a. ABB (Fischer & Porter); Series 10A3130.
    b. Brooks; Series DS-1350.
    c. "Or-equal."

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
    a. Anderson, Greenwood and Co.; Type M1.
    b. Swagelock.
    c. Rosemount
    d. "Or-equal."

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
    a. Ashcroft Utility; Gauge Series 1000.
    b. Marsh; Standard Gauge Series.
    c. Ametek U.S.; Gauge Series P500.
    d. Acculite; Series 2000.
    e. "Or-equal."

D. Valve, Needle:

1. Materials: Stainless steel, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers:
    a. Whitey.
    b. Hoke.

c. Swagelok.
d. “Or-equal.”

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Stainless steel, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
3. Manufacturers and Products:
   a. Whitey
   b. Hoke.
   c. Swagelock.
   d. “Or-equal.”

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: stainless steel, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
3. Manufacturers:
   a. Whitey.
   b. Hoke.
   c. Swagelock.
   d. “Or-equal.”

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
3. Manufacturers:
   a. Whitey.
   b. Hoke.
   c. Swagelok.
   d. “Or-equal.”

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
   c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.

5. Manufacturers:
   a. Whitey.
   b. Hoke.
   c. Swagelok.
   d. “Or-equal.”

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Stainless Steel construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Test Tap:

1. Manufacturers and Products:
   a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
   b. Crawford Fitting Co.: Swagelok quick-connects Series QC4 and caps QC4-DC.
   c. Parker; CPI Series precision quick couplings.

K. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on the Drawings.

L. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Manufacturers and Products:
      1) Swagelok tube fittings.
      2) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
      3) “Or-equal.”
2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.
      4) “Or-equal.”

M. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

N. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on the Drawings and as required in this section.
2. Pressure Gauge Scale Range: 150 percent of the process variable.
3. Mounting:
    a. Within consoles, panels, or a separate enclosure as shown.
    b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

O. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer's recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
4. Manufacturers:
    a. Globetray.
    b. Cope.
    c. "Or-equal."

P. Air Supply Sets:

1. Parts: Integrally Mounted:
    a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
    b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
    c. Pressure gauge.
    d. Inlet filter muffler.
    e. Power: 120V ac.
    f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
    g. Manufacturers and Products:
        1) ITT Pneumotive; GH Series.
        2) Gast.

2. Simplex Air Supply Sets:
   a. Air Receiver: 2 gallons.
   b. Compressors: One.
3. Duplex Air Supply Sets:
   a. Air Receiver: 20 gallons.
   b. Compressors: Two.
   c. Automatic Failover Control: Factory set at 20 psig.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Standard DIN rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: Minimum of one at each end of rail.
   g. Wire Preparation: Stripping only permitted.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
      5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
   j. Test Plugs: Soldered connections for 18 AWG wire.
      1) Pin Diameter: 0.079 inch.
      2) Quantity: 10, 20, 40 (need two plugs per test meter).

3) Manufacturer and Product: Entrelec; Type FC2.
4) "Or-equal."

2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Test Sockets: One screw test socket 0.079-inch diameter.
   h. Manufacturer and Product:
      1) Entrelec; Type M4/6.T.
      2) "Or-equal."
3. Terminal Block, Ground:
   a. Wire Size: 24 AWG to 10 AWG.
   b. Rated Wire Size: 10 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Electrically grounded to mounting rail.
   f. Manufacturer and Product:
      1) Entrelec; Type M4/6.P.
      2) "Or-equal."
4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product:
      1) Entrelec; Type M4/6.SNT.
      2) "Or-equal."
5. Terminal Block Diode:
   a. Rated Voltage: 24V dc.
   b. Rated Current: 30 ma.
   c. Wire Size: 16 AWG.
   d. Manufacturer and Product:
      1) Phoenix Contact ST-IN.
      2) "Or-equal."
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.

f. Fuse: 0.25 inch by 1.25 inches.
g. Indication: LED diode 24V dc.
h. Spacing: 0.512 inch, maximum.
i. Manufacturer and Product:
1) Entrelec; Type ML10/13.SFD.
2) "Or-equal."

7. Terminal Block, Fused, 120V ac:
a. Rated Voltage: 600V ac.
b. Rated Current: 25 amp.
c. Wire Size: 22 AWG to 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Gray body.
f. Fuse: 0.25 inch by 1.25 inches.
g. Indication: Neon lamp, 110V ac.
h. Leakage Current: 1.8 mA, maximum.
i. Spacing: 0.512 inch, maximum.
j. Manufacturer and Product:
1) Entrelec; Type ML10/13.SFL.
2) "Or-equal."

8. Terminal Block, Fused, 120V ac, High Current:
a. Rated Voltage: 600V ac.
b. Rated Current: 35 amps.
c. Wire Size: 18 AWG to 8 AWG.
d. Rated Wire Size: 8 AWG.
e. Color: Gray.
f. Fuse: 13/32 inch by 1.5 inches.
g. Spacing: 0.95 inch, maximum.

9. Manufacturer and Product:
a. Entrelec; Type MB10/24.SF.
b. "Or-equal."

B. Relays:

1. General:
a. Relay Mounting: Plug-in type socket.
b. Relay Enclosure: Furnish dust cover.
c. Socket Type: Screw terminal interface with wiring.
d. Socket Mounting: Rail.
e. Provide holddown clips.

2. Signal Switching Relay:
a. Type: Dry circuit.
b. Contact Arrangement: 2 Form C contacts.
c. Contact Rating: 5 amps at 24V dc and 120V ac.
d. Contact Material: Gold or silver.
e. Coil Voltage: As noted or shown.

f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Seal Type: Hermetically sealed case.
k. Manufacturer and Product:
    1) Tyco Electronics (Potter and Brumfield); Series KH/KHA.
    2) "Or-equal."

3. Control Circuit Switching Relay, Nonlatching:
    a. Type: Compact general purpose plug-in.
    b. Contact Arrangement: 3 Form C contacts.
    c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
    d. Contact Material: Silver cadmium oxide alloy.
    e. Coil Voltage: As noted or shown.
    f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
    g. Expected Mechanical Life: 10,000,000 operations.
    h. Expected Electrical Life at Rated Load: 100,000 operations.
    i. Indication Type: Neon or LED indicator lamp.
    j. Push-to-test button.
    k. Manufacturer and Product:
        1) TE Connectivity (Potter and Brumfield); Series KUP.
        2) "Or-equal."
4. Control Circuit Switching Relay, Latching:
    a. Type: Dual coil mechanical latching relay.
    b. Contact Arrangement: 2 Form C contacts.
    c. Contact Rating: 10A at 28V dc or 120V ac.
    d. Contact Material: Silver cadmium oxide alloy.
    e. Coil Voltage: As noted or shown.
    f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
    g. Expected Mechanical Life: 500,000 operations.
    h. Expected Electrical Life at Rated Load: 50,000 operations.
    i. Manufacturer and Product:
        1) TE Connectivity (Potter and Brumfield); Series KB/KBP.
        2) "Or-equal."
5. Control Circuit Switching Relay, Time Delay:
    a. Type: Adjustable time delay relay.
    b. Contact Arrangement: 2 Form C contacts.
    c. Contact Rating: 10A at 30V dc or 277V ac.
    d. Contact Material: Silver cadmium oxide alloy.
    e. Coil Voltage: As noted or shown.
    f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
    g. Repeatability: Plus or minus 2 percent.
    h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
    i. Time Delay Setpoint: As noted or shown.

j. Mode of Operation: As noted or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturer and Products:
1) TE Connectivity (Potter and Brumfield); Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.
2) "Or-equal."

C. Surge Suppressors:

1. General:
a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
b. Response: 5 nanoseconds maximum.
c. Recovery: Automatic.
d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
2. Suppressors on 120V ac Power Supply Connections:
a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
b. First-Stage Clamping Voltage: 350 volts or less.
c. Second-Stage Clamping Voltage: 210 volts or less.
d. Power Supplies for Continuous Operation:
1) Four-Wire Transmitter or Receiver: Minimum5 amps at 130V ac.
2) All Other Applications: Minimum 30 amps at 130V ac.
3. Suppressors on Analog Signal Lines:
a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
1) DC Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
2) DC Clamping Voltage Tolerance: Plus or minus 10 percent.
3) Maximum Loop Resistance: 18 ohms per conductor.
4. Manufacturers and Products:
a. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
b. 120V ac Lines: Emerson Edco HSP-121.
c. Field Mounted at Two-Wire Instruments:
1) Encapsulated in stainless steel pipe nipples.
2) Emerson Edco SS64 series.

d. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
   1) Enclosure:
      a) NEMA 4X fiberglass, Type 316 stainless steel with door.
      b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   2) Emerson Edco; SLAC series.

D. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
   a. Protect instruments from damage due to power supply failure.
   b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
   a. Type: Indicating.
   b. Mount so fuses can be easily seen and replaced.
   c. UL 508 Listed required.

E. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

2.04 PROGRAMMABLE LOGIC CONTROLLERS, FIELDBUS AND NETWORK COMPONENTS

A. The following criteria apply to PLC- (programmable logic controller) based, control packages required for general, such as Plant Scada System (PSS), or specific self-contained purpose based control package system(s). All deviations must be approved in writing by the Engineers.

B. All PLC systems shall conform to the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems and its associated datasheet.

C. PLC systems shall include the processor, I/O modules, module power supplies, analog I/O power supply, digital input wetting power supplies, operator interface, programming terminal, data highway hardware, datalink communication interface (as applicable), programming software, and runtime application software. All software, including programming licenses and operating licenses, is to be provided with the PLC such that no additional software will need to be purchased by Others to program, test, or operate the equipment.

D. Where shown on the Drawings and specified in detailed Specifications, provide redundant PLC Systems.

E. PLCs shall be manufactured by Allen-Bradley. For large PLC Systems (>100 I/O) such as the overall Plant Control System, the PLC shall be the ControlLogix series. For smaller PLC systems (<100 I/O), the PLC may be the ControlLogix or Compact Logix series. Other Suppliers shall be submitted to Owner for approval.

F. Software for Control Logix/Compact Logix PLCs shall be Rockwell Logix 5000 or Studio5000 Logix Designer. For OIT/HMI, software shall be "GE iFIX" "Or-equal," Owner approval.

G. Spares:

1. PLCs shall have at least 20 percent spare I/O of each type.
2. PLCs shall have at least 20 percent spare I/O rack slots for future cards.
3. PLC power supplies shall have at least 20 percent spare capacity.
4. PLC control panels shall have at least 20 percent spare terminal blocks for landing of field wiring.
5. PLC control panels shall have at least 20 percent spare space for installation of future equipment.

H. All PLC systems shall communicate with each other or with the PSS as shown on the Drawing 1419-I-SK-01, Conceptual architectural network drawing.

I. All PLCs shall have Fiber Optic/Ethernet Media Converters and patch panels in the PLC control panel for connections to Data Highway and Datalinks as shown on network drawings. Converters shall accept multimode type 50/125 micron core/cladding fiber or single mode 8.2/125 micron core/cladding fiber depending on the application. The media converters shall be powered from the PLC control panel's internal power distribution system.

J. Selected existing non-PLC equipment with remote communication capability will be modified to connect with the overall PSS using a dedicated Ethernet Datalink with Ethernet I/P protocol.

K. The PLC shall provide an alarm for any power supply failure. Alarms shall also be provided for any processor and I/O module failures.

L. Analog and discrete inputs which are powered from sources external to the PLC system shall be isolated. Minimum acceptable common mode isolation voltage is 250 volts.

M. Operator interface computers in control rooms and similarly climate-controlled areas shall be desktop PC type with the following features as a minimum:

1. Dual monitor, flat panel widescreen with minimum 22-inch diagonal, 1920 by 1200 resolution.
2. i7 Intel® processor, 8 cores, 4.8 GHz turbo 24MB Cache.
3. 8 GB, DDR3 RDIMM Memory, 1333 Mhz, ECC (Four 2GB DIMMs).
4. Four DMS59, 1 TB 3.5-inch SATA, 7.2K rpm Hard Drives per HMI workstation; configured for 2x RAID 1.
5. Two, 10/100/1000 Ethernet card with appropriate Ethernet Driver supporting 802.3ad.
6. 8X DVD+/-RW SATA optical drive.
7. Dual NVIDIA Quadro K2000 512MB, NVS 300.
8. Standard Windows USB keyboard and mouse ports.
9. All cables necessary for the PCMS installation to function correctly.
10. Where shown on the Drawings and specified in detailed Specifications provide redundant computers with hot back up.
11. Windows Operating System, version as required to support PLC and HMI software.

N. Operator interface computers on the plant floor shall be panel mount industrial PCs with touchscreen display and shall be suitable for the environment in which they are installed (NEMA 4X minimum for explosion proof for Class I Division 2 Group D areas, NEMA 12 for indoor plant).

1. Display Size: 17 inch.
2. Display Type: Color TFT LCD, 1024 x 768 XGA, 18-Bit Color Graphics.
3. Memory: 512MB RAM and 512MB Storage, 80MB NonVolatile Storage for Applications.
4. Secure Digital (SD) Card Slot: One.
5. Operating Temperature: 32-131F.
6. Relative Humidity: 5-95 percent Non-condensing.

7. Communication Ports:
   a. 2 - 10/100Base-T Ethernet Ports (supports Star, Linear, or Device Level Ring Topology).
   b. 1 – 10/100Base-T Ethernet Port (with IEEE 1588 support)
   c. 1 – USB-A and 1 – USB-B.
8. Manufacturers:
   a. Allen-Bradley Panel View Plus 7 Performance.
   b. "Or-equal."

O. Network Switches:

1. Ethernet Switch (ESW):
   a. Full compliance with IEC 61000 6-2 and 6-4.
   b. Supports 10Mbit/s Ethernet, 100Mbit/s Fast Ethernet and 1000Gbit/s Gigabit Ethernet via RJ45 connectors and Ethernet SFP Fiber Ports.
   c. Power: 120V ac.
   d. Port as required to provide two spare copper ports.
2. Manufacturers:
   a. CISCO 9300 Catalyst Series.
   b. "Or-equal."

2.05 I&C COMPONENTS

A. Conductivity Element and Transmitter:

1. General:
   a. Function: Measure, indicate, and transmit conductivity of noted process liquid.
   b. Sensor Type: Probe with either electrode or electrodeless sensor, as noted.
   c. Transmitter Type: Either two wire or four wire, as noted.
   d. Parts: Element, transmitter, interconnecting cable, junction box (if specified) and expendables.
2. Performance:
   a. Process Liquid: As noted.
   b. Process Range: As noted.
   c. Accuracy: Plus or minus 0.5 percent of measured range.
3. Features: Temperature Compensation: Automatic thermocompensator for process liquid temperatures 0 degrees to 200 degrees C.
4. Element:
   a. Type: Electrode, unless otherwise noted.
   b. Electrode Material: Type 316 stainless steel or titanium, unless otherwise noted.

c. Other Wetted Parts: Type 316 stainless steel or nonmetallic synthetic materials; manufacturer to confirm material compatibility with process liquid.
d. Probe Constant: As noted.
e. Process Connection: Insertion, 3/4-inch NTP, unless otherwise noted.
f. Mounting Hardware: As recommended by manufacturer for specific application and as shown on the Drawings.

5. Transmitter:
   a. Type: Four wire, unless otherwise noted.
   b. Features:
      1) Indicator: LCD Back-lit digital display.
      2) Scale Range: As noted.
      3) Contact Setpoint: Setpoint adjustable from 0 percent to 100 percent of full range, initial setting as noted.
   c. Signal Interface:
      1) Output: Isolated 4 mA to 20 mA dc for load impedance 0 ohm to 500 ohms minimum for 24V dc supply without load adjustments.
      2) Digital Communications: As noted.
      3) Contacts:
         a) When noted, SPST rated 3A continuous at 120V ac, minimum.
         b) Setpoint, as noted.
   d. Enclosure:
      1) Type: NEMA 4X/IP65.
      2) Mounting:
         a) Wall, unless otherwise noted.
         b) Mounting brackets.
   e. Power:
      1) Four-wire: 115V ac, unless otherwise noted.
      2) Two-wire: Loop powered.
   f. Additional Features:
      1) TPC or PID Control: If noted.
      2) HART Communication: If noted.
      3) FM Approved Class I Div 2: If noted or shown.
      4) FM Approved Class I Div 1: If noted or shown.
6. Cable: Length as required to accommodate device locations.
7. Junction Box (weatherproof): If noted.
8. Expendables (for Each Unit Provided): One 16-oz bottle 2,000 microS/cm conductivity standardizing solution if appropriate for noted range.

9. Manufacturers and Products (Four-Wire Units):
    a. Rosemount Analytical:
        1) Electrode Type: Model 400 series conductivity element and Model 54eC transmitter.
        2) Electrodeless Type: Model 228 series electrodeless conductivity element and Model 54eC transmitter.
    b. Foxboro:
        1) Electrode Type: Model 871CR contacting conductivity element and Model 875CR transmitter.
        2) Electrodeless Type: Model 871EC electrodeless conductivity element and Model 875EC transmitter.
    c. Hach—GLI International:
        1) Electrode Type: Model 3400 series contacting conductivity element and Model C53 series transmitter.
        2) Electrodeless Type: Model 3700E series electrodeless conductivity element and Model E53 series transmitter.
    d. Endress+Hauser:
        1) Electrode Type: Model W/H CLS XX contacting conductivity element and Model Mycom S CLM 153 transmitter.
        2) Electrodeless Type: Model InduMax P CLS 50 electrodeless conductivity element and Model Mycom S CLM 153 transmitter.
10. Manufacturers and Products (Two-Wire Units):
    a. Rosemount Analytical:
        1) Electrode Type: Model 400 series conductivity element and Model 5081C transmitter.
        2) Electrodeless Type: Model 228 series electrodeless conductivity element and Model 5081T transmitter.
    b. Foxboro:
        1) Electrode Type: Model 871 CR series contacting conductivity element and Model 870ITCR series transmitter.
        2) Electrodeless Type: Model 871 EC series electrodeless conductivity element and Model 870ITEC transmitter.
    c. Hach GLI International:
        1) Electrode Type: Model 3400 series conductivity element and Model Pro C3 transmitter.
        2) Electrodeless Type: Model 3700E series electrodeless conductivity element and Model Pro E3 transmitter.
    d. Endress+Hauser:
        1) Electrode Type: Model W/H CLS XX series conductivity element and Model Liquiline M CM42 transmitter.

2) Electrodeless Type: Model InduMax P CLS 50 series electrodeless conductivity element and Model Liquiline M CM42 transmitter.

e. "Or-equal."

B. ORP Element and Transmitter:

1. General:
   a. Function: Measure, indicate, and transmit ORP of process fluid.
   b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.
2. Performance:
   a. Element:
      1) Process Range: If and as noted.
      2) Range: Minus 1500 to plus 1500 mV.
      3) Operating Temperature: 32 degrees F to 185 degrees F.
      4) Operating Pressure: 100 psig maximum at 149 degrees F.
   b. Analyzer/Transmitter:
      1) Range: Minus 1400 mV to plus 1400 mV.
      2) Accuracy: Plus or minus 1 mV.
      3) Repeatability: Plus or minus 1 mV.
      4) Stability: Plus or minus 1 mV per month, noncumulative.
      5) Operating Temperature: Minus 32 degrees F to plus 122 degrees F.
      6) Operating Humidity: 95 percent maximum; relative humidity, noncondensing.
3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Body Style: Convertible with 1-inch NPT on both ends.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid.
   e. No field-replaceable parts, unless otherwise noted.
   f. Electrode Type: Flat glass or general purpose, unless otherwise noted.
   g. Integral Preamplifier: Required, unless otherwise noted.
   h. Mounting/Process Connections: As shown on the Drawings or as noted from among the following:
      1) Submersion:
         a) Sensor handrail assembly.
         b) Handrail mounting kit.
      2) Flow-through:
         a) 3/4-inch NPT PVC tee.
         b) 1-inch NPT PVC tee.
         c) 1-1/2-inch NPT PVC tee.
      3) Insertion.

4) Hot-Tap Retractable:
a) Suitable for 64-psig line pressure, unless otherwise noted.
b) 1-1/4-inch ball valve kit, unless otherwise noted.
c) Titanium Tube: 21 inches (12-inch insertion), unless otherwise noted.

i. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.

4. Analyzer/Transmitter:
a. Display: Graphic LCD, with backlighting.
b. Signal Interface:
1) Analog Outputs: Two isolated 4 mA to 20 mA dc outputs (ORP and temperature).
2) Discrete Outputs:
a) Process Alarms: Two SPSTs minimum, normally open.
b) Sensor/Analyzer and Process Fault Alarm: SPDT.
c) Contact Rating: 120 volts, 5 amps, resistive.
c. Enclosure.
1) Type: NEMA 4X.
2) Suitable for panel, 2-inch pipe, or wall mounting.
a) Wall and 2-inch mounting kit, unless otherwise noted.
d. Power: 115V ac, 50/60-Hz, unless otherwise noted.
e. Interconnecting Cable: Length as required.
f. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
5. Expendables (for each unit provided):
a. Chemicals:
1) ORP reference solution.
2) 32 ounces, minimum.
6. Accessories:
a. Junction Box: If noted.
1) NEMA 4X box for cable extension.
b. Rosemount Analytical; Model 399 (water), Model 396P (wastewater), or Model 396R (retractable) sensor and Model 54e ORP analyzer.
c. Hach; Digital Differential ORP sensor and sc100 controller.
d. Foxboro; 871A series ORP sensor and Model 875PH Intelligent Analyzer.
e. “Or-equal.”

C. pH Element and Transmitter:

1. General.
a. Function: Measure, indicate, and transmit pH of process fluid.

b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.

2. Performance:
   a. Element:
      1) Range: 0 pH to 14 pH.
      2) Operating Temperature: 32 degrees F to 158 degrees F.
      3) Operating Pressure: 80 psig maximum at 149 degrees F.
   b. Analyzer/Transmitter:
      1) Range: 0 pH to 14 pH units.
      2) Accuracy: Plus or minus 0.02 pH units.
      3) Repeatability: Plus or minus 0.05 pH units.
      4) Stability: Plus or minus 0.01 pH units per month, noncumulative.
      5) Operating Temperature: Minus 4 degrees F to plus 104 degrees F.
      6) Operating Humidity: 5 percent to 95 percent; relative humidity, noncondensing.
3. Element:
   a. Process Connection: 1-inch MNPT.
   b. Body Style: Convertible with 1-inch NPT on both ends.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid.
   e. No field-replaceable parts, unless otherwise noted.
   f. Electrode Type: Flat glass or general purpose, unless otherwise noted.
   g. Integral Preamplifier: Required, unless otherwise noted.
   h. Mounting/Process Connections: As shown on the Drawings or as noted from among the following:
      1) Submersion:
         a) Sensor handrail assembly.
         b) Handrail mounting kit.
      2) Flow-through:
         a) 3/4-inch NPT tee.
         b) 1-inch NPT tee.
         c) 1-1/2-inch NPT tee.
      3) Insertion.
      4) Hot-Tap Retractable:
         a) Suitable for 64-psig line pressure.
         b) 1-inch ball valve kit.
         c) Titanium Tube: 21 inches (12-inch insertion).
   i. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
      1) Install in accordance with manufacturer’s instructions and applicable codes.

4. Analyzer/Transmitter:
    a. Display: Graphic LCD, with backlighting.
    b. Signal Interface:
        1) Analog Outputs: Two isolated 4 mA to 20 mA dc outputs (pH and temperature).
        2) Discrete Outputs:
            a) Process Alarms: Two SPSTs minimum, normally open.
            b) Sensor/Analyzer and Process Fault Alarm: SPDT.
            c) Contact Rating: 120 volts, 5 amps, resistive.
    c. Enclosure.
        1) Type: NEMA 4X.
        2) Suitable for panel, 2-inch pipe, or wall mounting.
    d. Power: 115V ac, 50/60-Hz, unless otherwise noted.
    e. Interconnecting Cable: Length as required.
    f. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
5. Expendables (for each unit provided):
    a. Chemicals: 1 pint each of buffer solution for pH 4, pH 7, and pH 9.
6. Accessories:
    a. Junction Box: If noted.
        1) NEMA 4X box for cable extension.
    b. Rosemount Analytical; Model 399 (water), or Model 396R (retractable) sensor and Model 1056 pH analyzer.
    c. Hach; Digital Differential pH sensor and sc100 controller.
    d. Foxboro; 871A series pH sensor and Model 875 pH Intelligent Analyzer.
    e. “Or-equal.”

D. Dissolved Oxygen Element and Transmitter:

1. General:
    a. Function: Continuous measurement of dissolved oxygen (DO) concentration of process fluid.
    b. Type: Luminescent or fluorescence sensor.
    c. Parts: Element (sensor), transmitter (analyzer), external power supply, interconnecting cable, mounting hardware, and ancillaries.
2. Performance:
    a. Range: 0 to 20 ppm.
    b. Sensor Accuracy:
        1) Measurement: Plus or minus 0.2 percent of span.
        2) Temperature: Plus or minus 0.2 degrees C.
    c. Response Time: Less than 40 seconds to 90 percent of value upon step change.

3. Element:
    a. Luminescent or fluorescent sensor.
    b. Process Temperature Range: 32 degrees F to 122 degrees F.
    c. Submersion Depth: 350 feet maximum.
    d. Sensor Cable: Integral 33 feet of cable. Provide additional length as required.
    e. Junction Box: Provide junction or termination box and extension cable as required.
    f. Mounting: 1-1/2 UNF - 12 UNF thread.
4. Transmitter:
    a. Display:
        1) Graphic dot matrix LCD to display DO.
        2) Auxiliary Readout:
            a) Temperature.
            b) Diagnostic warnings.
            c) Error messages.
            d) Other information.
    b. Ambient Conditions:
        1) Temperature minus 4 degrees F to plus 140 degrees F.
        2) Humidity: 0 to 95 percent, relative, noncondensing.
    c. Signal Interface:
        1) Analog Output:
            a) Two isolated 4 mA to 20 mA dc for load impedance up to 500 ohms.
            b) Either output configurable for DO or temperature.
        2) Relay Outputs:
            a) Three SPST; 5 amps resistive, 115V ac/230V ac/30V dc.
            b) Each relay assignable to either DO or temperature.
            c) Function:
                (1) Control: Settings for fail safe on/off, high/low phasing, setpoint, deadband, and on/off displays.
                (2) Alarm: Settings for fail safe on/off, high alarm point, high alarm point deadband, low alarm point, low alarm point deadband, and on/off relays.
        3) Serial Communication: If and as noted.
    d. Enclosure: NEMA 4X/IP66 polycarbonate/aluminum.
    e. Mounting Hardware: Suitable to support panel, surface, horizontal pipe, and vertical pipe mounting.
    f. Power Requirements: 120V ac, 60-Hz.
    g. Stainless steel equipment tag.

5. Accessories:
    a. Unless otherwise noted, provide submersion mounting hardware and mounting bracket as required to perform appropriate installation.
    b. Provide sun shield for transmitter display.
6. Manufacturers and Products:
    a. Hach; sc100 LDO Analysis System.
    b. Insite IG; Model 1000 Dissolved Oxygen Analyzer.
    c. Environmental Instruments; FL-3 Dissolved Oxygen Analyzer.
    d. Royce Technologies; Model 98/9810 Dissolved Oxygen Sensor/Analyzer.
    e. "Or-equal."

E. Flow Element, Orifice:

1. General:
    a. Function: Measure flowrate.
    b. Type:
        1) Differential pressure producer.
        2) Paddle type concentric orifice plate.
    c. Parts: Orifice plate, orifice flanges, and ancillaries.
2. Service:
    a. Process Fluid: Water, unless otherwise noted.
    b. Process Temperature: As noted.
    c. Process Pressure (Upstream): As noted.
3. Performance:
    a. Flow Range: As noted.
    b. Pressure Differential at Maximum Flow: Approximately as noted.
    c. Machine orifice flanges in accordance with:
        1) ANSI B16.35, Steel Orifice Flanges.
        2) ANSI/API 2530 (AGA #3).
4. Supporting Calculations: Furnish supporting calculations to Engineer for review. As minimum, include the following:
    a. Minimum and maximum flow rates.
    b. Differential pressures at minimum and maximum flow rates.
    c. Inside diameter of actual pipe used on project.
    d. Plate size and hole diameter.
    e. Process pressure and temperature at maximum flow rate.
    f. Viscosity.
    g. Molecular weight or specific gravity (gases).
    h. Specific gravity (liquids).
    i. Super compressibility (gases).
5. Orifice Plate:
    a. Materials: Type 304 stainless steel, unless otherwise noted.
    b. Paddle type handle.

c. Concentric.

6. Flanges:
   a. Flange (Line) Size: As noted.
   b. Materials: Carbon steel, unless otherwise noted.
   c. Type: Raised face slip-on, unless otherwise noted.
   d. Class 300 (740 psig rating), unless otherwise noted.
7. Ancillaries:
   a. Pressure Taps: 1/2-inch NPT, unless otherwise noted.
   b. Gaskets for Orifice Plate: Nonasbestos.
   c. Fasteners:
      1) Steel stud bolts.
      2) Carbon steel hexagonal nuts.
      3) Carbon steel jack screws.
8. Manufacturers and Products:
   a. Daniel Flow Products, Inc., Houston, TX; Orifice Flanges (Catalog P) with Paddle Type Orifice Plate, Catalog 520.
   b. Fluidic Techniques, Mansfield, TX; Orifice Flanges with Series 120 Paddle Type Orifice Plate.
   c. "Or-equal."

F. Flow Element, Pitot-Static, Annubar:

1. General:
   a. Function: Produce pressure differential signal proportional to the square of the flow rate in a pipeline.
   b. Type: Multiple port, pitot-static differential pressure producing device.
   c. Parts: Flow element and mounting hardware.
2. Service:
   a. Fluid: Water, unless otherwise noted.
   b. Upstream Fluid Temperature: As noted.
   c. Upstream Static Pressure: As noted.
3. Performance:
   a. Flow Range: As noted.
   b. Pressure Differential at Full Scale Flow: Approximately as noted.
   c. Accuracy: As noted.
   d. Permanent Pressure Loss (Head Loss): As noted.
   e. Repeatability: Plus or minus 0.1 percent.
4. Flow Element Calculations: Verify actual inner pipe diameter and provide supporting calculations showing expected pressure differential at full scale flow and permanent head loss.
5. Features:
   a. Pitot Ports: Located across pipe diameter such that differential pressures of multiple sensing ports are sensed and averaged.

b. Element Material: Type 316 stainless steel, unless otherwise noted.
c. Pipe Size (ID and OD): As noted.
d. Pipe Schedule and Material: As noted.

6. Element Connections:
   a. Process Connections:
      1) Type: Weld fitting and compression ferrule, unless otherwise noted.
      2) Material: Carbon steel, unless otherwise noted.
   b. Instrument Connections: 1/4-inch NPT, unless otherwise noted.
7. Manufacturer and Product:
   a. Emerson Process Management, Rosemount Division; 485 Annubar.
   b. "Or-equal."

G. Flow Transmitter – Differential Pressure:

1. General:
   a. Function:
      1) Measure differential pressure.
      2) Transmit signal proportional to square root of differential pressure, as applicable.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; "smart electronics". Hart compatible.
   c. Parts: Transmitter and accessories.
2. Performance:
   a. Range: As noted.
      1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy: Plus or minus 0.10 percent of span, unless otherwise noted.
   c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
   d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
   e. Humidity: 0 to 100 percent relative humidity.
   f. Hazardous Location Certifications: If and as noted.
3. Features:
   a. Linear or square-root output, user-configurable.
   b. Factory preconfigure for square root output if transmitter tagged as "FT" or "FIT".
   c. Adjustable damping.

d. LCD indicator, unless otherwise noted.
   1) Display in either percent or engineering units, field configurable.
e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
   1) Includes drain/vent valves, process flanges and adapters, and process isolating diaphragm.
f. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
g. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4 mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
   b. FOUNDATION Fieldbus Protocol: If noted.
   c. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Three-valve manifold, unless otherwise noted.
      1) Includes one equalization and two isolation valves.
      2) Type 316 stainless steel.
8. Manufacturers and Products:
   a. Rosemount; Model 3051 CD.
   b. Foxboro; Model IDP10.
   c. SMAR; LD30XD Series.
   d. “Or-equal.”

H. Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.

b. Type:
   1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
   2) Full bore meter with magnetic field traversing entire flow-tube cross section.
   3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.
6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.

7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
    a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
    b. Liner Material:
        1) Teflon, unless otherwise noted.
    c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
    d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
    e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
    f. Grounding Ring:
        1) Required, unless otherwise noted.
        2) Quantity: Two, unless otherwise noted.
        3) Material: Type 316 stainless steel, unless otherwise noted.
    g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    h. Submergence:
        1) Temporary: not required, unless otherwise noted.
        2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
    i. Direct Buried (3 to 10 feet): If noted.
    j. Hazardous Area Certification:
        1) Suitable for installation in Class 1 Division 1, Groups C, D: If noted.
        2) Suitable for installation in Class 1, Division 2, Groups C, D: If noted.
9. Transmitter:
    a. Mounting: Surface (wall), unless otherwise noted.
    b. Display: Required, unless otherwise noted.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Required, unless otherwise noted.
            a) Forward and reverse flow rate.
            b) Forward, reverse and net totalization.
    c. Parameter Adjustments: By keypad or non-intrusive means.
    d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    e. Empty Pipe Detection:
        1) If noted.
        2) Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
        2) Supports Superimposed Digital HART protocol: If noted.

b. Discrete Outputs: If noted.
   1) Two discrete outputs, typical, rated for up to 30 volts, typical.
   2) Programmable as noted for the following typical parameters:
      a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.

c. Discrete Input: If noted.
   1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.

d. Other: As noted.

11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
    a. Features:
       1) Field programmable electronics.
       2) Self-diagnostics with troubleshooting codes.
       3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
       4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: If noted.
    a. Original meter parameter values available from Supplier by request.
15. Accessories:
    a. In situ Verification System: If noted.
       1) Quantity: One complete system provided for the project.
       2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
       3) Physical access to the flow-tube not required.
       4) Meet standards established by the National Testing Laboratory.
       5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.

6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
7) Windows-based software.

b. Primary Simulation System: If noted.
1) Quantity: One complete system provided for the Project.
2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
c) Switch selectable for forward, reverse and zero flow rate.
3) Verifies various input and output signals.

16. Manufacturers:
a. ABB.
b. Emerson Process, Rosemount.
c. Endress & Hauser.
d. Krohne.
e. "Or-equal."

I. Flow Element and transmitter, Coriolis:

1. General:
a. Direct measurement of mass flow and density independent of the fluid's physical properties, such as density, viscosity and homogeneity Level Transmitter.
b. Type: Coriolis effect.
c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
a. Stream Fluid:
1) As noted.
2) Suitable for liquids and gases.
3. Performance:
a. Flow Range: As noted.
b. Accuracy: Plus or minus 0.5 percent of rate for all flows.
4. Process Connection:
a. Meter Size (diameter inches): As noted.
b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D, unless otherwise noted.
c. Flange Material: Carbon steel, unless otherwise noted.
5. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.

6. Element:
    a. Meter Tube Material: Type 316 stainless steel, unless otherwise noted.
    b. Hazardous Area Certification:
        1) Suitable for installation in Class 1 Division 1, Groups C, D: If noted.
        2) Suitable for installation in Class 1, Division 2, Groups C, D: If noted.
7. Transmitter:
    a. Mounting: Compact, unless otherwise noted.
    b. Display: Required, unless otherwise noted.
    c. Parameter Adjustments: By keypad or non-intrusive means.
    d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
8. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
        2) Supports Superimposed Digital HART protocol: If noted.
    b. Discrete Outputs: If noted.
        1) Two discrete outputs, typical, rated for up to 30 volts, typical.
    c. Discrete Input: If noted.
        1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
    d. Other: As noted.
9. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
10. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
11. Factory Ready for Future In situ Verifications: If noted.
    a. Original meter parameter values available from Supplier by request.
12. Manufacturers:
    a. Yokowaga.
    b. Emerson Process, Rosemount.
    c. Honeywell.
    d. Krohne.
    e. Endress & Hauser
    f. “Or-equal.”

J. Flow Element and Transmitter, Vortex:

1. General:
   a. Direct measurement of mass flow rate and temperature simultaneously.
   b. Type: Vortex.
   c. Parts: Flow element, embedded temperature sensor, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for steam and gases.
3. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 1 percent of rate for all flows.
4. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: As noted.
5. Power (Transmitter): 10.5 to 30V dc.
6. Element:
   a. Body: Stainless steel CF8M, or similar.
   b. Shedder Bar: Duplex Stainless steel, or similar.
   c. Hazardous Area Certification:
      1) Suitable for installation in Class 1 Division 1, Groups C, D: If noted.
      2) Suitable for installation in Class 1, Division 2, Groups C, D: If noted.
7. Transmitter:
   a. Mounting: Compact, unless otherwise noted.
   b. Display: Required, unless otherwise noted.
   c. Parameter Adjustments: By keypad or non-intrusive means.
   d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
8. Signal Interface (at Transmitter):
   a. Analog Output:
      1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
      2) Supports Superimposed Digital HART protocol: If noted.
   b. Discrete Outputs: If noted.
      1) one discrete output, rated for up to 30 volts, typical.
   c. Other: As noted.
9. Cables:
   a. Types: As recommended by manufacturer.
   b. Lengths: As required to accommodate device locations.

10. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
11. Factory Ready for Future In situ Verifications: If noted.
    a. Original meter parameter values available from Supplier by request.
12. Manufacturers:
    a. Yokowaga.
    b. Emerson Process, Rosemount.
    c. Endress & Hauser
    d. "Or-equal."

K. Differential Pressure:

1. General:
    a. Function:
        1) Measure differential pressure.
        2) Transmit signal proportional to either differential pressure.
    b. Type:
        1) Electronic variable capacitance or silicon strain gauge.
        2) Two-wire transmitter; "smart electronics". Hart compatible
    c. Parts: Transmitter and accessories.
2. Performance:
    a. Range: As noted.
        1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
    b. Accuracy: Plus or minus 0.10 percent of span, unless otherwise noted.
    c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    e. Humidity: 0 to 100 percent relative humidity.
    f. Hazardous Location Certifications:
        1) Suitable for installation in Class 1 Division 1, Groups C, D: If noted.
        2) Suitable for installation in Class 1, Division 2, Groups C, D: If noted.
3. Features:
    a. Adjustable damping.
    b. LCD indicator, unless otherwise noted.
        1) Display in either percent or engineering units, field configurable.

c. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
   1) Includes drain/vent valves, process flanges and adapters, and process isolating diaphragm.
d. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
e. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
f. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4 mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
   b. FOUNDATION Fieldbus Protocol: If noted.
   c. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Three-valve manifold, unless otherwise noted.
      1) Includes one equalization and two isolation valves.
      2) Type 316 stainless steel.
8. Manufacturers and Products:
   a. Rosemount; Model 3051 CD.
   b. Foxboro; Model IDP10.
   c. SMAR; LD30XD Series.
   d. “Or-equal.”

L. Pressure Transmitter:

1. General:
   a. Function: Measure pressure and transmit signal proportional to pressure.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics”. Hart compatible.
   c. Parts: Transmitter and accessories.

2. Performance:
    a. Range: As noted.
        1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
    b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
    c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    e. Humidity: 0 to 100 percent relative humidity.
    f. Hazardous Location Certifications: If and as noted.
3. Features:
    a. Type: Gauge pressure, unless otherwise noted.
    b. Adjustable damping.
    c. LCD indicator, unless otherwise noted.
        1) Display in either percent or engineering units, field configurable.
    d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
        1) Includes drain/vent valves, process flanges and adapters, and process isolating diaphragm.
    e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
    f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
    g. Fill Fluid: Silicone, unless otherwise noted.
4. Process Connections:
    a. Line Size: 1/2 inch.
    b. Connection Type: FNPT.
    c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
    a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
        1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
    b. FOUNDATION fieldbus protocol: If noted.
    c. Profibus: If noted.
6. Enclosure:
    a. Type: NEMA 4X.
    b. Materials: Coated aluminum, unless otherwise noted.
    c. Mounting bracket, unless otherwise noted.
        1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.

7. Accessories:
    a. Two-valve (isolate and vent) Stainless Steel Manifold: If noted.
8. Manufacturers and Products:
    a. Gauge Pressure Units:
        1) Rosemount; Model 3051 TG.
        2) Foxboro; Model IGP20.
        3) SMAR; LD30XM Series.
    b. Absolute Pressure Units:
        1) Rosemount; Model 3051 TA.
        2) Foxboro; Model IAP20.
        3) SMAR; LD30XA Series.
        4) "Or-equal."

M. Pressure Differential Transmitter:

1. General:
    a. Function:
        1) Measure differential pressure.
        2) Transmit signal proportional to either differential pressure or square root of differential pressure, as applicable.
    b. Type:
        1) Electronic variable capacitance or silicon strain gauge.
        2) Two-wire transmitter; "smart electronics". Hart Compatible
    c. Parts: Transmitter and accessories.
2. Performance:
    a. Range: As noted.
        1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
    b. Accuracy: Plus or minus 0.10 percent of span, unless otherwise noted.
    c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    e. Humidity: 0 to 100 percent relative humidity.
    f. Hazardous Location Certifications: If and as noted.
3. Features:
    a. Linear or square-root output, user-configurable.
    b. Factory preconfigure for square root output if transmitter tagged as "FT" or "FIT".
    c. Adjustable damping.
    d. LCD indicator, unless otherwise noted.
        1) Display in either percent or engineering units, field configurable.

e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
   1) Includes drain/vent valves, process flanges and adapters, and process isolating diaphragm.
f. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
g. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4 mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
   b. FOUNDATION Fieldbus Protocol: If noted.
   c. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Three-valve manifold, unless otherwise noted.
      1) Includes one equalization and two isolation valves.
      2) Type 316 stainless steel.
8. Manufacturers and Products:
   a. Rosemount; Model 3051 CD.
   b. Foxboro; Model IDP10.
   c. SMAR; LD30XD Series.
   d. “Or-equal.”

N. Pressure Differential Switch:

1. General:
   a. Function: Monitor differential pressure.
   b. Type: Diaphragm actuated switch.
2. Performance:
   a. Setpoint:
      1) As noted.
      2) Repeatability: Plus or minus 1 percent.

b. Range: Noted setpoint shall fall between 20 percent and 90 percent of range.
c. Static Pressure:
1) Operating Static Pressure: As noted.
2) Operating static pressure must be less than switch's rated maximum static pressure.
d. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
e. Operating Temperature Range:
1) Dependent on actuator seal materials.
2) Buna-N Seal: 0 to 150 degrees F.

3. Features:
a. Actuator Seal: Buna-N, unless otherwise noted.
b. Fixed differential, unless otherwise noted.
c. Mounting: Surface, unless otherwise noted.

4. Process Connection:
a. 1/4-inch NPT female connections, unless otherwise noted.
b. Materials: Nickel-plated brass, unless otherwise noted.

5. Enclosure: NEMA 4X.

6. Signal Interface:
a. Contact Type:
1) SPDT, unless otherwise noted.
2) Rated for 10 amps minimum at 120V ac.
b. Hermetically Sealed Switch: If noted.

O. Pressure Switch, Adjustable Dead Band:

1. General:
a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.
b. Type:
1) Piston-actuated.
2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.

2. Performance:
a. Setpoint:
1) As noted.
2) Repeatability: Plus or minus 1 percent of range.
b. Reset Point: As noted.
c. Range: The noted setpoint shall fall between 20 percent and 80 percent of the range.
d. Deadband: Adjustable within nominally 25 percent and 85 percent of range.

e. Overpressure Proof Pressure:
   1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
   2) Pressure Inches of Water Ranges: 20 psig.
   3) Compound Range: 250 psig.
   4) Vacuum Range: 250 psig.
f. Operating Temperature Range:
   1) Dependent on actuator seal materials.
   2) For Buna-N seal, 0 degree F to 150 degrees F.

3. Features:
   a. Actuator Seal: Buna-N, unless otherwise noted.
   b. Adjustable deadband.
   c. Mounting: Surface, unless otherwise noted.
4. Process Connection:
   a. 1/4-inch NPT female connections, unless otherwise noted.
   b. Materials:
      1) Pressure psi ranges: Type 316 stainless steel, unless otherwise noted.
      2) Pressure inches of water ranges: Epoxy coated carbon steel, unless otherwise noted.
5. Enclosure: NEMA 4X, unless otherwise noted.
6. Signal Interface:
   a. Contact Type:
      1) SPDT.
      2) Rated for 10 amps minimum at 120V ac.
   b. Hermetically sealed switch: If noted.
7. Manufacturers and Products:
   a. Ashcroft; L or P Series.
   b. United Electric; J6 Series.
   c. For hazardous areas: Ashcroft P series NEMA 7, explosion-proof enclosure specified.
   d. “Or-equal.”

P. Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale range: As noted.
   b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
   a. Dial: 4-1/2-inch diameter.

b. Pointer vibration reduction: Required, unless otherwise noted. Use the following method.
   1) Liquid filled gauge front, unless otherwise noted.
      a) Glycerine fill, unless otherwise noted.
c. Case Material: Black thermoplastic, unless otherwise noted.
d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
   1) Stainless steel, unless otherwise noted.
e. Pointer: Adjustable by removing ring and window.
f. Window: Glass or acrylic, unless otherwise noted.
g. Threaded reinforced polypropylene front ring.
h. Case Type: Solid front with blow-out back.

4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.
5. Accessories:
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
6. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
   b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantatge.
   c. WIKA, Type 2XX.34.
   d. “Or-equal.”

Q. Temperature Element and Transmitter, Resistance:

1. General:
   a. Function: Measure temperature of process fluid and transmit analog signal proportional to temperature.
   b. Type: RTD.
   c. Parts: Element, thermowell, and transmitter.
2. Service:
   a. Process Fluid: As noted.
   b. Process Temperature Range: As noted.
3. Element:
   a. Type:
      1) Single element, unless otherwise noted.
      2) Three-wire, RTD.
      3) Platinum, 100 ohm nominal at 0 degree C.

b. Performance:
   1) Sensor Accuracy for 900 degrees F and Below: Plus or minus 0.5 degree F or plus or minus 0.25 percent of reading, whichever is larger.
c. Features:
   1) Dimensions (bare element): 1/4-inch diameter.
   2) Length to accommodate thermowell insertion and extension length.
   3) Spring-loaded element when thermowell is used.
   4) Sheath:
      a) Type 316 stainless steel, unless otherwise noted.
      b) Process Operating Temperature Range: Minus 320 degrees F to 900 degrees F, unless otherwise noted.
   5) Terminal Connection Head:
      a) General purpose, NEMA 4 weatherproof, unless otherwise noted.
      b) Maximum Ambient Temperature: 220 degrees F, unless otherwise noted.
   6) Thermowell Connection: Union coupler, stainless steel, unless otherwise noted.
   7) Sensitive Length: 1.6-inch minimum, measured from closed end.

4. Thermowell:
   a. Features:
      1) Inside Diameter: Sized to match thermocouple.
      2) Material: Type 316 stainless steel, unless otherwise noted.
      3) Insertion Length: As noted.
      4) Extension Length: 3 inches, unless otherwise noted.
   b. Process Connection: 1-inch NPT connection, unless otherwise noted.
   c. Well Type: Threaded straight, unless otherwise noted.
   d. Provide wake frequency calculation for thermowells as required.
5. Transmitter:
   a. Ambient Operation Conditions:
      1) Temperature: Minus 20 degrees F to 158 degrees F, with display.
      2) Relative Humidity: 0 to 100 percent, noncondensing.
   b. Type: Two-wire, powered by remote power supply.
   c. Performance:
      1) Digital Accuracy: Greater of plus or minus 0.09 degree F or plus or minus 0.01 percent of span.
      2) Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.
   d. Electrical Safety: Standard unless otherwise noted.

e. Features:
1) Indicator: Three-line LCD, unless otherwise noted.
2) Automatic reference junction compensation.
3) Failsafe Mode:
a) User configurable ON, unless otherwise noted.
b) Downscale, unless otherwise noted.
4) Electric Damping: 1.2 seconds.
f. Signal Interface: 4 mA to 20 mA dc.
g. Power: 24V dc external power supply.
h. Digital Communication: HART.
1) Supply one HART communicator for HART capable transmitters, if not already supplied under another Specification section.
i. Enclosure:
1) Materials: Epoxy-coated, low-copper aluminum, unless otherwise noted.
2) Type: NEMA 4X.
3) Mounting: Wall, pipe stand, or integral to thermowell, as noted.
a) For pipe stand, provide stainless steel mounting set, unless otherwise noted.
b) For integral thermowell mount, provide explosion-proof connection.

6. Manufacturers and Products:
a. Invensys/Foxboro; RTT20 Series Transmitter with PR Series RTD and T-Series Thermowell.
b. Rosemount; 78 Series Platinum RTD with Thermowell and Model 644H Transmitter
c. “Or-equal.”

R. T4 Temperature Element and Transmitter, Thermocouple:

1. General:
a. Function: Measure temperature of process fluid and transmit analog signal proportional to temperature.
b. Type: Thermocouple.
c. Parts: Element, thermowell, and transmitter.
2. Service:
a. Process Fluid: As noted.
b. Process Temperature Range: As noted.
3. Element:
a. Type:
1) Single-element, unless otherwise noted.
2) Iron-constantan, Type J, ungrounded, unless otherwise noted.

b. Performance:
   1) Accuracy: Plus or minus 4 degrees F or plus or minus 0.75 percent of reading, whichever is greater.
c. Features:
   1) Dimensions (Bare Element): 1/4-inch diameter.
   2) Length to accommodate thermowell insertion and extension length.
   3) Spring-loaded element when well is used.
   4) Sheath:
      a) Type 316 stainless steel, unless otherwise noted.
      b) Process Operating Temperature:
         (1) Range: Minus 320 degrees F to 1600 degrees F, unless otherwise noted.
   5) Terminal Connection Head:
      a) General purpose, NEMA 4 weatherproof, unless otherwise noted.
      b) Maximum Temperature: 220 degrees F, unless otherwise noted.
   6) Thermowell Connection: Union coupler, stainless steel, unless otherwise noted.
   7) Sensitive Length: 1.6-inch minimum, measured from closed end.

4. Thermowell:
   a. Features:
      1) Inside Diameter: Sized to match thermocouple.
      2) Material: Type 316 stainless steel, unless otherwise noted.
      3) Insertion Length: As noted.
      4) Extension Length: 3 inches, unless otherwise noted.
   b. Process Connection: 1-inch NPT connection, unless otherwise noted.
   c. Well Type: Threaded straight, unless otherwise noted.
   d. Provide wake frequency calculation for thermowells as required.
5. Transmitter:
   a. Ambient Operation Conditions:
      1) Temperature: Minus 20 degrees F to 158 degrees F, with display.
      2) Relative Humidity: 0 percent to 100 percent, noncondensing.
   b. Type: Two-wire, powered by a remote power supply.
   c. Performance:
      1) Digital Accuracy: Greater of plus or minus 0.07 degree F or plus or minus 0.01 percent of span.
      2) Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.
   d. Electrical Safety: Standard unless otherwise noted.

e. Features:
1) Indicator: Three-line LCD, unless otherwise noted.
2) Automatic reference junction compensation.
3) Failsafe Mode:
a) User configurable ON, unless otherwise noted.
b) Downscale, unless otherwise noted.
4) Electric Damping: 1.2 seconds.
f. Signal Interface: 4 mA to 20 mA dc.
g. Power: 24V dc external power supply.
h. Digital Communication: HART.
1) One HART communicator to be supplied for all HART capable transmitters, if not already supplied under another Specification section.
i. Enclosure:
1) Materials: Epoxy-coated, low-copper aluminum, unless otherwise noted.
2) Type: NEMA 4X.
3) Mounting: Wall, pipe stand, or integral to thermowell, as noted.
a) For pipe stand, provide stainless steel mounting set, unless otherwise noted.
b) For integral thermowell mount, provide explosion-proof connection.

6. Manufacturers and Products:
a. Invensys/Foxboro; RTT20 Series Transmitter with MINOX MT Series Thermocouple and Thermowell.
b. Rosemount; Series 183 Thermocouple and Thermowell, and Model 644H Transmitter.
c. “Or-equal.”

S. Thermometer, Adjustable Angle:

1. General:
a. Function: Indicate process temperature.
b. Type: Bi-metallic, circular dial.
c. Parts: Temperature gauge and thermowell.
2. Performance:
a. Scale Range: As noted.
b. Accuracy: 1 percent of full scale.
3. Thermometer Features:
a. Stem Length: 4 inches, unless otherwise noted.
b. Stem Type:
1) Every angle, unless otherwise noted.
a) Adjustable 90 degrees vertical, 360 degrees horizontal.

c. Dial:
   1) Heavy-duty glass, unless otherwise noted.
   2) 5-inch circular, unless otherwise noted.
   3) Hermetically sealed.
d. Construction: All-welded, stainless steel.

4. Thermowell:
   a. Type: 1/2-inch NPT connection, Type 316 stainless steel.
   b. Extension Neck: When noted, with length as noted.
5. Manufacturers and Products:
   a. Ashcroft; Series EI bimetal thermometer.
   b. WIKA; Type S5301 bimetal thermometer.
   c. "Or-equal."

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 92 13
PROCESS CONTROL VALVES AND REGULATORS

PART 1 GENERAL

1.01 OVERVIEW

A. This Document specifies technical requirements for process control valves and pressure regulating valves.

1.02 OBJECTIVES

A. This Specification establishes the minimum requirements for design, materials, fabrication, shop testing, documentation, coating, packaging, and delivery of Pressure Regulators and Control Valves. Control Valves include modulating valves as well as On/Off valves. Control Valves with actuators and Pressure Regulators shall be furnished in strict accordance with the requirements of this Specification and shall be complete with all the accessories required for proper operation.

B. Valve size, materials of construction and the required accessories shall be in accordance with the individual Control Valve and Pressure Regulator Specification Sheets (hereafter referred to as Valve Data Sheets).

1.03 REFERENCES

A. Related Sections:

1. Section 01 61 00, Common Product Requirements.
2. Section 40 50 20, Aboveground Power Plant Piping.
3. Section 40 90 00, Instrumentation and Control General Requirements.
4. Section 40 91 00, Instrumentation and Control Components.

1.04 CODES AND STANDARDS

A. Equipment shall be designed and manufactured in accordance with the applicable code or standard in effect at the date of the Purchase Order.

B. Applicable requirements in the latest edition of the following industry standards, codes, and the contents of this Specification shall be considered an integral part of this document:

1. American National Standards Institute (ANSI): C540, Standard for Power Actuating Devices for Valves and Sluice Gates.
2. International Society of Automation (ISA):
   a. S75.01, Flow Equations for Sizing Control Valves.
   b. S75.04, Face to Face Dimensions for Flangeless Control Valves.

c. S75.05, Control Valve Terminology.
d. S75.11, Inherent Flow Characteristic and Rangeability of Control Valves.
e. SP75.17, Control Valve Aerodynamic Noise Prediction.
f. RP75.23, Considerations for Evaluating Control Valve Cavitation.

3. American Society of Mechanical Engineers (ASME):
   a. B1.20.1, Pipe Threads, General Purpose (inch).
   b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
   c. B16.5, Steel Pipe Flanges and Flanged Fittings.
   d. B16.10, Face-to-Face and End-to-End Dimensions of Valves.
   e. B16.11, Forged Steel Fittings, Socket Weld and Threaded.
   f. B16.20, Ring-Joint Gaskets and Grooves for Steel Pipe Flanges.
   g. B16.25, Buttwelding Ends.
   h. B16.34, Valves—Flanged, Threaded and Welding End.
   i. B31.1, Power Piping.
   j. ASME Section I, Boiler & Pressure Vessel Code.
4. ANSI/FCI 70-2, Control Valve Seat Leakage.
5. International Electrotechnical Commission (IEC): 534-8-3, Control Valve Aerodynamic Noise Prediction Method.
6. Manufacturer's Standardization Society (MSS):
   a. SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
   b. SP-61, Pressure Testing of Steel Valves.
   c. SP-102, Multiturn Valve Actuator Attachment – Flange and Driving Component Dimensions and Performance Characteristics.
7. National Electrical Manufacturers' Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.

C. In the event of conflict, the order of precedence shall be Purchase Order, this Specification including attachments, then referenced industry standards. Supplier shall submit written exceptions for Owner approval.

D. It shall be the responsibility of the Supplier to be knowledgeable of the requirements for both the standards and codes mentioned above. Any changes or alterations to the equipment to make it meet standard and code requirements shall be at the Supplier's expense.

1.05 FORBIDDEN MATERIALS

A. No equipment shall contain mercury or asbestos.

1.06 SCOPE OF SUPPLY

A. Equipment and services furnished shall include:

1. Design, fabrication, testing, and delivery of all valves, complete with actuators and accessories, to meet the requirements of this Specification. Valves shall be supplied as complete units with all accessories mounted, piped, wired and calibrated.
2. All interconnecting instrument tubing and fittings between the valve actuator, positioner, and filter regulator.
3. Any special tools required for assembly, disassembly, and maintenance.
4. Recommended spare parts list for two years of operation.
5. Any lifting eyes or support lugs required for lifting and handling of all supplied equipment.
6. Sizing calculations and dimensional drawings. These Drawings shall show the valve complete with all accessories and actuators and shall also show weight and noise calculations. Sizing of each control valve to meet the functional requirements to be able to properly maintain set points without hunting, oscillations and noise is sole responsibility of the Supplier of the valve.
7. Safety is utmost concern. Provide safe failure mode for each control valve.
8. Completed motor datasheets for motor operated valve applications.
9. Installation, Operation and Maintenance Manuals including wiring and tubing drawings.

B. Equipment and services furnished by others shall include:

1. Receiving, unloading, storage, and installation of all supplied equipment.
2. Electrical wiring for power and signals for position indicating lights, solenoids, positioners, motor operators, and/or control stations.
3. All external piping, tubing, valves, and fittings, except as specified to be furnished by the Supplier.
4. Thermal insulation and lagging.
5. Instrument/service air, and other utilities as required.

C. Conflicts and Deviations: Should a conflict exist between this Specification and other reference documents; it shall be the responsibility of the Supplier to call attention to the discrepancy and request a written ruling or interpretation from Owner.

1.07 SUBMITTALS

A. Documentation and data shall be provided in accordance with the Submittal Register and Section 01 33 00, Submittal Procedures. Documentation shall include, but is not limited to, the following:

1. For Gas Service Applications:
   a. Capacity (C_v) as a function of travel; confirmation that the required rangeability can be met with the proposed control valve.
   b. Noise calculations, including calculation basis and results, for each specified flow condition; the maximum total inaccuracy (i.e., tolerance expressed in plus or minus dBA for each noise calculation) shall be specified and added to the calculated noise level.
   c. Body and trim exit fluid velocity head calculations, including number of discrete pressure drop stages required, for each specified flow condition; also specify body and trim exit fluid velocities expressed in sonic velocity (Mach number).
   d. Filled in data sheet as presented as a supplement to this Specification.
2. For Liquid Service Applications:
   a. Capacity (C_v) as a function of travel; confirmation that the required rangeability can be met with the proposed control valve.
   b. Noise calculations, including calculation basis and results, for each specified flow condition; the maximum total inaccuracy (i.e., tolerance expressed in plus or minus dBA for each noise calculation) shall be specified and added to the calculated noise level.
   c. Cavitation index data and choked flow parameter data both as a function of travel specific to the selected control valve and application. Supplier shall supply written confirmation that the selected control valve eliminates cavitation damage.
   d. Size Scale Effect (SSE) and Pressure Scale Effect (PSE) correction data for the cavitation index data.
   e. Body and trim exit fluid velocity calculations, including number of discrete pressure drop stages required, for each specified flow condition.
   f. Filled in data sheet as presented as a supplement to this Specification.
3. For Motor Operated Valve Applications:
   a. Low Voltage AC Induction Motors Data Sheet for each motor operated valve. Refer to Division 26, Electrical.
   b. Complete Specifications, catalog cut sheets, product bulletins, and descriptive literature.
   c. Principal dimensions, incoming power, general construction, and outline of the actuator mechanism.

d. Other Operating Characteristics:
    1) Output torque or thrust.
    2) Nominal power at running torque.
    3) Nominal power at locked rotor.
    4) Speed or travel time.
e. Actuator options being supplied.
f. Electrical wiring diagrams with list of symbols.
g. Manufacturer's test report for the following:
    1) Voltage, phase and frequency.
    2) Stroke time (seconds).
    3) Seating (or maximum dynamic) torque.
    4) Seating load amps.
    5) Torque-switch and limit-switch function.

4. For All Applications:
    a. Actuator load calculations for each control valve.
    b. Prior test reports of actuator performance stability showing performance curve of previous experience with the same specification.
    c. Hydrostatic test report for each control valve.
    d. Seat leakage test report for each control valve.
    e. Stroke performance test report for each control valve.
    f. Certified Material Test Reports for each control valve.
    g. Catalog cut sheets.
    h. Valve drawings and calculations, including outline dimensions, weights, circuit diagrams, section drawings, part lists, and materials.
    i. Operation and maintenance manuals, including instructions from any low tier suppliers.
    j. Complete descriptive literature, including product bulletins, operating and design temperatures, maintenance pull space requirements, any limitations on valve mounting position, bevel detail of butt weld end connection, recommendations for field welding, packing torque requirements, and post weld heat treatment of alloy valves.
    k. Certified Material Test Report (CMTR):
        1) Furnish for both body and bonnet material.
        2) Signed by manager of valve Supplier's quality control department and shall show purchase order number and Project name/number.
        3) Certify that valve is new and complies with requirements of this Specification.
    l. Certified Test Report: Furnish for all valves.
    m. Installation instructions.
    n. Recommended spare parts if disassembly for post weld heat treatment is required for installation, with unit prices.

o. Recommended parts for steam blow restoration, with unit prices.
p. Recommended spare parts for 1 year's operation, with unit prices.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Care should be exercised to prevent damage to all seating surfaces after the hydro-test.
2. End connections shall be sealed securely to prevent entry of contaminants and to protect the end connections from damage.
3. All valves, actuators, and accessories shall be packaged or crated to prevent deterioration, contamination, or physical damage during transit and storage. Any articles or material that may be otherwise lost shall be boxed or wired in bundles and marked for identification with the control valve tag number, purchase order number and Project name/number.
4. Ship metal seated valves in closed position.
5. All special tools, spare parts, storage instructions, or instruction manuals shall be boxed or crated separately from the valves, clearly identified, and included in the same shipment.
6. All valve assemblies shall be prepared for shipment so that handling and unloading may be facilitated. At no time are valves, actuators, or accessories to be shipped in a disorderly arrangement or situation of disarray so as to promote damage or hamper inspection of the equipment when received on the jobsite.

B. Storage: Protect valves to withstand at least 6 months of unsheltered storage at jobsite before installation.

1.09 QUALITY ASSURANCE

A. A quality assurance program is required, summarized in a quality assurance manual and supported by written procedures for controlling activities affecting quality, such as welding, heat treatment and nondestructive examination.

B. Manufacturing/assembly facilities shall be accessible for inspection, audit and/or witness of work, inspections and tests.

C. The equipment furnished shall be guaranteed to conform to the requirements set forth and to the specified Codes, Standards and Regulations, and that all specified tests have been satisfactorily completed.

1.10 WARRANTY AND GUARANTEES

A. Furnish Supplier's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Supplier must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Control and regulator valve designs shall be based on the requirements of the application, process operating conditions, this Specification, and the Project Piping Specification (Section 40 50 20, Aboveground Power Plant Piping). Each control valve shall be designed and manufactured to properly integrate with the control loop it is being used for.

2.02 APPLICATIONS

A. Applications, common names and uses, and their key attributes covered under this Specification are defined in Chapter 12 of the ISA Guide "Control Valves, Practical Guides for Measurement and Control," and are summarized below:

1. Process Control/Feed Regulation:

Application	Common Names and Uses
Chemistry Control (Conductivity, pH, ORP, dissolved oxygen, etc.)	ACV
Flow Control	FCV, Throttling
Level Control	LCV, Deaerator, Heater Drain
Pressure Control	PCV, Injection
Pressure Reduction, Back Pressure	PRV, Gas Regulator
Temperature Control	TCV, Deaerator Spray

2. Key attributes for process control/feed regulation applications are accuracy of control resulting from small signal changes, and high rangeability resulting from increased pressure differentials that exist across the control valve during startup, shutdown, and low-load process conditions. Control valves shall meet these attributes.
3. The key attribute for continuous letdown applications is accuracy of control. Control valves shall meet this attribute.
4. Key attributes for intermittent letdown applications are tight shutoff and fast stroke speeds. Control valves shall meet these attributes.
5. Key attributes for recirculation applications are tight shutoff, anti-cavitation and/or low noise trim, and pipe vibration elimination. Control valves shall meet these attributes.

2.03 PROCESS OPERATING CONDITIONS

A. Process Data:

1. For each control valve or regulator, process data shall be specified on Valve Data Sheets for the following three flow conditions as a minimum: Normal flow rate, maximum flow rate, and minimum flow rate. Other flow conditions will be included if relevant to the particular application.
   a. Normal Flow Rate: This flow condition is generally referred to as the design flow or material balance flow.
   b. Maximum Flow Rate: This flow condition shall be consistent with the plant or equipment operational maximum flow condition. The maximum flow condition is generally the governing case for required maximum C_v capacity.
   c. Minimum Flow Rate: This flow condition shall be consistent with the plant turndown requirement or equipment turndown capability. The minimum flow condition generally subjects the control valve to the highest differential pressure condition. The minimum flow conditions are generally the governing case for the required trim performance.
      1) Minimum and normal flow conditions shall also be specified for control valve services identified with “normally no flow” as well as the required flow conditions during non-normal plant operating conditions such as startup, venting, depressurizing, etc.
      2) Sizing calculations shall be provided for all specified flow conditions.

2. Data Sheets: Individual control valve specification requirements shall be specified on Valve Data Sheets. The Contract Documents provide general Valve Data sheets templates. Customize each data sheet for the specific application and fill in all based on specific customized calculations.
3. Seat Leakage:
    a. Seat leakage classification shall be in accordance with ANSI/FCI 70-2. The leakage class shall be determined by the service application. Soft-seated valves shall not be applied in services with design temperature conditions over 450 degrees F (230 degrees C) or in flashing liquid services.
    b. Leakage problems are commonly related to insufficient seat loading. While a control valve with insufficient seat loading may pass a specified leakage test after it is manufactured, the same valve will not meet the specified leakage rate after it has been subjected to thermal distortion, flashing, or erosive service.
    c. Seat ring circumference is defined as the line of contact between the plug and the seat when the valve is in the fully closed position.
    d. The maximum shutoff differential pressure shall always be calculated and specified for the selected control valve. For all metal-to-metal shutoff applications equal to or exceeding ANSI/FC1 70-2 Class IV requirements, actuator load calculations shall be provided. Calculations are required to show the minimum load to be applied to the plug-seat arrangement for meeting the required shutoff specifications.

2.04 CONTROL VALVE AND REGULATOR SIZING

A. Valves and actuators shall have a minimum design life of 25 years at the specified conditions, excluding items such as gaskets, packing, trim, elastomer parts, and lubrication materials.

B. Each control valve or regulator shall be sized and selected to provide reliable operation and control at the specified operating and design conditions. Control valve sizing shall generally be based on ISA S75.01, “Flow Equations for Sizing Control Valves.” Deviation from the ISA formulas may be permitted provided that the deviation and associated justification are detailed in the technical quotation.

C. Minimum trim performance requirements shall be accurately evaluated.

D. Control valve body size shall not be more than one line size smaller than the upstream pipe. If greater reduction is required, reduced trim shall be used, or associated piping shall be revisited to determine if line size is appropriate.

E. All control valves in continuous service shall be installed with full line size block valves and if necessary, a bypass valve; omission of bypass valve must be approved in writing by the Engineers. Other control valves not having isolating block valves and bypass valve shall have a de-clutchable handwheel for manual operation. Handwheel gearing shall be capable of opening or closing the valve under full differential pressure. At or near the handwheel shall be an indicator showing valve directional movement, including an indication of full open and full closed. Top mounted handjacks shall only be used for limit stops.

F. Cage trim globe valves are preferred for most services up to 4-inch size. Rotary valves may be used for larger sizes where process conditions permit their application. Post guided valves may be used in low pressure applications (less than 150 psi pressure drop).

G. Piping Geometry Factor, FP: For valves mounted between pipe reducers or other pipe fittings, the calculated valve capacity shall be corrected for a decrease in valve capacity conforming to ISA S75.01. The piping geometry factors FP, control valve correction factor, calculated F_{LP} and/or X_{TP} factors shall be specified as part of valve selection and sizing.

H. Control valve noise level shall not exceed 85 dBA at 1 meter under any of the specified flow conditions. Equipment supplier shall furnish predicted noise level for each control valve.

I. Position switches shall be provided on modulating valves where it is necessary to prove position. Position switches shall be preferably proximity style, but other mechanically actuated types may be acceptable with written approval from the Engineers. Position switches shall be form C, hermetically sealed, dry contact type with 1/2-inch or 3/4-inch NPT electrical connections. Position switches shall be rated minimum 2A at 30V dc, 5A at 120V ac.

J. Body Size:

1. Control valve bodies with reduced trims shall be considered for applications with the following conditions:
    a. Pressure drop in excess of 750 psi (5,170 kPa).
    b. Gas/vapor outlet velocities in excess of 0.3 Mach.
    c. High noise exceeding 85 dBA.
    d. Choked flow.
    e. Flashing exceeding 5 percent weight of liquid being vaporized.
    f. Erosive fluids.
    g. Future capacity increase is anticipated.
2. In all cases, the control valve nominal body size shall not exceed the nominal line size, nor shall it be less than 1/2 of the nominal line size. The minimum body size shall be 3/4 inch. Reduced trim shall be used where process conditions require smaller C_v's.

K. Minimum Rangeability: The installed rangeability (actual available rangeability) of each control valve in the process system shall meet all flow conditions specified. The specified minimum flow conditions shall be fully controllable. The trim shall operate above 10 percent travel at minimum flow.

L. Minimum control valve size shall be 3/4 inch. If smaller sizes are required, reduced trim shall be used. 1-1/4-, 2-1/2- and 5-inch sizes shall not be used. All 1 inch and larger control valves shall be flanged, socket welded, or butt welded as required by Project Piping Specifications. Slip-on flanges are prohibited.

M. Control valves in pressure classes 900 and higher shall have socket or butt welded ends as required by Project Piping Specifications.

2.05 CONTROL VALVE AND REGULATOR DESIGN

A. Minimum Rating:

1. The valve type, materials, end connection, body wall thickness and pressure rating shall meet or exceed the Project Piping Specification, Section 40 50 20, Aboveground Power Plant Piping.
2. The valve shall be rated to meet the design pressure and design temperature of the application.
3. For flanged valves, the valve body rating shall never be lower than the flange rating. The flange rating for valve bodies smaller than 16-inch nominal size shall be minimum ASME Class 300 unless indicated differently on the Valve Data Sheets. Flange rating for valve bodies 16-inch nominal size and larger shall be minimum ASME Class 150.
4. Unless specified otherwise on the Valve Data Sheets or in the Project Piping Specification (Section 40 50 20, Aboveground Power Plant Piping), all valves in ANSI class 150# through 600# shall have raised face flanged end connections. Flanges shall be in accordance with ASME B16.5.

B. Materials:

1. Control valve body materials shall meet, or exceed, the requirements of the application. Body and trim materials shall meet the temperature requirements.
2. Body material shall normally be carbon, alloy, or stainless steel, as required by the application and in compliance with The Project's Piping Specification. Cast or ductile iron shall not be used. Standard valve trim shall be stainless. Other materials shall be considered and shall be defined as specialty valve trims. Brass, copper, or copper bearing alloys shall not be used for any service. PTFE V-Ring packing shall be used for temperatures of minus 40 degrees F to plus 450 degrees F. Grafoil packing should be used for temperatures above 450 degrees F.

3. Trim materials shall be selected to withstand corrosion, erosion, and wear under severe service conditions. Material combinations shall be selected for maximum galling resistance. AISI 200 and 400 series stainless steel, or Engineer-approved equivalent, shall be used as a minimum.
4. Hard facing or heat treating shall be applied to trim seating surfaces of valves per manufacturer recommendations but, as a minimum, they shall include erosive applications, steam applications with pressure drop conditions exceeding 50 psi (350 kPa) and applications with pressure drop conditions exceeding 580 psi (4,000 kPa).
5. Packing shall be compatible with packing box and trim materials, packing box dimensions and tolerances, surface finish of packing box and stem, stem speed, spacers, and design temperature. Packing shall be PTFE V-ring or graphite type (see Paragraph Gaskets, Packing and Bonnet).
6. Like parts of valves of the same class, size and model shall be interchangeable. Parts subject to wear, erosion, corrosion or other deterioration, or requiring periodic adjustment, inspection or repair shall be accessible and capable of reasonably convenient removal, easy replacement, and repair.

C. Flow Direction:

1. Flow direction arrows shall be cast on the valve body, or otherwise permanently attached to the valve.
2. For balanced trim valves, flow direction for liquid service applications shall be flow-to-close and flow direction for gas service applications shall be flow-to-open.
3. For unbalanced valve trim, flow should be to close to prevent very large unstable forces in the nearly closed position.

D. Trim Design:

1. Valve trim shall be of the quick-change type for ease of maintenance. Trim shall be designed to provide equal pressurization around the plug in order to minimize vibration and prevent any potential for binding. Control valve trim design shall be selected to meet the requirements of this Specification.
2. Supplier shall have a minimum of 5-years' experience with any proposed control valve trim design.

E. Gaskets, Packing and Bonnet:

1. Body gaskets for temperatures below 450 degrees F (230 degrees C) shall be PTFE or equal. Over 450 degrees F (230 degrees C), a spiral-wound gasket, grafoil-type gasket, or equal shall be used. In all cases, valve gaskets for body/bonnet joints or bottom flange joints shall be metal seal or spiral-wound stainless steel with nonasbestos or Teflon filler suitable for the operating and design conditions.
2. PTFE V-ring packing shall be used for services up to 450 degrees F (230 degrees C). Above 450 degrees F (230 degrees C), graphite or manufacturer's recommended packing shall be used.
3. A standard bonnet shall be specified for temperatures of 32 degrees F (0 degrees C) to 450 degrees F (230 degrees C). Above 450 degrees F (230 degrees C) and below 32 degrees F (0 degrees C), an extended bonnet and/or special packing shall be considered. Manufacturer's recommendation shall be evaluated and followed when feasible.

F. End Connections: End connections shall be specified on Valve Data Sheets.

1. Flanged Connections:
   a. Flanged connections shall comply with ASME B16.5. Dimensions of flanges larger than 24-inch size shall comply with industry standards. Raised face (RF) flanges shall be used for lines rated up to and including ASME Class 600 and up to a design temperature of 900 degrees F (480 degrees C). The gasket contact surface of raised face flanged valves up to and including ASME Class 600 ratings shall be smooth machine-finished with a smoothness of 125 to 250 AARH.
   b. Ring joint (RTJ) flanges shall be used for lines rated ASME Class 900 and above, and for design temperature conditions exceeding (900 degrees F) 480 degrees C. Ring grooves shall comply with ASME B16.20.
   c. Unless otherwise noted on Valve Data Sheets, face-to-face dimensions of flanged valves and end-to-end dimensions of butt-weld valves shall comply with ASME B16.10. Supplier to advise in writing if alternate face-to-face dimensions are proposed.
2. Butt-Welded Connections:
   a. Welded connections on valves 2-1/2 inches and larger shall be butt-weld type.
   b. Schedules and wall thicknesses of butt-welded connections shall comply with the Project Piping Specification, Section 40 50 20, Aboveground Power Plant Piping. Schedule and wall thickness will be provided on Valve Data Sheets.

c. Beveled in accordance with ASME B16.25.
d. Bored to match pipe schedule specified on Valve Data Sheets.
e. Schedule bore ends for carbon steel shall be beveled in accordance with ASME B16.25 Fig. 2(a).
f. Schedule bore ends for alloy steel shall be beveled in accordance with ASME B16.25 Fig. 4, 5(b) or 6(b).
g. Backing rings are prohibited.

3. Socket-Welded Connections for 2 inches and smaller valves:
   a. Welded connections on valves 2 inches and smaller shall be socket weld type.
   b. Schedules and wall thicknesses of socket-welded connections shall comply with the Project Piping Specification, Section 40 50 20, Aboveground Power Plant Piping. Schedule, wall thickness and rating class (typically CL3000 minimum or CL6000) will be provided on Valve Data Sheets.
   c. Shall comply with ASME B16.11 and ASME B16.34 paragraphs 6.2 and 6.3.

2.06 CONTROL VALVE AND REGULATOR PERFORMANCE

A. Noise:

1. The maximum noise level emission from a control valve or regulator manifold installation, including contributions from piping elbows and reducers, shall not exceed the following limits for any specified operating condition measured 1 meter from the valve:
   a. 85 dBA for process control/feed regulation, continuous letdown, intermittent letdown daily service, and recirculation daily service applications.
2. Noise shall be calculated in accordance with methodology outlined in ISA SP75.17 and IEC 534-8-3 guidelines. The maximum noise levels are specified in terms of equivalent continuous A-weighted Sound Pressure Levels (SPL) with an upper tolerance of plus 0 dBA. Inaccuracy of calculated noise levels shall be listed in valve proposal. Noise emission from control valves, including upper tolerance, shall be guaranteed not to exceed the above-stated limits for any specified operating condition.
3. Control valve noise shall be treated at the source except as noted below. The provision of low-noise multipath multistage trim designs is generally most cost effective. Diffusers, baffle plates, and silencers, either inside the valve body or downstream of the valve, shall not be permitted for the following applications:
   a. Process control/feed regulation.
   b. Continuous letdown.

c. Intermittent letdown in daily service.
d. Recirculation in daily service.

4. For other applications, special attention shall be given to the limited flow rangeability of these devices (i.e., noise reduction from these devices is generally reduced at low flow conditions). Noise generated by diffusers or orifice plates shall be calculated by ISA SP75.17 or IEC 534-8-3 as a separate system from the valve trim and included in the overall noise source.
5. A maximum of 5 dBA credit may be used for the application of insulation for noise reduction.
6. Detailed noise calculations shall be submitted with the proposal in accordance with methodology outlined in ISA SP75.17 and IEC 534-8-3 guidelines. The calculation basis and results shall be shown for manual or computer calculations. Control valves supplied shall be guaranteed to meet the above requirements.

B. Vibration and Erosion Limits:

1. Proper control valve or regulator selection shall ensure that the required energy can be dissipated without exceeding the maximum vibration levels in the piping system and without exceeding the wear properties of the trim material. Control valve trim design shall be selected to facilitate maximum reduction of control valve induced vibration and trim wear.
2. Control valve vibration and trim erosion can be reduced by multistage multipath trim designs. In order to minimize vibration, control valves shall be selected based on Table 12.3 of the ISA Guide, “Control Valves, Practical Guides for Measurement and Control” summarized below:
    a. Liquid Service Applications: The design shall provide a sufficient number of discrete pressure drop stages to maintain the trim exit velocity below 100 feet per second (30 m per second) for single-phase liquids and 75 feet per second (23 m per second) for cavitating, flashing, and/or erosive services. Supplier shall specify number of discrete pressure drop stages required and provide body and trim exit velocity calculations with proposal. The calculation basis and results shall be shown for manual or computer calculations.

b. Gas Service Applications:

1) The design shall provide a sufficient number of discrete pressure drop stages to maintain the trim exit fluid velocity head (V_h) below 70 psia (480 kPa) for continuous or intermittent duty and 150 psia (1,030 kPa) for infrequent duty. Valve trim exit fluid velocity head shall be calculated based on ISA Guide, "Control Valve, Practical Guides for Measurement and Control" as follows:

$$V_h = \text{Kinetic Energy} = p_o V_o^2 / (2\, g_c)$$

Where:

p_o = valve trim exit fluid density
V_o = valve trim exit fluid velocity
g_c = gravitational constant in unit of measurement

2) Supplier shall specify number of discrete pressure drop stages required and provide body and trim exit fluid velocity head calculations with proposal. The calculation basis and results shall be shown for manual or computer calculations.

C. Cavitation, Choked Flow and Flashing:

1. ISA S75.01, the ISA Guide, "Control Valves, Practical Guides for Measurement and Control" and the manufacturer's valve cavitation index data shall be used for determining the severity of cavitation, choked flow, or flashing conditions in the control valves. Control valves shall be designed to prevent cavitation damage.
2. The design of valves in cavitation and flashing service shall be based on Chapter 7 of the ISA Guide, "Control Valves, Practical Guides for Measurement and Control" and include the following techniques for cavitation-resistant valves:
   a. Reduce the pressure in multiple stages.
   b. Direct flow away from the valve body and pipe walls.
   c. Break the flow into many small streams.
   d. Force the flow through multiple turns or tortuous paths.
3. The design shall provide a sufficient number of discrete pressure drop stages to maintain the trim exit velocity below 75 feet per second (23 m per second) for cavitation and flashing service. Supplier shall specify number of discrete pressure drop stages required and provide body and trim exit velocity calculations with proposal. For multiconstituent fluids, special consideration shall be given to the potential for cavitation of the minor components in the fluid.
4. Contingencies on the minimum required control valve cavitation index shall be applied to compensate for inaccuracies in process data and inaccuracies in manufacturer's control valve cavitation index data.

D. Flow Characteristic: control valve flow characteristics shall be selected to meet the rangeability requirements as defined in paragraph 2.04.G, Minimum Rangeability, and to provide stable control over the required range of operating conditions. Manufacturer shall select the control valve flow characteristic specified on the Valve Data Sheet.

E. Valves in liquid service shall not cavitate under any service conditions. Any level of cavitation is unacceptable.

2.07 VALVES

A. Control valve – Rotary:

1. Rotary motion control valves shall be segmented ball, eccentric disc/plug or butterfly type.
2. Rotary motion control valves design shall be:
   a. One-piece cast body with integral or bolted bonnet (split body design is not allowed).
   b. Trunnion-mounted closure member (floating closure member is not allowed).
   c. Allow throttling control up to 90-degrees rotation.
3. The type of rotary motion control valves shall be selected adequately selected to the designated application as per the recommendations of the Valve manufacturer.

B. Control Valve – Butterfly:

1. Butterfly valves shall be considered in the following situations if economically attractive and also side-entry is acceptable:
   a. A high flow rate with a low pressure drop.
   b. For corrosive services where a body lining is required.
2. Butterfly valves shall be an integral flanged body or lug type (wafer type valves are not permitted).

C. Pressure regulating valve:

1. Pressure or temperature regulator valves are self-operated service regulators. They shall be used only in instances of low-pressure fuel gas, air, inert gas, and water services. Local indication of controlled media shall be available.
2. Pressure or temperature regulator valves shall be of a manufacturer's standard construction and materials. The valve supplied must have materials suitable for the application.

D. Manufacturers:

1. For the above mentioned valves:
   a. Fisher Valves.
   b. Floserve Valves.
   c. Masoneilan valves.
   d. Or approved manufactures.

E. The class rating shall be established to provide a general guide for selection of the appropriate valve pressure-temperature ratings. The class rating for steel valves shall be in accordance with ASME B16.34. The valve rating and materials shall be suitable for the design temperature at the design pressure, or valve set pressure plus accumulation, whichever is greater.

F. Valves shall be properly selected and have acceptable ASME B16.34 pressure-temperature ratings that meet or exceed the system design pressure and temperature requirements.

G. Pressure relieving devices shall be used on all pressure vessels, exchangers, and all of the equipment and piping as specified by the appropriate codes.

2.08 SAFETY, RELIEF AND ON/OFF VALVES

A. Safety, relief, and safety relief valves shall normally be of the direct spring loaded type. Pilot operated or balanced bellows type relief valves may be used with written approval from the Engineers

B. Pressure relief valves are classified as safety valves, relief valves, or safety relief valves. These valves are defined as follows:

1. Safety Valve: An automatic, reclosing, pressure-relieving device actuated by the static pressure upstream of the valve characterized by full opening pop action at valve set pressure. Safety valves are used for steam, gas, or vapor service.
2. Relief Valve: An automatic, reclosing, pressure-relieving device actuated by the static pressure upstream of the valve which opens in proportion to the increase in upstream static pressure over the valve set pressure. Relief valves are primarily used for liquid service.

C. Safety Relief Valve: An automatic, reclosing, pressure-relieving device suitable for use as either a safety or relief valve depending on the application.

1. Manufacturers:
   a. Baker Hughes Consolidated.
   b. Anderson Greenwood.

c. Crosby.
d. Pentair.
e. “Or-equal.”

D. On/off control valves shall be provided with limit switches for fully opened and fully closed feedback to the control system. Limit switches shall preferably be proximity type, but other mechanically actuated styles may also be acceptable with written approval from Engineers. Limit switch contacts shall consist of form C, hermetically sealed, dry contact type with 1/2-inch or 3/4-inch NPT electrical connections. Limit switches shall be rated minimum 2A at 30V dc, 5A at 120V ac.

E. Shutdown valves shall have fail-safe actuators.

F. Shutdown valves specified as “Fire Safe” shall meet the requirements of API 607.

G. All tubing shall be seamless Type 316 stainless steel. Tube fittings shall be stainless steel compression fittings, ferrule style.

H. Solenoid valves shall be complete with suppression diodes.

I. Solenoid valves supplied with on/off control valves shall have continuous duty encapsulated coils with Class H insulation and shall be powered by 24V dc unless otherwise specified by the Engineers.

J. Solenoid valves supplied for emergency operation on modulating control valves shall have continuous duty encapsulated coils with Class H insulation and shall be 24V dc powered unless otherwise specified by the Engineers on valve Data Sheets.

K. Solenoid valve coil enclosures shall be rated minimum NEMA 4X and shall be explosion proof for Class 1 Div. 2 Group D areas.

2.09 ACTUATOR SELECTION

A. Supplier shall be responsible for correctly sizing the actuators based on the process operating conditions and this Technical Specification.

B. Actuator systems shall be typically pneumatic type, either diaphragm or double-acting piston. Pneumatically actuated spring and diaphragm actuators are preferred. Double-acting piston or motor operated actuators may be acceptable with written permission from the Engineers, or if called for on Data Sheets. For applications with valve bodies greater than 2-inch nominal size and pressure drop in excess of 580 psi (4,000 kPa), diaphragm actuators shall not be applied. Piston actuators may be used where high thrust or long stroke is required. The actuator shall be sized to shut off

against at least 110 percent of the maximum shutoff pressure. Pneumatic actuators shall be designed to function with instrument air supply ranging from 60 psig to 125 psig.

C. Motor-operated valves, in general, shall not be used for modulation. In cases where air is not available or the force required to actuate and seat the valve exceeds pneumatic valve capability, motor operated valves may be considered with written permission from the Engineers.

D. Motor Operated Actuators:

1. Refer to Section 26 05 05, Low Voltage AC Induction Motors, for technical requirements for motor operators.
2. Shall comply with ANSI C540 and NEMA MG1.
3. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve. Size for maximum differential pressure and size for double disc friction, where applicable. The maximum differential pressure shall be the design pressure on the Data Sheet.
4. Provide stem protection for rising stem valves.
5. Actuator Operation - General:
    a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves.
    b. Manual override handwheel.
    c. Local Valve Position Indication.
6. Electronic Control Module shall have the following features as a minimum:
    a. Setup of the actuator shall be available through a push button, menu driven interface at the actuator controls or through remote communications with a Laptop computer.
    b. Controls shall be designed to configure valve parameters and setup limit switches without opening the actuator’s enclosure.
    c. All configurable settings shall be stored in EEPROM.
    d. Over-torque detection and protection.
    e. Jammed-valve detection and protection.
    f. Motor over-temperature detection and protection.
    g. Incorrect phase rotation detection and protection.
    h. Lost phase detection and protection.
    i. Dynamic braking to limit overrun (for modulating service).
    j. Instantaneous reversal detection and protection.
    k. Automatic self-test and diagnostics.
    l. On-board data logger for torque and position profiles and statistics, time and date stamped.
    m. Capable of downloading data logs and statistics to a laptop computer for troubleshooting and analysis.

7. Motor operator terminal enclosures shall be rated NEMA 4X minimum or better as specified on the Valve Data Sheets.
8. Terminal enclosures shall be furnished with space heaters in the limit switch and motor compartment. Motor compartment heaters shall be interlocked with actuator operation. Heaters shall be rated for 240V ac and operated at 120V ac.
9. Motors shall have electromechanical or electronic reversing motor controllers rated up to 60 starts/hour for ON/OFF and Throttling service, and continuous duty rated for modulating service.
10. Actuator Power Supply:
    a. 480V ac, 3 phase, 3 wire, 60-Hz, unless otherwise specified on Valve Data Sheets.
    b. Internal control power transformer with primary and secondary fuses, 120V ac secondary.
    c. Externally operable power disconnect switch.
    d. 120V ac space heater (rated for 240V ac, operated at 120V ac).
11. Limit switch and status contacts shall be dry type, SPDT, rated for 5A at 120V ac and 2A at 30V dc.
12. Motor insulation shall be class F, non-hydroscopic, sealed, encapsulated, or otherwise protected in accordance with the requirements of NEMA MG-1.
13. Controls and indications:
    a. Local controls to allow opening, closing, stopping in mid travel, and Jogging, as specified on Valve Data Sheets.
    b. Status Contacts for monitoring by Plant Control System:
        1) Fully Opened.
        2) Fully Closed.
        3) At least one contact that can be programmed to actuate at any position between 0 and 100 percent opened.
        4) Local/Remote status.
        5) Fault.
    c. Command terminals that accept dry contacts for remote control from Plant Control System, as specified on Valve Data Sheets:
        1) OPEN command (momentary for ON/OFF or throttling service, maintained for modulating service).
        2) CLOSE command (momentary for ON/OFF or throttling service, maintained for modulating service).
        3) STOP command (for throttling service).
    d. Current position transmitter (if specified on Valve Data Sheets), isolated 4 to 20 mA DC loop powered signal in proportion to 0 to 100 percent OPENED, with 0.5 percent accuracy and 0.5 percent repeatability, capable of driving a 750 ohm load, for connection to and monitoring by the Plant Control System.

e. Analog Position Controller (for modulating service, if specified on Valve Data Sheets):
   1) Provides remote control of valve position from external isolated 4 to 20 mA DC signal with 0.5 percent accuracy and 0.5 percent repeatability.
   2) Deadband and motion inhibitor to prevent hunting.

14. Motor operators and all required accessories shall be furnished and mounted on the valve.
15. A completed AC Motor Data Sheet shall be submitted for all motor operated valves; refer to Division 26, Electrical.
16. Manufacturers:
    a. Auma.
    b. Rotork.
    c. Limitorque.

E. All required accessories, such as control solenoids, limit switches, positioners, filter regulators, etc. shall be furnished, mounted, tubed and calibrated.

F. Air operators shall be sized to operate the valve through its complete cycle against the opening and closing load with an air source of 60 psig.

G. All air operators shall be capable of operating the valve with 60 psig air pressure. All air operators shall be capable of withstanding without damage a maximum air pressure of 150 psig. If air pressure regulators or filter/regulators are needed to provide this capability, they shall be provided as part of the operator. Filter/regulator shall be Fisher type 67 CFR with gauge or Engineer-approved equivalent.

H. Pneumatic signals shall be 3-15 psig.

I. Position of the operator shall be manufacturer's standard unless otherwise noted on the Valve Data Sheet.

J. Air operator failure position upon loss of air pressure shall be identified on the Valve Data Sheet. Air operators shall preferably be the single acting spring and diaphragm type. Upon loss of air pressure, the operator shall be designed to move the valve disc or plug to the fail-safe mode on spring energy only. Springs shall be sized to operate the valve against a differential pressure equal to the design pressure given on the Valve Data Sheet.

K. Piston actuators may be used when necessary.

L. Solenoid valves shall be manufactured by Automatic Switch Co (ASCO) or Engineer-approved equivalent.

M. Materials:

1. Materials and rating of the pneumatic actuators shall be suitable for the application and the operating environment.
2. Pneumatic Tubing and Fittings: Materials of the pneumatic tubing and fittings shall be a minimum of AISI Type 316 stainless steel. Carbon steel, copper, bronze, brass, and AISI Type 304 stainless steel materials shall not be used on a control valve and actuator assembly. Air tubing, fittings, or connection nipple sizes shall not be less than 1/4-inch NPT.
3. Tubing shall be manufactured by Swagelok or Engineer-approved equivalent.
4. Tube fittings shall be Swagelok or Parker Type 316 stainless steel ferrule type compression fittings or Engineer-approved equivalent.

N. Performance:

1. Valve Travel Position Accuracy: The total maximum inaccuracy of the valve travel position due to any limitation (i.e., repeatability, deadband, resolution, hysteresis, etc.) shall be less than 2.0 percent.
2. Stability: In modulation, no more than one overshoot greater than 2.0 percent shall be observed during shop performance and field testing. Test reports shall be submitted with proposal showing performance curve of previous experience with the same specification.
3. Fail Position:
   a. Air failure position shall be accomplished without the aid of process pressure conditions. Air failure position shall be testable during inspection and during plant commissioning when piping systems are depressurized.
   b. When an internal spring return feature cannot achieve the failure mode of a piston actuator, piston actuators shall be equipped with a fail-safe trip system. Boosters may be applied, as required, to meet actuator stroke response requirements on large or fast control signal changes.
4. Stroke Speed Requirements:
   a. Control valve and actuator assembly shall be selected to achieve the stroke speed requirements specified on the Valve Data Sheets.
   b. All applications need to be verified for the actual stroke speed requirements. Stroke times shall be tested on a 100 percent control signal step change without the aid of process pressure conditions. Stroke times shall be tested during manufacturer inspection. Manufacturer shall document the test criteria and results of the functional tests performed during factory inspection to verify operability and stroke speed. Boosters may be applied to meet stroke time requirements, but stroke movements shall remain stable at 20 percent, 50 percent, and 80 percent control signal step changes.

c. Fast stroke time requirements under failure conditions shall be separately specified on Valve Data Sheets. Quick-exhaust valves may be used, provided that they do not interfere with the normal control operation of the actuator system.

O. Actuator Yoke: Yoke assemblies shall be cast or welded. Bolted yoke assemblies are not to be used. Yoke assemblies shall be designed such that they will accept installation of all accessories needed to meet the requirements of this Specification.

P. Manufacturers:

1. Fisher.
2. Masoneilan.
3. Flowserve.

2.10 ACCESSORIES

A. Each control valve shall be provided with accessories such as valve positioners, I/P converters, limit switches, transducers, solenoid valves, filter regulators, hand jacks, etc. as required by service or as specified elsewhere in this document. These devices shall be mounted on the control valve, where practicable.

B. All control valves shall have position indicators mounted on the stem and visible to the operator.

1. Positioner shall function as an intelligent (HART) digital valve positioner and controller.
2. Pneumatic positioners shall preferably be Fisher DVC6000 series intelligent digital valve controllers. Alternate positioners may be acceptable with written permission from Owner.
3. Valve positioners shall be provided with gauges to indicate air supply pressure and output pressure to the valve.
4. Positioner shall respond to 0.05 percent step changes in both directions.
5. Input and Output Signals:
   a. Input control signal shall be 4 to 20 mA. HART capable control signal shall be considered if available and supported by control system.
   b. Output position transmitter signal shall be 4 to 20 mA. Position feedback via HART protocol on input control signal shall be considered if available and supported by control system.
6. Integral electro-pneumatic transducer which utilizes the latest technology. Flapper style air control assemblies are not acceptable.
7. Integrally mounted valve positioners shall not be used in potentially severe vibrating service conditions. In these cases, the positioner shall be mounted separately from the valve and actuator assembly.

8. The accuracy of the positioner shall be 0.5 percent of span.
9. Local pneumatic AUTO/MANUAL switch (when specified on Valve Data Sheet).

C. Handwheels: When handwheels are required, they shall meet the following requirements:

1. Neutral position shall be clearly indicated.
2. Handwheel mechanism shall not add friction to the actuator.
3. Maximum rim pull shall be a maximum of 50 pounds.
4. Handwheels for rotary valves shall be mounted on the valve shaft and shall include a clutching and de-clutching arrangement.
5. Handwheels for large valves shall be gear-assisted.

D. Limit Switches: When limit switches are required, they shall meet the following requirements:

1. Limit switches shall be actuated by a mechanical switch or proximity sensor.
2. Limit switch enclosures shall be hermetically sealed.
3. Switch contact outputs shall be dry contact, single-pole, double-throw (SPDT).

E. Limit Stops: When limit stops are required, they shall meet the following requirements:

1. Limit stops shall be mechanical devices mounted on the actuator that prevent the valve from opening past a set position.
2. The limit stops will be so designed that they prevent tampering with the set position and require a special tool to reset.
3. Limit stops shall not be part of the handwheel assembly.

F. Valve Position Indicator: When position indicators are required, they shall meet the following requirements:

1. The indication pointer shall be directly connected to the stem or shaft.
2. The valve position shall be indicated on a reversible scale with clearly graduated markings at 25 percent valve opening position intervals and the words OPEN and CLOSED at the valve travel limits.

G. Valve Position Transmitter: An electronic travel position transmitter, either separate or integral to the positioner providing a proportional valve stem or shaft position signal, shall be supplied. Valve position sensing shall be accomplished using a noncontact, solid-state, Hall-Effect sensor.

H. Filter-Regulator Air Set: Filter regulators shall be provided for all control valves (On/Off service as well as Modulating service), unless otherwise specified or noted. The air regulator set shall comply with the following requirements:

1. Aluminum body and spring case.
2. Filter.
3. 1/4-inch NPT minimum connections.
4. Square head outlet pressure adjusting screw.
5. Outlet pressure gauge.
6. Minus 20 degrees F to Plus 180 degrees F operating temperature.
7. Can operate on 60 psig typical instrument air pressure.
8. 250 psig maximum inlet pressure.
9. Outlet pressure as required by actuator.
10. Internal relief valve.

I. Solenoid Valves: The solenoid valve shall comply with the following requirements:

1. Stainless steel body.
2. 1/4-inch NPT minimum connections.
3. Mounted as close as possible to the valve actuator and always downstream of the control valve positioner.
4. Continuously powered and rated for the hazardous area classification.
5. Solenoid Voltage shall be 24V dc unless otherwise specified on Valve Data Sheets.
6. Coil shall have built-in surge suppression.
7. Coil insulation shall be Class H.

J. Volume Tanks:

1. Minimum Rating: Volume tanks shall be mechanically designed to withstand a minimum pressure of 135 psig (930 kPag). Volume tanks shall be manufactured in accordance with ASME VIII. Division 1 (stamped UM) requirements, or equivalent.
2. Sizing: Volume tanks shall have a minimum capacity for two complete stroke operations of the control valve at the minimum available instrument air pressure of 60 psig (415 kPag).

2.11 MARKING AND IDENTIFICATION

A. Nameplates: All valves and accessories shall be tagged with manufacturer's standard nameplate in accordance with standard industry practices. The tag shall bear all pertinent instrument information such as manufacturer, model number, serial number, body and trim size, ANSI rating, etc. In addition, each valve shall include a permanently attached stainless steel nameplate engraved or stamped with the valve tag number. Wired-on tags are not acceptable.

B. Identification Tags:

1. In addition to nameplates, each valve accessory and loose item shall be furnished with a permanently attached stainless steel identification tag stamped with applicable tag number.
2. Valve tag number as indicated in Section 01 58 53, Project Equipment Identification for tagging and numbering.

C. Marking: Control valve body/bonnet, flanges, etc., shall be marked in accordance with ANSI/ASME B16.34. The direction of flow shall be cast or steel-stamped on the valve body or, alternatively, a stainless steel arrow shall be permanently fixed to the body by rivets or screws for all appropriate valves that have been designed or selected for a specific flow direction.

2.12 PAINTING

A. All parts that are not corrosion resistant by material selection shall be protected from corrosion by the environment. Manufacturer’s standard paint specifications shall be used unless otherwise specified on Valve Data Sheets. The valve stem and any other moving parts shall not be painted but shall be otherwise protected from the environment.

2.13 SOURCE QUALITY CONTROL

A. Tests:

1. The manufacturer and Supplier shall have an auditable program for quality control. The program shall ensure that all equipment supplied is new, meeting and/or exceeding all applicable requirements.
2. The Owner or Owner’s representative has the right to enter the manufacturer’s or Supplier’s facility at any time during the manufacture of an order for inspection of processes and procedures.
3. Valves shall be inspected using manufacturer's standard non-destructive examination procedures. Defects shall also be identified and repaired using the manufacturer's standard procedures.

4. Pressure boundary hydrostatic testing shall be in accordance with ANSI/ASME B16.34. Valves shall not be painted before the shell hydrostatic test is complete.
5. The shell hydrostatic test shall be performed prior to the main seat leakage test. The valves shall show no leakage during hydro-test.
6. Following the shell hydrostatic test, a main seat leakage test shall be performed. The hold time shall be a minimum of five minutes. Main seat leakage shall not exceed the limits for the ANSI Class specified on the Data Sheets: Seat leakage test pressures shall be per ANSI/FCI 70-2.
7. A performance test shall be performed after the hydrostatic test by which the valve, actuator and accessories will be completely assembled and tested for hysteresis, stroke time and deadband. If the valve has a handwheel, limit switches or position transmitter, they will be checked for function at this time.
8. All test documentation shall be supplied for review.
9. Field hydro-testing will be performed by others on the systems in which the valves will be installed. Manufacturer shall advise of any limits and precautions applicable to the valves for the onsite system hydro-test.
10. Torque and limit switches shall be set by the valve actuator manufacturer after assembly with the valve.
11. Each completed electric motor operated valve assembly shall be cycled from full open to full closed and back to full open for verification of limit and torque switch function and setting, and ability of motor operator to open and close valve after seat leakage test has been performed.

B. Inspection: Owner or Owner's representative shall have right to inspect at any stage of fabrication equipment, materials, and associated QA/QC documentation covered by this Specification including Suborder(s).

C. Inspection and Test Plan (ITP): Manufacturer shall provide an Inspection and Test Plan (ITP) that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner three weeks (or as otherwise specified) prior to testing.

2.14 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer's recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

PART 3 EXECUTION

3.01 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. AC Induction Motor Datasheet for Motor Operated Valves:
   a. Refer to Section 26 24 19, Low Voltage AC Induction Motors Data Sheets for a blank motor datasheet.
   b. A completed one motor datasheet shall be supplied for each motor operated valve.
   c. Template of Control Valve data sheet; a data sheet shall be supplied for each control valve.

END OF SECTION

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SECTION 40 94 23
PDCS ELECTRICAL CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This Document specifies the requirements of the Electrical Control System (ECS) for the Power Distribution Control System (PDCS), a purpose specific Industrial Control System (ICS). The scope includes furnishing all engineering, design, labor, materials, equipment, programming, testing services, construction services, and other control systems required to interface with the PDCS ECS to provide a fully functional system.

B. The scope includes:

1. All networking required for a standalone Operational Technology (OT) control system deterministic network ring, independent from any existing legacy and/or Information Technology (IT) network. All system communications shall be evaluated against the Risk Management Framework (RMF) and be considered OT category RMF Level 1 or 2.
2. All required network switches that will enable independent Electrical Control System (ECS) communication between ECS components utilizing 61850 communications protocol and managed interfaces with non-ECS system elements. Network switches shall be managed and block-by-default.
3. All master, non-equipment specific, ECS hardware required to interface with equipment specific hardware and able to perform autonomously if the supervisory network communication is interrupted. Such ECS hardware includes, but is not limited to, remote terminal units, serial port expanders, protocol converters, etcetera, as required to provide a totally functional PDCS ECS.
4. Provide redundant critical ECS equipment where failure of any single equipment would cause loss of ECS function and/or degraded system performance; such as, network switches, hardware, power supplies, etcetera.
5. All support equipment required to complete the totally functional PDCS ECS.

6. All input/output points included in the Specification, the aggregation of all Specification sections, including those points that may not be shown on the Drawings but required per Specification section. This requirement is included with emphasis to highlight that not all input/output points are explicitly shown on the Drawings and review of all Specification sections for input/output requirements is the responsibility of the Supplier and exclusion of input/output points from the Drawings is not a basis for change.

C. The electrical distribution equipment nodes, as shown on the Documents, shall be supervised and controlled by the PDCS ECS and integrated into the PDCS HMI System with comprehensive display, control, and historical data access.

D. The Supplier is responsible for configuration, application programming, testing, and system training to deliver a completely integrated PDCS ECS safely, reliably, and efficiently monitoring and controlling all devices connected to the PDCS.

E. The PDCS ECS shall comply with the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems to ensure system resilience against cyber threats.

F. The PDCS ECS is comprised of both new and existing equipment, of which some of the existing equipment will require retrofit or upgrade work planned under this Project. The retrofit or upgrade to existing equipment will require extensive field verification. Supplier is required to field verify all information provided for the existing equipment.

G. This Specification section does not stand alone and must be read with Section 40 94 24, PDCS Human Machine Interface (HMI) which specifies the human-machine interface. Comprehensive coordination is required between the PDCS ECS specified herein and the PDCS HMI System specified in Section 40 94 24, PDCS Human Machine Interface (HMI), as well as other control system interfaces specified in Section 40 94 25, PDCS Data Exchange Interface (DEI) which specifies the data exchange interface requirements to enable monitoring and control of the overarching equipment and systems under the PDCS's control to implement all specified control and data exchanges between these pieces of equipment, workstations, and control system servers to deliver a completely integrated PDCS as shown and specified in the Documents.

H. Careful consideration shall be given to construction sequencing due to the critical nature of the electrical distribution system and high importance given to safety and system availability. At no time during construction shall the Work prevent safe reliable operation of the electrical distribution network.

1.02 REFERENCES

A. The latest edition for all codes and standards referenced in this Specification shall be the edition in effect at the time of Contract Award.

B. Industry Standards:

1. International Electrotechnical Commission (IEC):
   a. 15802, Information Technology – Telecommunications and Information Exchange Between Systems – Common Specifications – Medium Access Control (MAC) Service Definition.
   b. 60529, Enclosure Protection from Environment.
   c. 60834, Performance and Testing of Teleprotection Equipment of Power Systems.
   d. 60870, Telecontrol Equipment and Systems Series.
   e. 61000-4-11, Electromagnetic Compatibility.
   f. 61131, Programmable Controllers.
   g. 61850, Interoperability for Advance Protection and Control Applications.
   h. 52439, Industrial Communications Networks.
   i. 62443, Industrial Network and System Security Series.
   j. 62351, Power Systems management and Associated Information Exchange – Data and Communications Security.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 802.1,
   b. 1050, Generating Station I&C Equipment Grounding.
   c. 1588, A Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
   d. 1613, Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations.
   e. IEEE 1686, Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities.
   f. 1815, electric Power Systems Communications – Distributed Network Protocol (DNP3).
   g. C37.21, Standard for Control Switchboards.
   h. C37.90.1, Electrical Surge Withstand Capability.
   i. C37.90.2, Radio Frequency Interference.
3. International Society of Automation (ISA):
   a. 71, Environmental Conditions for Process Measurement and Control Systems.
   b. 77.42.01 (R 2011), Fossil Fuel Power Plant Feedwater Control System - Drum Type.
   c. ANSI/ISA 12.12.01-2000, Hazardous Location Certification.
4. National Electrical Manufacturers Association (NEMA): NEMA 250, Enclosures for Electrical Equipment.

5. National Fire Prevention Association (NFPA): NFPA 70, National Electrical Code (NEC).
6. National Fire Prevention Association (NFPA): NFPA 85, Boiler and Combustion Systems Hazards Code.
7. National Institute of Standards and Technology (NIST):
    a. 800-30, Information Security Guide for Conducting Risk Assessments.
    b. 800-37, Risk Management Framework for Information Systems and Organizations.
    c. 800-53, Security and Privacy Controls for Federal Information Systems and Organizations.
    d. 800-82, Guide to Industrial Control Systems (ICS) Security.
8. UL:
    a. 508, Safety Standard for Industrial Control Equipment.
    b. 840, Electrical Equipment Insulation Coordination.
    c. 1449, Standard for Surge Protective Devices.
    d. 1604, UL Certification for Existing Products.
    e. 1778, Standard for Uninterruptible Power Supply Equipment.

C. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work.
6. Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.
7. Section 40 90 10, Instrumentation and Control Summary of Work.
8. Section 40 94 24, PDCS Human Machine Interface.
9. Section 40 94 25, PDCS Data Exchange Interface.

D. The Supplier has the ultimate responsibility for the complete identification and execution of all applicable codes, standards, and regulations.

E. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this document.

F. These codes and standards set forth the minimum requirements. These may be exceeded by the Supplier if, in its judgment and with Owner’s acceptance, superior or more economical designs or materials are available.

G. The most severe requirements shall prevail in the event of conflict between requirements, specifications and applicable and governing codes. All conflicts among the Codes, specifications and/or purchase order shall be brought to the Owner’s attention for written resolution prior to release for fabrication.

H. Violations resulting from stipulations in the existing codes shall be corrected by the Supplier at its own expense.

I. The Supplier shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

1.03 DEFINITIONS

A. BOP - Balance of Plant.

B. Drawings – Drawings includes all technical drawings and documents used to define the system(s) and equipment specified herein.

C. ECS – Electrical Control System.

D. FAT - Factory Acceptance Test.

E. HMI - human-machine interface; a computer-based operator interface for a control system.

F. PAC – Programmable Automation Controller.

G. PCS - Plant Control System.

H. PDCS – Power Distribution Control System.

I. PLC - Programmable Logic Controller.

J. SAT - Site Acceptance Test.

1.04 SUBMITTALS

A. Documentation shall be provided in accordance with the Submittal Register and Section 01 33 00, Submittal Procedures.

B. Supplier shall provide the following information:

1. Drawing list and submittal schedule.
2. A layout Drawing of the proposed system(s) showing all modules used within the system.
3. Overall system architecture and communications diagram.
4. A physical Drawing stating all dimensions of the system enclosures as well as a detailed bill of materials for each enclosure.
5. All standard product literature pertinent to the proposed system.
6. Utilities List (power, instrument air, etc.).
7. Enclosure power, grounding, wiring termination and layout Drawings.
8. System hardware chassis or rack layout Drawings.
9. Enclosure detail Drawings, including external connection Drawings.

10. Bill of materials, which shall use actual manufacturer names and part numbers.
11. Manufacturer's product data sheets annotated for specific application for each component.
12. Input/Output (I/O) points list for all I/O required for a fully functional interface. The I/O list shall contain all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner/Engineer, as well as the final controller program native file.
13. For each Enclosure tabulate and summarize:
    a. Required voltages, currents, and phases(s).
    b. Maximum permitted safe operating temperature of each component.
    c. Calculations: Maximum heat dissipations in Btu per hour.
    d. Steady State Temperature Calculations: Provide heat load calculations showing the panel estimated internal steady state temperature in the applicable service conditions.
14. Installation Drawings, instructions, product bulletins and manuals.
15. Operation and maintenance manuals for all hardware and software.
16. Controller logic programming documentation, including software backup and recovery plans.
17. HMI screen graphic and pop-up captures.
18. Preliminary and final Data Exchange Tables listing all READ and WRITE BITS and WORDS with their control system addresses involved in data exchange with controlled ECS hardware.
19. Test plans/procedures and reports (step-by-step instructions) for Factory and Site Acceptance Tests.
20. List of recommended spare parts.

C. The Supplier shall provide Controller logic at 75 percent completion for Owner review and comment.

D. Supplier shall provide one final hard copy and one electronic copy of all configuration files after the Factory Acceptance Test (FAT).

E. Supplier shall provide input/output (I/O) database configuration for all I/O. The database shall include all system diagnostic and communication I/O, as well as set points for all alarms and analog logic. The Supplier shall be responsible for all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner, as well as the final controller program in native format with complete documentation and the final data exchange tables for communications with all ECS controlled hardware.

1.05 QUALITY ASSURANCE

A. The Supplier shall maintain a quality manual/system which meets the requirements of the applicable international quality system standard appropriate to the contracted Scope of Work throughout the duration of this Purchase Order as well as ISO 9000 requirements.

B. The Supplier quality plan shall be issued for review and for monitoring during the Project. Reporting requirements must include the Owner requirements and additional requirements as stated below.

C. The Supplier shall be responsible to ensure that the Suppliers and Sub-Suppliers meet the intent of the requirements of this Specification and are able to demonstrate their compliance.

D. Requirements covered by this Purchase Order/Specification shall apply to lower tier Sub-Suppliers, including Owner's access (accompanied by Supplier) to facilities and records.

E. All materials and hardware to be furnished and all Work to be performed under this Specification shall be subject to review, inspection, and testing as described below.

1.06 WARRANTY AND GUARANTEES

A. The Supplier shall provide copies of Manufacturer's warranties and the Supplier's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier (or equipment Manufacturer under the supervision of the Supplier) shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 ELECTRICAL CONTROL SYSTEM GENERAL DESIGN

A. ECS hardware shall be IEC 61850 compliant.

B. The ECS shall consist of multiple logical remote terminal units (RTUs), redundant controller modules, power supplies, I/O modules, communication modules, Remote I/O modules and chassis or rack, and all required accessories per this Specification to provide a fully functional system.

C. Redundancy:

1. Controllers and data highway communication between controllers are required to be redundant. Power supplies are required to be redundant.
2. I/O modules, local and remote I/O module communications, and datalink communications to other control packages are not required to be redundant.
3. Other power supplies shall be redundant if used for multiple functions such as wetting, analog loop power, or interposing relay power.

D. System electronics shall be shielded against electromagnetic interferences and shall be capable of withstanding surges in power supplies.

E. All ECS hardware shall be designed with a temperature margin allowance for heat buildup inside the enclosure in which the hardware is mounted.

F. Enclosures for outdoor usage shall be designed to prevent against freezing, wind, rain, saline's, fume, and dust.

G. ECS hardware shall be designed to operate on 120V ac, 60-Hz, single-phase power or 125V dc power.

H. All communication hardware, software, programming to establish communication interfaces shown on the Data Sheets and Drawings.

I. All fiber optic cable, media converters, patch panels, patch cords, power supplies to support the communication.

J. Configuration of the system based on datalink list developed in the format defined herein and as necessary to provide a fully functional interface to perform the intended purpose. Configuration shall include controller configuration, datalink configuration, communication equipment configuration, and all other system configuration required to provide operational interface communication links.

K. During execution of the Contract, Owner and Engineer shall select the points required for interface communication based on the Data Sheets and Drawings. Supplier shall be responsible for obtaining the detailed data from the interfaced equipment necessary to perform the interface configuration. An allowance for programming and configuration of an additional 100 points or 35 percent of designed point quantity, whichever is less, during actual commissioning.

L. Supplier shall obtain services from demonstrated established experienced, a minimum of 100,000 points and ten projects experience, selected hardware Systems Integrator and Supplier(s) to provide field support to establish interface communication links.

M. All data files and software tools used for setup and programming. Software licenses shall be provided by Supplier to support initial configuration and site commissioning.

N. Integrating, commissioning, and startup of interface equipment, data links, and all related accessories and equipment.

2.02 INTENDED USE OF THE SPECIFIED EQUIPMENT

A. The ECS functionality is a subset of PDCS providing direct control electrical distribution equipment for reliable resilient fault tolerant operation of the electrical distribution system as shown on the Drawings. Further detail of the ECS equipment being controlled can be found on the ECS Logical Unit Data Sheets.

2.03 CHASSIS/RACK

A. Every controller chassis or rack shall have a redundant power supply. Each I/O chassis or rack shall include its own redundant power supply.

B. Where dual-redundant controllers are utilized the chassis or rack shall have sufficient positions to house the redundant controller modules and all required communication modules.

C. I/O chassis or rack shall be provided separate from controller chassis or rack. Each I/O chassis or rack shall include redundant power supplies, communication module for link to associated controllers, and all required I/O modules. Each I/O chassis or rack shall include 20 percent spare space, a minimum of 2 positions, for future use. If one chassis or rack is not sufficient for these requirements, a second and subsequent chassis or rack shall be provided as needed.

D. Further chassis or racks shall be provided to accommodate all the required I/O and communications modules with 20 percent spare space, a minimum of two positions, for future use. If one chassis or rack is not sufficient for these requirements, a second and subsequent chassis or rack shall be provided as needed.

E. The Supplier shall consider Supplier spacing, heat, and grounding requirements when mounting the chassis or rack in the enclosure.

F. The chassis or rack shall be mounted a minimum of 6 inches away from the top and bottom of the enclosure, and a minimum of 4 inches from either side. If the enclosure is a free-standing cabinet with bottom flush with the floor, the chassis or rack shall be mounted a minimum of 12 inches from the bottom of the enclosure to provide cable entry/spreading space.

G. The Supplier shall connect an equipment grounding conductor from each chassis or rack directly to an individual bolt on the enclosure ground bus.

2.04 POWER SUPPLIES

A. Power supplies shall be provided for:

1. Chassis or rack power supplies.
2. 24V dc loop supplies for analog I/O (refer to Paragraph Chassis/Rack for details).
3. 24V dc wetting power for digital inputs (refer to Paragraph Chassis/Rack for details).
4. 24V dc auxiliary power for digital outputs (refer to Paragraph Chassis/Rack for details).
5. Other functions as required.

B. The Supplier shall provide redundant 120V ac power supplies for each I/O chassis or rack with the appropriate jumpers installed to match the input voltage. One of the power source shall be 120V ac UPS power and other source shall be from 120V ac no UPS reliable power bus.

C. The Supplier shall provide one redundant pair of 24V dc power supplies. This redundant pair shall be used for analog loop power, digital input wetting power, and digital output power to drive auxiliary/interposing relays.

D. The Supplier shall consider future system expansion when sizing the power supplies. Excessive loading of the power supplies shall also be considered to avoid shutdowns or premature failures.

E. Power for hardware shall be fed separately from power for non-critical items such as convenience receptacles and lights.

F. Each power supply shall have its own incoming power feed and circuit breaker.

G. Each power supply shall have a hardwired failure alarm (built into the power supply, if available, or by powering the coil of a relay from the power supply if not) as an input to the control system.

2.05 CONTROLLERS

A. The controllers shall be from Schweitzer Engineering Laboratory (SEL) Real Time Automation Controller (RTAC)

B. A single RTAC shall be provided per electrical distribution system ‘logical’ node; essentially per functional switchgear assembly. The RTAC shall facilitate system wide communication from the intelligent electronic devices (IEDs) in the ‘logical’ via the PDCS communications architecture. The RTAC shall manage multi-IED sequential logic sequences, such as primary source fail over, primary source restoration, and others as required for safe and functional operation of the logical and the wider SWBNO managed electrical network. The operation of the IEDs shall not be dependent on the health of the RTAC, such that the RTAC can fail and not impact the IED point of service protection functionality.

C. When selecting the controller, the Supplier shall consider the following:

1. Number of controller tasks.
2. Number of communications cards used.
3. Amount of controller memory needed.
4. Ability to support a system clock for sequence of operation time stamping and time synchronizing of IED functions.
5. Ability to support a local HMI.

D. All controllers shall be provided with enough memory to accommodate the 20 percent spare system automation logic.

E. Control configuration shall be stored in on-board non-volatile memory. Alarm indication of low backup battery voltage shall be provided, unless flash memory is used, and no back-up battery is needed.

2.06 COMMUNICATIONS

A. All interface data communication shall be managed by the common PDCS communications scheme.

B. All protection-class ECS data exchange packet delivery communications shall meet the following Service Level Specification (SLS) reliability standards.

Protection Scheme	Security		Dependability	
	P_{uc} – Delayed Messages	**1 sec Cyclic GOOSE Scheme – Delayed GOOSE**	**P_{mc} – Unwanted Messages**	**1 sec Cyclic GOOSE Scheme – Unwanted GOOSE, Other**
Intertripping	$<10^{-8}$	<1 / year	$<10^{-4}$	<9 / day
P_{uc} – Probability unwanted command P_{mc} – Probability missed command				

C. SLS (speed, dependability, reliability, and performance) for IED and LAN:

1. Signal exchange success > 99.99 percent of time.
2. Signal transfer between devices is < 3ms.
3. Ethernet transit via LAN is < 1ms.
4. LAN outages must be momentary, < 16ms, during signal exchange to maintain protection and automation.
5. Device ethernet failover must occur within one processing cycle.

D. All interface system communications shall be evaluated against the Risk Management Framework (RMF) and be considered Operational Technology (OT) category RMF Level 1 or 2.

1. Data flow diagram shall be developed by the Supplier to facilitate data flow understanding and evaluation against RMF. Data flow diagram shall include data path communication protocol(s) and performance criteria.
2. Data path communication protocol(s) shall be evaluated, among a range of criteria, for performance, security, reliability, resilience, versatility, and applicability. There are various data communication protocols that have differing strength and weaknesses that are intended to be vetted via this process.

E. Where technologically feasible interface system communications links shall be deterministic and utilize cybersecure methods to ensure system resilience against cyber threats.

F. Any taps, terminators, patch cords, patch panels, fiber optic cable, media converters, configuration and diagnostic software, repeaters, or adapters required for communication design shall be provided by the Supplier.

G. Any Ethernet connections outside buildings or longer than 100 meters shall be via fiber optic cable. The Supplier shall provide all required fiber optic patch panel and patch cables as required with the equipment.

H. All dynamic data communications rates shall be sufficient to support safe reliable control and supervision holistically applied to both the interfaced equipment and the PDCS.

I. Ethernet/IP Communications, where not in conflict with other requirements herein, shall:

1. Interface between controllers shall be via redundant Ethernet/IP connection operating at 100 Mbits per second.
2. Local and remote I/O interfaces shall be via non-redundant Ethernet/IP connection operating at 100 Mbits per second.
3. Interface to the HMI stations shall be via non-redundant Ethernet/IP connection operating at 100 Mbits per second.
4. Printer interfaces shall be non-redundant Ethernet/IP connection operating at 10/100 Mbits per second.
5. The Supplier shall provide a pair of redundant managed Ethernet switches in network rack enclosures as shown on the Drawings.
6. Any taps, terminators, media converters, configuration and diagnostic software, repeaters, or adapters required for equipment design shall be provided by the Supplier.
7. Any Ethernet connections outside buildings or longer than 100 meters shall be via fiber optic cable. The Supplier shall provide all required fiber optic converters with the equipment.

J. General Data Processing and Communication:

1. All dynamic data displays shall be updated often enough to permit safe control of the process.
2. The total execution time from operator initiation of any field output command, to the update of the resultant field status input shall be of short enough duration to sufficiently and safely control the process.
3. Analog and digital loops shall be capable of being processed at a tunable rate of four times per second (250 milliseconds processing time) or faster.

2.07 INPUT/OUTPUT MODULES

A. I/O Modules permitted for use in the system shall be from the same family of hardware used on the application. All I/O provided by the Supplier shall be either in the form of an independent IED or a slave to an IED interconnected to the RTAC. When selecting I/O modules the Supplier shall take into account the location of the monitored point and the number of points to be monitored.

B. Each I/O module shall be provided with a pre-fabricated cable assembly with Removable Terminal Block (RTB) and I/O Interface Module (IFM). For wiring 14AWG or larger the Supplier shall provide an extended housing for the I/O module. Where the IFMs are not integral to the IED they shall be DIN rail mounted and adequately spaced to permit field cable terminations. All IFMs shall be provided with screw clamp terminals. Supplier must submit the type of IFM blocks proposed for review and approval by the Owner prior to purchase.

C. In addition to application requirements, the system shall be provided with 20 percent spare I/O, all functional and pre-wired to I/O IFMs. Additionally, in the case of spare digital outputs, spare auxiliary relays shall be provided and wired. Spare I/O points are for Owner's future use.

D. The system shall be provided with 20 percent spare I/O positions, a minimum of two positions per I/O rack or chassis, for Owner's future use. All installed spare I/O must be tested.

E. Both digital and analog I/O (except thermocouples) shall be Supplier-wired to I/O IFMs via pre-fabricated cable assembly.

F. Analog and digital I/O shall accept field or system power as required by equipment design.

G. Digital input polling (wetting) voltage shall be 125V dc or 24V dc as shown on the Drawings. Analog loop voltages shall be 24V dc nominal, or otherwise, as shown on the Drawings.

H. Digital output voltage shall be 125V dc or 24V dc as shown on the Drawings. Each digital output channel, including spares, shall be wired to an IFM, then to an auxiliary/interposing relay for final connection to field devices. Auxiliary relay contacts shall be 2-Form C (DPDT), dry, and rated at 10.0 amperes resistive, 3.0 amperes inductive at 120V ac and 30V dc. Auxiliary relays shall be plug-in type with DIN rail-mounted socket.

I. The following I/O types shall be individually fused:

1. Analog input (4-20ma).
2. Digital input.
3. Digital output.

J. All analog I/O shall be provided with appropriately rated surge suppressors.

2.08 CONFIGURATION SOFTWARE

A. Supplier shall provide and configure the interface equipment with Original Equipment Manufacturer (Supplier) recommended software. Any other software specifically required for programming of interfaces shall be supplied by Supplier.

B. Software licensing shall be planned and structured such that the Owner shall not incur additional costs, beyond those of the Contract cost, necessary to operate and maintain the permanent installation after turnover from Supplier. All Project specific software licensing for the benefit of the Project shall be in the Owner's name and remanded to the Owner upon turnover of the Project.

2.09 CONFIGURATION REQUIREMENTS

A. The software shall be installed and configured by the Supplier. The configuration shall be completely annotated utilizing enhanced descriptors for all segments of each rung or logical element.

B. The hardware and configuration shall be simulated and debugged before shipment unless another method of testing is approved by the Owner. The debugging function shall include all interactions with the system HMI(s).

C. The software shall allow configuration to transfer, multiply, repeat, or report all inputs and outputs as required. All inputs and outputs shall be fully configured and programmed in the system. Spare installed I/O will be identified as such within the program.

D. Control configuration shall be based on the Supplier's standard configuration and specific equipment requirements unless specified otherwise within the Drawings. The Owner may modify the control via the review process with no impact to cost.

E. Tags are to be global. Tags in the program are to be defined as controller tags and not program tags. This will allow the use of global tags within the program.

F. Supplier database of all tags shall include an identifier of the controller and graphics associated with these points shall be provided to the Owner.

G. Analog Input Functions:

1. All card fault points will be monitored and alarmed.
2. The program shall provide reasonability checks for all analog inputs. Data shall be automatically tagged as bad on the HMI and in data logs if the input value is out of range or in the case of a point fault.
3. All analog input points shall be checked against high and/or low process limits. An analog input outside these limits shall be considered in alarm.

4. All analog input points shall have re-alarm capabilities. Once a point is in alarm, it will re-alarm (if point has been assigned to re-alarm) if its value continues to increase or decrease beyond the re-alarm limit assigned to that point. Re-alarm to a higher priority color, if needed. Re-alarm limits shall be specified in percent of input range or engineering units.
5. All analog input points shall have the capability of being assigned an alarm dead band and time delay for control of nuisance alarms.
6. It shall be possible to automatically inhibit the alarming of any analog input or composed point (either analog or digital) by the state of one or more contact closure input, digital logic output or the values of analog variables in order to eliminate nuisance alarms (e.g., low temperature alarms disabled during startup, low pressures when no pumps are running). When a point is inhibited, no alarm indication will be given to the operator and it will not be shown in alarm on assigned alarm groups. Upon restoration of alarm functions, the point will be scanned for alarming and, if in alarm, the normal operator indication shall occur.
7. All inhibited alarms shall be automatically logged. A summary of inhibited alarms shall be provided.
8. Provisions shall be made to avoid erroneous alarms on temperature differences and rate of change alarms when scanning of a point first resumes.
9. High and low alarm set points shall be capable of configuration using a “process curve algorithm” as well as fixed point alarms.
10. Rate of change alarms shall be individually adjustable and be provided on analog points where required for the process.

H. Analog Composed Points:

1. Analog composed points are defined as points resulting from calculations involving two or more analog points. The results of these calculations shall be assigned point numbers and shall be alarmed, displayed, trended or logged. These points shall be identified as “bad quality” input points when they go “BAD”.
2. Analog composed point capabilities shall be the same as specified for analog inputs.

I. Thermocouple Inputs:

1. The processing for thermocouple inputs is the same as that described for analog inputs above. The system shall also perform the following:
   a. Check for open thermocouple and provide alarm.
   b. Linearize thermocouple readings.
   c. Special fifth-order polynomial or at least 21 segment curve fit.
2. The reading shall be cold junction compensated.

J. RTD Inputs: The RTD temperature element shall be connected to an analog transmitter; processing for RTD inputs is similar to that described for analog inputs above.

K. Contact Inputs:

1. The system shall scan contact inputs at the controller level for status change. Normal state for a contact shall be definable as either open or closed.
2. The system software shall have the ability to apply digital filtering or time delay to all contact inputs.

L. Accumulated Pulse Inputs: Scan or store pulse inputs such that the system resolves up to 60 pulses per second.

M. Contact Outputs: Shall be configured as necessary to meet the requirements of the Supplier's system and the Owner's external interfaces. All digital outputs shall be digital contact output modules with electrically isolated contacts, utilizing interposing relay assemblies where required for contact capacity.

N. Control Drive Outputs: Shall be configured as necessary to meet the hardware requirements of the Supplier's system and the Owner's external interfaces.

O. Totalized Pulse Outputs: Shall be configured as necessary to meet the requirements of the Supplier's system and the Owner's external interfaces.

P. Modulating Controls:

1. Maintain constant-loop gain or sensitivity for any modulating control loop containing multiple final control elements in service or able to respond to the automatic signal at any time.
2. Provide bumpless transfer from manual to automatic and from automatic to manual on all modulating loops without any intermediate manual balancing.
3. Response rate for each modulating loop shall be sufficient to prevent limiting response to sudden changes. Response shall be limited by the characteristics of the equipment under control and not the control system.
4. Provide for manual control of all final control elements from local operator interfaces by Supplier.
5. Transfer a control loop to manual and alarm if system determines a malfunction in the loop that would prevent proper automatic operation of the loop. Any signal, which transfers a loop to manual, shall be individually alarmed and individually presented through the operator faceplate.

6. All controllers shall track their own output when in manual or automatic control for bump less transfer. Master Controllers will track the appropriate signal when their slave controllers have reached a high or low limit. In addition, Master controllers will not be allowed in Auto if their Slaves are in Manual.
7. Provide drive failure alarms on all control outputs where position indication feedback is provided. The alarm shall be presented, and the control loop transferred to manual when the position feedback deviates from demand position by a pre-assigned high limit.
8. Provide programmable filtering in the configuration program for all analog input signals to minimize erratic control action.

Q. Digital Controls:

1. Programming of all digital control loops shall be in ladder diagram format or a simplified high-level logic programming language.
2. All digital control loops shall be displayed on the local HMI workstation. The operator shall be able to issue commands to start/stop and open/close process equipment from loop displays (faceplates) on the local HMI. These commands shall be communicated to the appropriate controller through the communication network. The controller will manipulate the appropriate I/O module to provide the required action.

R. Alarm Functions:

1. General:
   a. Alarm function shall be realized through the HMI graphic screen and audio alarm. Alarms should be programmed with intelligence to avoid nuisance alarms and only annunciate when a true alarm condition occurs. Alarms will be prioritized according to their importance and by the prioritization developed during Project implementation phase by the Project team. No local annunciators are required unless required for safety or are critical to monitoring the process. Hardwired alarm signals from device to control system or from control system hardware to control system hardware must use a failsafe wiring scheme.
   b. The system shall compare all analog input points, composed points, etcetera, against high and/or low alarm limits. If an input is determined to be beyond either of these limits or if a contact input designated as an alarm is determined to be in alarm, the system shall display an alarm message.
   c. Once an analog point is in alarm, it shall re-alarm if its values continue to increase or decrease beyond the re-alarm limit.
2. Alarm sequence shall be as follows. Alarm visual presentation for each alarm sequence listed below shall be unique by color.
   a. Alarm Occurs: Audible alarm at contact closure is provided with a time tag and alarm message displayed on the HMI.

b. Alarm Acknowledgement: HMI alarm displays visually changes and audible alarm is silenced.
c. Return to Normal: Alarm display visually changes with an audible alarm. Alarm display clears when the point has been acknowledged.
d. Re-alarms: Re-alarms are treated like new alarms.
e. One common alarm acknowledge scheme shall be used for all alarms on the HMIs so that only one action is required by the operator to easily acknowledge from the HMI.

2.10 SECURITY

A. The system shall be configured with strong password access protected security to allow different permissions for the operator, engineer, and supervisor. Passwords shall meet the following requirements:

a. Passwords to change once per year.
b. Passwords are a minimum of eight characters, cannot form a name, date, acronym, or a word and contain at least one character from each of the following:
1) Uppercase English character.
2) Lowercase English character.
3) Digit (0 to 9).
4) Special Character (!, @, #, $, %, &).
c. User accounts are locked out after three failed logon attempts and requires reset by the system administrator.
d. Auto user log off should be implemented such that a User is logged off after an initially programmed 15-minute period (adjustable, set by Owner between 0 to 30 minutes) of inactivity.
e. Users shall be locked out of the system if they have no activity in the last 30 days (adjustable).

B. The system shall include Anti-Virus and Malware detection software.

C. Software patches and upgrades shall be performed by Owner.

2.11 LICENSES

A. All software licenses required to operate, maintain and program the control system components shall be included with the system. The licenses shall be sufficient to meet the process operating and control requirement for the scope of I/O specified (including spare capacity specified). The licenses shall not be limited to the quantity of HMI graphic screens programmed at the conclusion of this Project.

B. Ownership of licenses shall be transferred to the Owner at the successful conclusion of the Factory Acceptance Test.

C. The Owner shall be able to copy displays, configuration Drawings, and database files developed for this Project without limit.

2.12 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. White engraved nameplates with black letters on cabinets and devices. As a minimum and per the Drawings, name plates shall indicate:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

C. This article is included more to inform the ECS development process with Project standardized tagging and continue the Project standardized tagging within the ECS “programmed” infrastructure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be per manufacturer’s written recommendations.

B. All work shall be performed in accordance with the Supplier prepared and Owner/Engineer approved construction sequence.

C. Field Quality Control:

1. Provide following field testing:
   a. Insulation resistance of each winding to ground and to other windings.
   b. Power factor testing of bushings before and after installation.
   c. Proper operation of cooling fans and controls.
   d. Proper operation of pressure relief device, sudden pressure relay and auxiliary relay, liquid level indicator, and tap changer.
2. Provide assistance during initial energization including investigation and remediation of any failures or misoperation of equipment or system.
3. Twenty four hours after initial energization, sample insulating liquid and test for dielectric strength, moisture content, neutralization number, color, content, and complete gas-in-oil analysis.

4. Manufacturer’s service personnel shall be factory trained and shall report to the field Site with all tools, test equipment, and materials as required to perform the service required in paragraphs 1 through 3 above.

3.02 TESTING AND INSPECTION - GENERAL

A. The Owner reserves the right to witness all tests and shall be notified at least 21 days in advance of the tests.

B. An Inspection and Test Plan (ITP) shall be provided that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing.

C. The Supplier shall enlist the support of equipment Manufacturer services as needed for testing.

D. All control panels and enclosures shall be tested for proper wiring and operation before shipping.

E. The communication software shall be subject to Owner/Engineer witnessed factory and Site acceptance tests. The software shall not be shipped from the place of configuration until the factory acceptance tests have been deemed to have been passed by the Owner/Engineer.

F. For testing of the communication links between the PDCS and any existing general or purpose-based control or data interface systems, Supplier can use emulator software to demonstrate the successful communication.

G. The system shall be subject to Owner witnessed factory and Site acceptance tests. The system shall not be shipped from the place of assembly and configuration until the factory acceptance tests have been deemed to have been passed by the Owner.

H. Certified test reports for the tests performed shall be transmitted to the Owner prior to shipment of the system. When requested by the Owner, the Supplier shall review the test results with them and obtain approval for shipping.

I. Should the system fail a specified factory test or show abnormal results, the Supplier shall immediately inform the Owner. The cause of the problem and the proposed corrective action shall be discussed with the Owner prior to the implementation of corrective actions. After the problem is corrected, the specific system function shall be re-tested. All repair details shall be documented and included in the Test Report.

J. The Supplier shall provide to the Owner, full cooperation and assistance in any factory inspection at the Supplier's premises provided reasonable written advance notice has been given to Supplier.

K. Major items supplied under this Specification by the Supplier shall be given standard applicable tests at the factory during or at the completion of manufacture. A test procedure shall be prepared for each test which shall describe the test to be performed, the applicable item of equipment being tested, the standards and method of testing, and the testing facility's capabilities and shall state a proposed test date. All test procedures shall be submitted to the Owner for review. Successful completion of the test shall be a precondition for shipment of the tested item to the jobsite. The Owner shall be notified in writing at least 14 days before any final factory test of any major components.

L. Owner representatives shall participate in formal design reviews at Project kickoff, and at approximately 25 percent and 75 percent completion of control logic and operator graphic development.

3.03 FACTORY ACCEPTANCE TESTS

A. The Supplier's equipment shall be subject to witnessed Factory Acceptance Test (FAT). The control system shall not be shipped from the place of assembly/configuration until the factory acceptance tests have been deemed to have passed by the Owner.

B. FAT procedures/Test Plan shall be submitted to the Owner a minimum of 30 days prior to factory tests for review/comment.

C. FAT test shall not be scheduled before approval of the FAT test procedure.

D. Factory acceptance test simulation shall include discrete items such as pump and fan motors, motor operated valves, solenoid valves, and circuit breakers. The FAT shall demonstrate that each simulated discrete device can be operated and that its graphic symbol shows the correct status. The FAT shall demonstrate that each control loop can be transferred smoothly between manual and auto mode and can automatically control the simulated process. All transmitter analog signals shall be simulated at the field terminal blocks and verified for correct display in engineering units on the graphic screens. Verify proper working of all controller faceplates, including simulated displays of set points, controller outputs, control valve percent open position displays and AUTO/MANUAL operation. Use a control loop simulator for verifying control algorithms in AUTO mode. The simulator shall allow simulating the "process" for each control loop.

E. To the greatest extent practical, communications to subsystems shall be tested during the FAT. Simulate and verify data exchanges between various devices using the data exchange tables as basis. Setup the control system in the factory including the logical nodes, Servers, engineering workstations, and operator workstations as shown on the block diagram. Simulate I/O actions at the I/O modules and observe responses at the local HMI and the remote workstations. Similarly simulate actions at the local HMI and remote workstations and observe responses at the I/O. Simulate and test all control interlocks, sequencing, and control algorithms.

F. Before the control system is shipped to the Site, the control system shall be completely assembled in one location, powered up and a complete, automated, closed-loop Factory Acceptance Test (FAT) performed by the Supplier prior to notifying the Owner that the system is ready for formal factory acceptance testing to be performed with Owner involvement.

G. All software, including application software, all logic programs, automated sequencing and tripping logic, all modulating logic, all HMI screens, logs, and performance calculation software, and all data link software shall be loaded into the control system and tested.

H. All hardware shall be validated which shall include the following as a minimum:

1. A functional test of all inputs and outputs shall be performed.
2. All I/O shall be tested and function and ranges verified.
3. Interconnecting communications cabling shall be installed and the Supplier shall demonstrate, test, and prove all interconnections and communications between the various interconnected components of the control system.
4. Power and ground connections and cabinet wiring shall be inspected for compliance with design Drawings.
5. Branch circuit fuses shall be inspected for compliance with design Drawings.
6. Each cabinet power supply shall be tested for verification of load and fail over capability.
7. Each controller shall be tested for verification of fail over capability.

I. All logic functionality shall be tested and verified using appropriate automated closed loop simulation of field equipment for all loops.

J. All HMI graphic and data points shall be verified. All data links shall be tested and functionality verified.

K. All logs and reports shall be verified.

L. Baseline system parameters shall be provided to the Owner during the Factory Acceptance Test.

M. The FAT will not take place until the Owner has approved a FAT plan. The FAT plan shall include an overview of the test plan activities, methodology, schedules, and required resources as well as a list of the functional tests to be performed. The procedure shall list the satisfactory acceptance criteria of each test.

N. Supplier shall submit a test procedure 30 days in advance of the FAT for review and approval.

O. All system deficiencies will be corrected by the Supplier prior to shipping unless otherwise agreed to by the Owner.

P. The actual system database will be used for all testing.

Q. The Supplier will demonstrate, test, and prove all interconnections and communication between the various interconnected components of the control system.

R. Minimum FAT Requirements:

1. Checkout of all inputs and outputs, analog and digital.
2. Demonstration of system algorithms by use of loop simulator where applicable.
3. Creating and handling of error and device failure conditions.
4. Redundancy checks and fail-safe proofing.
5. Demonstration of power/fail restart.
6. Demonstration of online database editing capabilities.
7. Demonstration of any CPU and data link loading of system.
8. Demonstrating operation of the application software.
9. Demonstrating of all displays, logs, reports, and operator/user procedures.
10. Demonstrate system to be fully integrated, including hardware and software.

S. The FAT will be considered successful and approved by the Owner when the system has successfully passed all the tests to the Owner’s satisfaction. The Owner must approve any delayed punch list item not repaired during the FAT test. Faulty and/or incorrect operation will, at the discretion of Owner, be cause for suspension or restart of the FAT test.

T. All control system data interfaces to external control systems shall be demonstrated to be fully configured by installing communications hardware specified for each system interface.

1. Simulated data values from each control system shall be indicated and verified on the HMI Workstation and on the external system display.
2. Data communications transfer rates shall be optimized and documented prior to acceptance and delivery of the control system.

U. The Supplier, after installation and prior to declaring the system operational, must demonstrate to the satisfaction of the Owner that the system performs in accordance with this Specification and Test Procedure used for the FAT.

3.04 SITE ACCEPTANCE TESTING (SAT)

A. Initial Power-Up and Functional Verification: Upon completion of control system installation at the Project Site, the Supplier shall conduct the initial power-up and on-site system diagnostic and functional tests to verify system functionality and make the system operational. Onsite testing shall be completed as soon as possible after Site system enclosure installation and power feed termination.

B. Communication and Operation Verification: After the system is installed in the Project Site and made operational, the Supplier shall exercise all hardware, communication links, software, and configuration programs to ensure proper operation and prove compliance with the Specifications. The Owner’s personnel will use the system during calibration, checkout, and initial operation of plant systems.

C. The Supplier shall supply all special tools or special equipment for erection and commissioning of the control system.

D. Supplier shall submit a SAT procedure 30 days in advance of the SAT for review and approval. An approved SAT procedures submittal is a pre-requisite to scheduling a SAT.

E. Minimum Items to be tested During SAT:

1. Redundancy checks and fail-safe proofing.
2. Demonstration of all interconnections and communication between the various interconnected components of the control system.
3. Demonstration of power/fail restart.
4. Demonstrating operation of the application software.
5. Repeat of Factory Tests
6. Demonstrating of all displays, logs, reports, and operator/user procedures.

7. Demonstrate system to be fully integrated, including hardware and software.
8. Final acceptance cannot be given until all equipment is operating safely and satisfactorily, all system functions operational from the workstations and local HMIs, and all punch list items are resolved to Owner's satisfaction. Successful demonstration that the control system is satisfactorily operating system equipment and related balance of plant equipment. All control algorithms are maintaining correct system operation following a disturbance.

3.05 TRAINING

A. Provide training so that the Owner can operate, maintain, change system configuration (including cyber security aspects of the system), and repair the complete system.

B. Provide competent, factory authorized personnel to provide instruction to O&M personnel. Include sufficient hours of training to provide complete training for operation and maintenance of the equipment and system.

C. Provide the name and resume of proposed instructor; instructor must have at least 5 years of experience as an instructor, with 3 years of experience teaching the designated course. Instructor's primary language shall be English.

D. Owner reserves right to reject proposed instructor. Owner reserves right to have the Integrator repeat portions of the training (at Integrator's expense) if Owner feels training was inadequate.

E. Provide training manual that includes, as a minimum, the following:

1. Course objective.
2. Course outline.
3. Theory of operation.

F. Overview Training:

1. This training shall be for all personnel to describe the system architecture, interconnections, functions, and capabilities:
   a. System Network.
   b. Communication Interfaces.
   c. Workstation Interfaces.
   d. Application Software Programs.
   e. Controller Programming.
   f. Security Configuration/Concepts.
2. Review system terminology, abbreviations, and acronyms.
3. Review screen display data and access.

G. Operator Training:

1. The course shall be an in-depth instruction on the following topics:
   a. Human Machine Interface (HMI).
   b. Display organization.
   c. Alarms.
   d. Device control.
   e. System communications.
   f. System power-up and shutdown.

H. Administrator Programming/Configuration Training:

1. The course shall be an in-depth instruction on the following topics, as a minimum:
   a. Loading software, and printer setup.
   b. Database creation and editing.
   c. Configuration of report formats.
   d. Create and edit HMI displays.
   e. Review diagnostic routines, error reporting and interpretation of results.
   f. Review system-operating software.
   g. Controller addressing, programming and upgrades.
   h. Assigning passwords.
   i. Review and modify system security measures.
   j. Generate backup and restoration of files
   k. Review programming languages and software structure/organization.
   l. Create and display objects.
   m. Use the program editor.
   n. Access real-time database and other computers/systems on the network.
   o. Integrating programs into the system.
   p. Manage the TCP/IP Network Configuration.
   q. Archive database and system configuration information.
   r. Upgrading hardware and software

3.06 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer’s recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

3.07 PROTECTION

A. Protect equipment from construction or accidental damage during the installation period prior to system testing and turnover to the Owner.

END OF SECTION

SECTION 40 94 24
PDCS HUMAN MACHINE INTERFACE

PART 1 GENERAL

1.01 SUMMARY

A. This Specification, together with applicable Data Sheets and/or Supplements, covers the technical requirements for the design, materials, equipment, programming, testing services, and construction services required to provide totally functional Human-Machine Interface (HMI) for the Power Distribution Control System (PDCS) to enable operator monitoring and control, historical data collection, and data export to business system of the equipment and systems under the PDCS's control, as well as HMI system configuration and maintenance access.

B. The Scope includes:

1. Interconnection to the PDCS Operational Technology (OT) control system network ring and required network switches.
2. All workstations required to perform operator monitoring and control, HMI system configuration, historical data collection, and data export to business system.
3. Equipment cabinets housing switches, servers, and other equipment not otherwise deployed for performance of the HMI System functions.
4. Provide redundant critical HMI System equipment where failure of any single equipment would cause loss of HMI System function and/or degraded system performance; such as, network switches, servers, power supplies, display monitors, etc.

C. The PDCS HMI System as shown on the Documents is diagrammatic in nature. It is the Suppliers responsibility to provide a PDCS HMI System that meets the intent of this Specification for a totally functional PDCS HMI System.

D. The Supplier is responsible for configuration, application programming, training, and testing to deliver a completely integrated PDCS HMI System efficiently communicating with all devices connected to the PDCS.

E. The PDCS HMI shall comply with the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems to ensure system resilience against cyber threats.

F. The PDCS HMI System is comprised of both new and existing equipment, of which some of the existing equipment will require retrofit or upgrade work planned under this Project. The retrofit or upgrade to existing equipment will require extensive field verification. Supplier is required to field verify all information provided for the existing equipment.

G. This Specification section does not stand alone and must be read with Section 40 94 23, PDCS Electrical Control System which specifies the PDCS Electrical Control System (ECS). Comprehensive coordination is required between the PDCS HMI specified herein and the PDCS Control System specified in Section 40 94 23, PDCS Electrical Control System, as well as other control system interfaces specified in Section 40 94 25, PDCS Data Exchange Interface (DEI) which specifies the data exchange interface requirements to enable monitoring and control of the overarching equipment and systems under the PDCS's control to implement all specified control and data exchanges between these pieces of equipment, computer work stations, and control system servers to deliver a completely integrated PDCS as shown and specified in the Documents.

H. Careful consideration shall be given to construction sequencing due to the critical nature of the electrical distribution system and high importance given to safety and system availability. At no time during construction shall the Work prevent safe reliable operation of the electrical distribution network.

1.02 REFERENCES

A. The latest edition for all codes and standards referenced in this Specification shall be the edition in effect at the time of Contract Award.

B. Industry Standards:

1. International Electrotechnical Commission (IEC):
   a. 60529, Enclosure Protection from Environment.
   b. 61000-4-11, Electromagnetic Compatibility.
   c. 61131, Programmable Controllers.
   d. 62443, Industrial Network and System Security Series.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 1050, Generating Station I&C Equipment Grounding.
   b. C37.21, Standard for Control Switchboards.
   c. C37.90.1, Electrical Surge Withstand Capability.
   d. C37.90.2, Radio Frequency Interference.
3. International Society of Automation (ISA):
   a. 71, Environmental Conditions for Process Measurement and Control Systems.
   b. 77.42.01 (R 2011), Fossil Fuel Power Plant Feedwater Control System - Drum Type.
   c. 62443-2-1, Security for Industrial Automation and Control Systems.

d. ANSI/ISA 12.12.01-2000, Hazardous Location Certification.

4. National Electrical Manufacturers Association (NEMA): NEMA 250, Enclosures for Electrical Equipment.
5. National Fire Prevention Association (NFPA): NFPA 70, National Electrical Code (NEC).
6. National Fire Prevention Association (NFPA): NFPA 85, Boiler and Combustion Systems Hazards Code.
7. UL:
   a. 508, Safety Standard for Industrial Control Equipment.
   b. 840, Electrical Equipment Insulation Coordination.
   c. 1604, UL Certification for Existing Products.

C. Related Sections, as applicable include but are not limited to:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 61 00, Common Product Requirements.
3. Section 26 00 00, Electrical General Requirements.
4. Section 26 00 10, Electrical Summary of Work.
5. Section 26 05 75, Basic Electrical Materials and Methods.
6. Section 40 90 10, Instrumentation and Control Summary of Work.
7. Section 40 94 23, PDCS Electrical Control System.
8. Section 40 94 25, PDCS Data Exchange Interface.

D. The Supplier has the ultimate responsibility for the complete identification and execution of all applicable codes, standards, and regulations.

E. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this document.

F. These codes and standards set forth the minimum requirements. These may be exceeded by the Supplier if, in its judgment and with Owner’s acceptance, superior or more economical designs or materials are available.

G. The most severe requirements shall prevail in the event of conflict between requirements, specifications and applicable and governing codes. All conflicts among the Codes, specifications and/or purchase order shall be brought to the Owner’s attention for written resolution prior to release for fabrication.

H. Violations resulting from stipulations in the existing codes shall be corrected by the Supplier at its own expense.

I. The Supplier shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

1.03 DEFINITIONS

A. BOP: Balance of Plant.

B. Drawings: Drawings includes all technical drawings and documents used to define the system(s) and equipment specified herein.

C. ECS: Electrical Control System.

D. FAT: Factory Acceptance Test.

E. HMI: human-machine interface; a computer-based operator interface for a control system.

F. PAC: Programmable Automation Controller.

G. PCS: Plant Control System.

H. PDCS: Power Distribution Control System.

I. PLC: Programmable Logic Controller.

J. SAT: Site Acceptance Test.

1.04 SUBMITTALS

A. Documentation shall be provided in accordance with the Submittal Register and Section 01 33 00, Submittal Procedures.

B. Supplier shall provide the following information:

1. Drawing list and submittal schedule.
2. Completed Fill-In Data Sheet.
3. A layout Drawing of the proposed system showing all modules used within the system.
4. Overall system architecture and communications diagram.
5. A physical Drawing stating all dimensions of the system enclosures as well as a detailed bill of materials for each enclosure.
6. All standard product literature pertinent to the proposed system on compact disk.
7. Utilities List (power, instrument air, etc.).
8. Enclosure power, grounding, wiring termination and layout Drawings.
9. Chassis layout Drawings.
10. Enclosure detail Drawings, including external connection Drawings.
11. Bill of materials, which shall use actual manufacturer names and part numbers, not Supplier tracking codes.
12. Manufacturer’s product data sheets annotated for specific application for each component.

13. For each Enclosure tabulate and summarize:
    a. Required voltages, currents, and phases(s).
    b. Maximum permitted safe operating temperature of each component.
    c. Calculations:
        1) Maximum heat dissipations in Btu per hour.
        2) Steady State Temperature Calculations: Provide heat load calculations showing the panel estimated internal steady state temperature in the applicable service conditions.
14. Installation Drawings, instructions and manuals including panel wiring and Interconnection diagrams.
15. Operation and maintenance manuals for all hardware and software.
16. Logic and HMI graphics programming documentation (see below).

C. The Supplier shall provide logic at 75 percent completion for Owner review and comment.

D. The Supplier shall provide HMI graphics at 75 percent completion for Owner/Engineer review and comment.

E. Supplier shall provide one final hard copy and one electronic copy of all configuration files, upon successful completion of the Factory Acceptance Test (FAT).

1.05 QUALITY ASSURANCE

A. The Supplier shall maintain a quality manual/system that meets the requirements of the applicable international quality system standard, as well as ISO 9000 requirements, throughout the duration of the Project.

B. The Supplier quality plan shall be issued for review and for monitoring during the Project. Reporting requirements must include the Owner requirements and additional requirements as stated below.

C. The Supplier shall be responsible to ensure that the Suppliers, Sub-Suppliers, and Sub-Suppliers meet the intent of the requirements of this Specification and are able to demonstrate their compliance.

D. Requirements covered by this Purchase Order/Specification shall apply to lower tier Sub-Suppliers, including Owner’s access (accompanied by Supplier) to facilities and records.

E. All materials and hardware to be furnished and all Work to be performed under this Specification shall be subject to review, inspection, and testing as described below.

1.06 WARRANTY AND GUARANTEES

A. The Supplier shall provide copies of Manufacturer's warranties and the Supplier's extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Supplier shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Supplier shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Supplier (or equipment Manufacturer under the supervision of the Supplier) shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner's representative.

PART 2 PRODUCTS

2.01 HMI SYSTEM GENERAL DESIGN

A. Redundancy:

1. Communications interfaces are required to be redundant.
2. Power supplies are required to be redundant.

B. System electronics shall be shielded against electromagnetic interferences and shall be capable of withstanding power surges.

C. All system equipment shall be designed with a temperature margin allowance for heat buildup inside the enclosure in which the equipment is mounted.

D. Enclosures for outdoor usage shall be designed to prevent against freezing, wind, rain, saline's, fume and dust.

E. Equipment shall be designed to operate on 120VAC, 60Hz, single-phase power.

2.02 HUMAN MACHINE INTERFACE (HMI)

A. Each PDCS logical node shall be supplied with one HMI. The HMI shall be configured for local ONLY PDCS controlled equipment operations and system wide status display.

B. Centralized HMIs shall be industrial grade and capable of communicating with the PDCS/ECS.

C. PDCS logical node HMI station shall be Rockwell Automation PanelView Plus 7 Performance or better. The PDCS logical node HMI shall have a color display with a minimum 12-inch touch sensitive surface.

D. HMI shall be capable of providing overview displays, group displays, loop displays, alarm displays, graphics, and trending.

2.03 GENERAL HMI CONFIGURATION REQUIREMENTS

A. The following defines the minimum graphics information and functionality for Supplier configured HMIs:

1. All graphics shall have the data and time displayed on the page.
2. Graphics shall be configured in a consistent manner, for example, common information displayed on all graphics should be located in the same place on each graphic, e.g. time, date, navigation arrows, etc.
3. All graphic control shall indicate when their associated control is not operable.
4. All graphics must show status changes in a manner that permits recognition by colorblind operators.
5. All graphics shall indicate bad quality for the given process points.
6. All HMI graphics require Owner/Engineer approval.
7. Communication/Control System Status Display:
    a. Displays shall be available showing status of all communication links on the system.
    b. When failure condition is detected on a communication device on the network, the operator shall be alerted.
    c. Graphic symbols shall change color to indicate malfunctions.

2.04 SPECIFIC HMI CONFIGURATION REQUIREMENTS – LOCAL HMI

A. For situations where the Operator Interface HMI is local to the PLC system, the Supplier shall provide an HMI mounted on the front door of the PLC enclosure.

B. The HMI shall provide control interface, monitoring, alarming, historical functions and trending of various system parameters.

C. The HMI operator interface shall meet the requirements as noted in the associated Data Sheet.

D. The graphics display shall have the ability to display all control loop information, process/template graphics and other various input data.

E. Historical trending data shall be stored on the HMI memory, and the system shall be capable of trending all values in the control system.

2.05 SPECIFIC HMI CONFIGURATION REQUIREMENTS – OPERATOR AND ENGINEERING WORKSTATIONS

A. For situations where the Workstation HMI is not local to the control system enclosure, the Supplier shall provide workstations appropriate to the environment for the operator HMI.

B. For uncontrolled environments a hardened industrial monitor and hardened industrial computer shall be provided in a free standing enclosure suitable for the surrounding environmental conditions. The free standing enclosure shall include provisions for an industrial keyboard and mouse. The display shall be mounted such that the operator can stand in a comfortable position in front of the enclosure.

C. Access to the Workstation shall be controlled using individual username and password.

D. Furnish a Workstation with Windows operating system compatible with the Wonderware software.

E. As a minimum, the Workstation shall meet the requirements of the associated Data Sheet.

F. The Supplier shall provide and install the runtime and development server software with appropriate licenses. All development and runtime software, licenses and drivers shall be purchased and turned over to the Owner with the equipment. The HMI shall be configured according to best practices followed in the power industry for similar applications.

G. The graphics display shall have the ability to display all control loop information, process/template graphics and other various input data. Cursor position control shall be provided by keypad, trackball and/or mouse, or keypad operation.

H. Historical trending data shall be stored on hard disk (or similar devices), and the system shall be capable of trending all values in the control system. The Workstation shall be ergonomically designed and rated for the surrounding environmental conditions. The Workstation shall operate from a Microsoft Windows operating system per Owner Specifications. The access to the workstation shall be controlled using individual username and password.

2.06 SERVER CONFIGURATION REQUIREMENTS

A. KVM Console:

1. Provide a Rack Console KVM (Keyboard, Video, Mouse) Switch to connect to the servers.
   a. Console shall have a 19-inch LCD monitor.
   b. Console shall be compatible with both PS/2 and USB servers' keyboard and mouse ports.
   c. Console shall have a KVM switch with sufficient ports for all rack servers plus two spare ports, 8-Ports minimum.
   d. Console shall be supplied with all cables needed for the servers including those for the two spare ports.

B. System Servers:

1. Provide HMI Database and Graphics Servers that meet the requirements of the associated Data Sheet.

C. Wonderware servers shall be virtualized with automatic failover functionality.

D. License Server shall be virtualized and store the license information for all the system licenses. All licenses shall be managed via this server. Licensing shall be either dynamic or static based on the application and/or hardware.

E. Domain Controller / Server shall be virtualized and respond to security authentication requests (logging in, checking permissions, etc.) within the PDCS architecture. Supplier shall be responsible for creating individual login usernames, passwords and access rights for all the operators and the plant supervisors.

F. A dedicated virtualized historian server shall be furnished as part of the PDCS with access to storage that includes:

1. RAID quality storage for data backup (RAID level as recommended by Supplier).
2. RAID-level five quality storage for archiving of older data.
3. physical media drive for remote archiving of data.

G. Virtualized Windows Terminal Server: A virtualized Windows Terminal Server shall be furnished as part of the HMI system to enable access to the HMI without installed programming.

2.07 POWER SUPPLIES

A. Power supplies shall be provided for:

1. Controller/chassis power supplies.

2. 24V dc loop supplies for analog I/O.
3. 24V dc wetting power for digital inputs.
4. 24V dc auxiliary power for digital outputs.
5. Other functions as required.

B. Where required by application and as shown on the Drawing, control system panels may require as many as four separate power feeders. Where a power supply requires subdivision within the control system panel, that subdivision shall be designed by the Supplier, providing all internal power distribution including circuit breakers for main feeders and individual fused circuits for all solenoid valves and other outputs.

1. Control system primary hardware UPS feeder 1.
2. Control system primary hardware UPS feeder 2.
3. Control system secondary hardware ‘reliable power’ for I/O powering.
4. Cabinet house power for cabinet utilities; lights, receptacle.

C. The Supplier shall consider future system expansion when sizing the power supplies. Excessive loading of the power supplies shall also be considered to avoid shutdowns or premature failures.

D. Power for control system hardware shall be fed separately from power for non-critical items in the control panel such as convenience receptacles and lights.

E. Each power supply shall have its own means of isolation, such as a circuit breaker, within the internal control panel power distribution. Where redundant power supplies are configured in the control panel, redundant power supplies shall be fed from independent power feeds to the control panel.

F. Each power supply shall have a hardwired failure alarm, built into the power supply, if available, or by powering the coil of a relay from the power supply if not, as an input into the control system.

2.08 COMMUNICATIONS

A. All interface data communication shall be managed by the common PDCS communications scheme.

B. All interface system communications shall be evaluated against the Risk Management Framework (RMF) and be considered Operational Technology (OT) category RMF Level 1 or 2.

C. Where technologically feasible interface system communications links shall be deterministic and utilize cybersecure methods to ensure system resilience against cyber threats.

D. Ethernet/IP Communications: Interface to the HMI, servers and operator workstations shall be via Ethernet/IP connection unless otherwise required by system hardware or approved alternate configuration.

E. Data Processing and Communication:

1. All dynamic data displays shall be updated often enough to permit safe and functional control.
2. System capacity and performance shall be based on a minimum of five attributes from every controlled device based on a configurable triggering event.

2.09 HMI CONFIGURATION SOFTWARE

A. Supplier shall provide and configure the HMI workstation using Wonderware software (latest version as of purchase order date) with appropriate licenses.

2.10 GENERAL HMI CONFIGURATION REQUIREMENTS

A. The following defines the minimum graphics information and functionality for Supplier configured HMI:

1. All graphics shall have the data and time displayed on the page.
2. Graphics shall be configured in a consistent manner, for example, common information displayed on all graphics should be located in the same place on each graphic, e.g. time, date, navigation arrows, etc.
3. All graphic control shall indicate if their associated control is not operable.
4. All graphics must show status changes in a manner that permits recognition by colorblind operators.
5. All graphics shall indicate bad quality for the given process points.

B. Histories:

1. An event history shall be capable of storing up to 200 points. The data shall be stored in a one-hour circular buffer and provide data for a combined 1-hour pre-trip and post trip log.
2. A point attribute history shall provide for the storage of database attributes of the real-time variable for trending and reporting of data.
3. A history of the operator alarms shall be stored for the alarm log.
4. A history of the operator events (actions) shall be stored for the operator log.

2.11 SECURITY

A. The system shall be configured with strong password access protected security to allow different permissions for the operator, engineer, and supervisor. Passwords shall meet the following requirements:

1. Passwords to change once per year.
2. Passwords are a minimum of 8 characters, cannot form a name, date, acronym, or a word and contain at least one character from each of the following:
   a. Uppercase English character.
   b. Lowercase English character.
   c. Digit (0 to 9).
   d. Special Character (!, @, #, $, %, &).
3. User accounts are locked out after 3 failed logon attempts and requires reset by the system administrator.
4. Auto user log off should be implemented such that a User is logged off after an initially programmed 15-minute period (adjustable, set by Owner between 0 to 30 minutes) of inactivity.
5. Users shall be locked out of the system if they have no activity in the last 30 days (adjustable).

B. The system shall include Anti-Virus and Malware detection software.

C. Software patches and upgrades shall be performed by Owner.

2.12 OPERATOR INTERFACE HMI CONFIGURATION REQUIREMENTS:

A. The Operator Interface HMI shall consist of a high-end graphics operator interface. The primary function of the HMI will be for daily operation, but it will also support initial configuration of control system parameters, maintenance tasks, and troubleshooting. All control related tasks shall be accomplished through the HMI.

B. Graphic displays shall use pop-up windows. These shall be predefined during configuration for size, content and location. The content of each pop-up window shall include dynamic displays for text, (change of state) numeric, and graphic data.

C. The process graphic displays shall be fully interactive displays providing full process monitoring and manipulation. This interaction shall allow for the changing of setpoint, output, mode, ratio, bias, etc., for modulating parameters. The interaction shall also allow for issuance of start/stop and open/close commands for loops.

D. The process graphic displays shall use windowing capabilities to pull up windows with the individual faceplate for all analog or on-off (digital) loops that are operated from the graphic. Windows shall also be used for equipment diagnostic displays separately showing dynamic permissive and interlocks for all analog and digital control loops.

E. All HMI graphics require Owner/Engineer approval.

F. From the HMI the operator shall have complete control of the equipment. These include the following as a minimum:

1. The operator shall interactively control equipment from the graphics using either the keyboard or mouse on a remote HMI or keypad and function keys on an enclosure mounted HMI.
2. For modulating control loops, the operator shall be able to adjust the loop setpoint, set controller output in manual, set the bias and ratio adjustments and select the controller operating mode, such as auto or manual.
3. The operator shall be able to start and stop equipment, open and close valves or position dampers, start or stop sequences, etc.
4. The operator shall be able to tag out equipment through the faceplate displays for maintenance.

G. It shall be possible for the operator to initiate and perform all of the graphic display functions described in this section. These include the following as a minimum:

1. Overview displays:
   a. Shall provide the operator with a summary of the state of the major control loops and variables in the system.
   b. Shall indicate the relative deviation between each control loop’s process value and its setpoint or target value.
   c. When a control loop reaches or exceeds the maximum deviation, a visual alarm shall appear on the display advising the operator where the abnormal condition is occurring.
   d. The overview display shall indicate the control loop mode.
2. Faceplate displays:
   a. This display shall provide the operator with control and monitoring information on a single analog control loop or on/off controlled equipment in the system. Faceplate displays shall be provided for each device controlled.
   b. In all cases, faceplate displays may contain multiple control functions and status and allow mode selections for automatic sequenced control (i.e. load demand computer, equipment train start-up/shutdown, etc.).

c. All equipment must be controlled through faceplate displays.
d. Faceplate displays shall “pop-up” from graphics for status and control of equipment.
e. The information shown on the display shall include, as a minimum and as applicable, the following: loop description, loop ID (tag), process variable, setpoint and output graphic as shown for that loop in the group display and status (manual, cascade, auto, on, off, tag out, and final drive power available). All tuning parameters, configuration parameters and alarm limits for the loop shall be available on a separate point ID or loop display.

3. Pop-up Window Displays:
   a. Pop-up windows shall be used for the operator call-up of faceplate, preprogrammed trend displays, status or help, and tag-out displays from process graphic, faceplate group, or other pop up displays.
   b. Pop-up windows shall include a poke-field target or similar means to return to the previously displayed pop-up window or graphic.
   c. Faceplate pop-ups shall be called from each equipment symbol on process graphics or from other faceplates where equipment operation is slaved or closely associated.
   d. Tag-out display pop-ups shall be called from each faceplate. The tag-out display shall allow the tag-out operation as indicated on the faceplate. The tag-out display shall show all tags applied to the device. The display shall include the tag’s serial number, comment, date, and time stamp.
4. Single-point definition displays of Analog and Digital process points and shall include the following information:
   a. Process point ID.
   b. Process point description.
   c. Value or status.
   d. Engineering units (if applicable).
   e. High and low alarm limits (if applicable).
   f. High and low re-alarm limits (if applicable).
   g. High and low trip limits (if applicable).
   h. Rate of change alarm (if applicable).
   i. Return to normal dead band values (if applicable).
   j. Calibration data.
5. Group log displays with the following information:
   a. Group log identification.
   b. Point ID and description of each point.
   c. Value and status of each point.
   d. Engineering units (if applicable).
   e. Date and time.

6. Trend displays:
    a. Trend displays for each point shall include the point description, time base and ordinate magnitude.
    b. The trend time base shall be assignable.
    c. Trending of historical information shall be available. The operator shall be able to scroll backward or forward through the data.
    d. All trend displays shall include date, time, and load.
    e. Bar charts, data tables, and other customized graphic displays.
7. Data Logging Functions:
    a. The system shall have the data logs built in the HMI.
    b. All data logs shall have the date and time displayed on top of page.
    c. The control system shall have the capability to automatically or manually store data on the archival storage device when it exceeds the memory capacity of the system.
    d. The operator shall have the capability to demand a printout of a periodic log at any time. The printout of this log shall consist of the hourly values and the end of day values of each variable at the time of demand.
    e. The periodic log shall have the capability to spool data for historical storage for the Owner's use off the system.
8. Operator Action Log:
    a. The system shall maintain a log of any operator control action from the console.
    b. The log shall maintain all action of assigned points for at least the most recent 72 hours.
    c. The log shall be capable of being displayed on the operator console or printed on demand.
9. Alarm displays:
    a. The alarm summary shall list all alarms as well as points exceeding re-alarm limits. These alarms shall be listed in the sequence they were detected.
    b. Messages for alarms, displayed on the overview display, shall include the following information: point tag (ID), point description, value or status, engineering units (if applicable), date and time.
    c. All system alarms shall be available for historical operator information, and the operator shall be able to shift pages for alarm review.
10. Communication/Control System Status Display:
    a. Displays shall be available showing status of all communication links on the system, including data highway between control system controllers and remote I/O links.

b. When failure condition is detected on a communication device on the network, the operator shall be alerted.
c. Graphic symbols shall change color to indicate malfunctions.

11. Device Diagnostic Display:
    a. Displays shall be available that indicate the status and nature of any malfunctions to the card level.
    b. The system shall notify the operator when a malfunction has occurred.

2.13 CONFIGURATION AND PROGRAMMING OF SERVERS AND WORKSTATIONS

A. Configuration and programming of following, but not limited to, HMI equipment is part of the scope of the Work:

1. Primary Operations Location Servers.
2. Alternate Operations Location Servers.
3. Primary Operations Location Operator Workstation(s).
4. Alternate Operations Location Operator Workstation(s).
5. Primary Operations Engineering Location Engineering Workstation(s).
6. Alternate Operations Engineering Location Engineering Workstation(s).
7. All network switches, printers, and other hardware furnished and shown on the block diagrams.

B. Configuration and Application programming shall follow the same functional requirements specified in paragraph Configuration and Programming of Servers and Workstations. Basically, all of the control and monitoring features available at the local HMI shall be available at the workstations. Provide all standard data storage and retrieval functions.

2.14 LICENSES

A. All software licenses required to operate, maintain, and program the control system components shall be included with the system. The licenses shall be sufficient to meet the process operating and control requirement for the scope of I/O specified (including spare capacity specified). The licenses shall not be limited to the quantity of HMI graphic screens.

B. Ownership of licenses shall be transferred to the Owner at the successful conclusion of the Factory Acceptance Test.

C. The Owner shall be able to copy displays, configuration drawings, and database files developed for this Project without limit.

2.15 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. White engraved nameplates with black letters on cabinets and devices. As a minimum and per the Drawings, name plates shall indicate:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

C. This article is included more to inform the HMI development process with Project standardized tagging and continue the Project standardized tagging within the HMI “programmed” infrastructure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be per manufacturer’s written recommendations.

B. All work shall be performed in accordance with the Supplier prepared and Owner/Engineer approved construction sequence.

C. Field Quality Control:

1. Provide following field testing:
   a. Insulation resistance of each winding to ground and to other windings.
   b. Power factor testing of bushings before and after installation.
   c. Proper operation of cooling fans and controls.
   d. Proper operation of pressure relief device, sudden pressure relay and auxiliary relay, liquid level indicator, and tap changer.
2. Provide assistance during initial energization including investigation and remediation of any failures or misoperation of equipment or system.
3. Twenty four hours after initial energization, sample insulating liquid and test for dielectric strength, moisture content, neutralization number, color, content, and complete gas-in-oil analysis.

4. Manufacturer’s service personnel shall be factory trained and shall report to the field Site with all tools, test equipment, and materials as required to perform the service required in paragraphs 1 through 3 above.

3.02 TESTING AND INSPECTION - GENERAL

A. The Owner reserves the right to witness all tests and shall be notified at least 21 days in advance of the tests. An approved test plan must be in place before scheduling any test.

B. The Supplier shall enlist the support of equipment Manufacturer services as needed for testing.

C. All control panels and enclosures shall be tested for proper wiring and operation before shipping.

D. The system shall be subject to Owner witnessed factory and Site acceptance tests. The system shall not be shipped from the place of assembly and configuration until the factory acceptance tests have been deemed to have been passed by the Owner.

E. Certified test reports for the tests performed shall be transmitted to the Owner prior to shipment of the system. When requested by the Owner, the Supplier shall review the test results with them and obtain approval for shipping.

F. Should the system fail a specified factory test or show abnormal results, the Supplier shall immediately inform the Owner. The cause of the problem and the proposed corrective action shall be discussed with the Owner prior to the implementation of corrective actions. After the problem is corrected, the specific system function shall be re-tested. All repair details shall be documented and included in the Test Report.

G. The Supplier shall provide to the Owner, full cooperation and assistance in any factory inspection at the Supplier’s premises provided reasonable written advance notice has been given to Supplier.

H. Major items supplied under this Specification by the Supplier shall be given standard applicable tests at the factory during or at the completion of manufacture. A test procedure shall be prepared for each test that shall describe the test to be performed, the applicable item of equipment being tested, the standards and method of testing, and the testing facility's capabilities and shall state a proposed test date. All test procedures shall be submitted to the Owner for review. Successful completion of the test shall be a precondition for shipment of the tested item to the jobsite. The Owner shall be notified in writing at least 14 days before any final factory test of any major components. An approved test plan must be in place before scheduling a factory test.

I. Owner’s representatives shall participate in formal design reviews at Project kickoff, and at approximately 25 percent and 75 percent completion of control logic and operator graphic development.

3.03 FACTORY ACCEPTANCE TESTS

A. The Supplier’s equipment shall be subject to witnessed Factory Acceptance Test (FAT). The system shall not be shipped from the place of assembly/configuration until the factory acceptance tests have been deemed to have passed by the Owner.

B. FAT procedures shall be submitted to the Owner/Engineer a minimum of 30 days prior to said tests for review/comment.

C. FAT test shall not be scheduled before approval of the FAT procedure.

D. Factory acceptance test simulation shall include discrete items such as pump and fan motors, motor operated valves, solenoid valves, and circuit breakers. The FAT shall demonstrate that each simulated discrete device can be operated and that its graphic symbol shows the correct status. The FAT shall demonstrate that each control loop can be transferred smoothly between manual and auto mode and can automatically control the simulated process.

E. To the greatest extent practical, communications to subsystems shall be tested during the FAT.

F. Before the equipment is shipped to the Site, the equipment shall be completely assembled in one location, powered up and a complete, automated, closed-loop Factory Acceptance Test (FAT) performed by the Supplier prior to notifying the Owner/Engineer that the system is ready for formal factory acceptance testing to be performed with the Owner involvement.

G. All software, including application software, all logic programs, automated sequencing and tripping logic, all modulating logic, all HMI screens, logs, and performance calculation software, and all data link software shall be loaded into the equipment and tested. Use a Control loop simulator to simulate the process for each control loop.

H. All hardware shall be validated which shall include the following as a minimum:

1. A functional test of all inputs and outputs shall be performed.
2. The rack, slot, and channel assignment of each signal shall be verified.
3. All I/O shall be tested, and function and ranges verified.
4. Interconnecting communications cabling shall be installed, and the Supplier shall demonstrate, test, and prove all interconnections and communications between the various interconnected components of the control system.
5. Verify interfaces with the external systems using simulated hardwired I/O and Ethernet Data Exchange Tables as applicable. Likewise, the server and workstation interfaces shall be simulated using a Laptop simulator to generate the data exchange.
6. Power and ground connections and cabinet wiring shall be inspected for compliance with design Drawings.
7. Branch circuit fuses shall be inspected for compliance with design Drawings.
8. Each cabinet power supply shall be tested for verification of load and fail over capability.
9. Each redundant controller shall be tested for verification of fail over capability.

I. All logic functionality shall be tested and verified using appropriate automated closed loop simulation of field equipment for all loops.

J. All HMI graphic and data points shall be verified.

K. All logs and reports shall be verified.

L. Baseline system parameters shall be provided to the Owner/Engineer during the Factory Acceptance Test.

M. The FAT will not take place until the Owner has approved a FAT plan. The FAT plan shall include an overview of the test plan activities, methodology, schedules, and required resources as well as a list of the functional tests to be performed. The procedure shall list the satisfactory acceptance criteria of each test.

N. Supplier shall submit a test procedure 30 days in advance of the FAT for review and approval.

O. All system deficiencies will be corrected by the Supplier prior to shipping unless otherwise agreed to by the Owner/Engineer.

P. The actual system database will be used for all testing.

Q. The Supplier will demonstrate, test, and prove all interconnections and communication between the various interconnected components of the control system.

R. Minimum FAT Requirements:

1. Checkout of all inputs and outputs, analog and digital.
2. Demonstration of system algorithms by use of loop simulator where applicable.
3. Creating and handling of error and device failure conditions.
4. Redundancy checks and fail-safe proofing.
5. Demonstration of power/fail restart.
6. Demonstration of online database editing capabilities.
7. Demonstration of any CPU and data link loading of system.
8. Demonstrating operation of the application software.
9. Demonstrating all displays, logs, reports, and operator/user procedures.
10. Demonstrate system to be fully integrated, including hardware and software.
11. Demonstration of error free operation of Data Exchange Tables (DETs) using laptop to simulate the servers and workstations. Test and verify all READ and WRITE BITS and WORDS are exchange correctly at both ends.

S. The FAT will be considered successful and approved by the Owner when the system has successfully passed all the tests to the Owner’s satisfaction. The Owner must approve any delayed punch list item not repaired during the FAT test. Faulty and/or incorrect operation will, at the discretion of Owner, be cause for suspension or restart of the FAT test.

T. All data interfaces to external control systems shall be demonstrated to be fully configured by installing communications hardware specified for each system interface.

1. Simulated data values from each control system shall be indicated and verified on the HMI Workstation and on the external system display.
2. Data communications transfer rates shall be optimized and documented prior to acceptance and delivery of the system.

U. The Supplier, after installation and prior to declaring the system operational, must demonstrate to the satisfaction of the Owner that the system performs in accordance with this Specification and Test Procedure used for the FAT.

3.04 SITE ACCEPTANCE TESTING (SAT)

A. Initial Power-Up and Functional Verification: Upon completion of system installation at the Project Site, the Supplier shall conduct the initial power-up and onsite system diagnostic and functional tests to verify system functionality and make the system operational. Onsite testing shall be completed as soon as possible after Site system enclosure installation and power feed termination.

B. Communication and Operation Verification: After the system is installed in the Project Site and made operational, the Supplier shall exercise all hardware, communication links, software, and configuration programs to ensure proper operation and prove compliance with the Specifications. The Owner’s personnel will use the system during calibration, checkout, and initial operation of plant systems.

C. The Supplier shall supply all special tools or special equipment for erection and commissioning of the Work.

D. Supplier shall submit a SAT procedure 30 days in advance of the SAT for review and approval. Approved Test Plan is a prerequisite to conducting SAT.

E. Minimum Items to be Tested During SAT:

1. Demonstration of all interconnections and communication between the various interconnected components of the system including field instrumentation connected to the control system and related signal integrity.
2. All I/O tests shall be in cause and effect format. Initiate an action at the HMI and observe response at the final control element. Initiate an action at a field sensor and observe response at the HMI.
3. Repeat of the FAT done at the Supplier’s facility.
4. Demonstration of power/fail restart, and failover scheme.

5. Demonstrating operation of the application software.
6. Demonstrating all displays, logs, reports, and operator/user procedures.
7. Demonstrate system to be fully integrated, including hardware and software.
8. Demonstrate satisfactory data exchange between the PDCS, any external interfaces, the Servers and Operator Workstations.
9. Final acceptance cannot be given until all equipment is operating safely and satisfactorily, all system functions operational from the workstations and local HMIs, and all punch list items are resolved to Owner's satisfaction. Successful demonstration that the control system is satisfactorily operating system equipment and related balance of plant equipment. All control algorithms are maintaining correct system operation following a disturbance.

3.05 TRAINING

A. Provide training so that the Owner can operate, maintain, change system configuration (including cyber security aspects of the system), and repair the complete system. Owner personnel will include Operators, Engineers, and System Administrators.

B. Provide competent, factory authorized personnel to provide instruction to O&M personnel. Include sufficient hours of training to provide complete training for operation and maintenance of the equipment and system.

C. Provide the name and resume of proposed instructor; instructor must have at least 5 years of experience as an instructor, with 3 years of experience teaching the designated course. Instructor's primary language shall be English.

D. Owner reserves right to reject proposed instructor. Owner reserves right to have the Integrator repeat portions of the training (at Integrator's expense) if Owner feels training was inadequate.

E. Provide training manual that includes, as a minimum, the following:

1. Course objective.
2. Course outline.
3. Theory of operation.

F. Overview Training:

1. This training shall be for all personnel to describe the system architecture, interconnections, functions, and capabilities:
   a. System Network.
   b. Communication Interfaces.
   c. Workstation Interfaces.

d. Application Software Programs.
e. Controller Programming.
f. Security Configuration/Concepts.

2. Review system terminology, abbreviations, and acronyms.
3. Review screen display data and access.

G. Operator Training:

1. The course shall be an in-depth instruction on the following topics:
   a. Human Machine Interface (HMI).
   b. Display organization.
   c. Alarms.
   d. Device control.
   e. System communications.
   f. System power-up and shutdown.

H. Administrator Programming/Configuration Training:

1. The course shall be an in-depth instruction on the following topics, as a minimum:
   a. Loading software, and printer setup.
   b. Database creation and editing.
   c. Configuration of report formats.
   d. Create and edit HMI displays.
   e. Review diagnostic routines, error reporting and interpretation of results.
   f. Review system-operating software.
   g. Controller addressing, programming and upgrades.
   h. Assigning passwords.
   i. Review and modify system security measures.
   j. Generate backup and restoration of files
   k. Review programming languages and software structure/organization.
   l. Create and display objects.
   m. Use the program editor.
   n. Access real-time database and other computers/systems on the network.
   o. Integrating programs into the system.
   p. Manage the TCP/IP Network Configuration.
   q. Archive database and system configuration information.
   r. Upgrading hardware and software.

3.06 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer's recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description and Drawing reference and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

3.07 PROTECTION

A. Protect equipment from construction or accidental damage during the installation period prior to system testing and turnover to the Owner.

3.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. Data Sheets.

END OF SECTION

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DATA SHEETS:
PDCS HMI

PROJECT: CTG-7
CP #: 1419
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS

EQUIP NAME: HMI Station
TAG NO.
P.O. NO. BY CONTRACTOR
LOCATION: New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
TERMINAL			
DISPLAY SIZE	in	12	
OPEN ARCHITECTURE	Y/N	Y	
CONFORMALLY COATED	Y/N	Y	
STAINLESS STEAL		OPTIONAL	
ENCLOSURE RATING		NEMA 4X	
INTERNAL			
OPERATING SYSTEM		MICROSOFT	
CPU	GHz	X86-1.3	
RAM	MB	512	
OPERATING FREQUENCY	Hz	60	
INTERNAL STORAGE	MB	512	80 MB non-volatile storage
REAL-TIME CLOCK	MIN	BATTERY BACKED	+/- 2 min Accuracy
OPERATING TEMPURATURE	°F	32 - 131	
USB		2 USB-A & 1 USB-B	
INPUT POWER	VDC	18-30VDC or 100-24VAC	
ETHERNET		2 - 10/100Base-T	Ports to support device-level ring, linear or star network topologies
SOFTWARE			
FACTORYTALK MACHINE	EDITION	7.0 OR LATER	
FACTORYTALK VIEWPOINT			
PDF VIEWER	VERISION	LATEST	
ACTIVEX CONTROLS			
REMOTE TERMINAL CONTROL			
FTP SERVER			
CERTIFICATIONS			
UL LISTED, CLASS I/DIVISION II	GROUP	A	
UL LISTED, CLASS I/DIVISION II	GROUP	B	
UL LISTED, CLASS I/DIVISION II	GROUP	C	
UL LISTED, CLASS I/DIVISION II	GROUP	D	

DATA SHEETS: **PDCS HMI** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** Monitors **TAG NO.** **P.O. NO.** BY CONTRACTOR **LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
MONITOR			
DISPLAY SIZE DIAGONAL	IN	27	
RESOLUTION	PIXEL	1920 X 1200	or higher
CONTRAST RATIO		1000:01:00	
ASPECT RATIO		16:9 WIDESCREEN	
VIEWING ANGLE (HORIZONTAL)	DEGREES	170	
VIEWING ANGLE (VERTICAL)	DEGREES	170	
RESPONSE TIME	ms	8	
BRIGHTNESS	cd/m^2	300	
SCREEN		ANTI-GLAR	
SPEAKERS		INTEGRATED	
POWER MANAGEMENT		ENERGY STAR CERTIFIED	
VIDEO INPUTS			
ANALOG		VGA	
DIGITAL		DVI	
HIGH DEFINITION MULTIMEDIA INTERFACE		HDMI	

DATA SHEETS: **PDCS HMI**	
PROJECT: CTG-7	**EQUIP NAME:** Operator Workstations **TAG NO.**
CP #: 1419	**P.O. NO.** BY CONTRACTOR
CLIENT: SEWERAGE & WATER BOARD OF NEW ORLEANS	**LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
INTERNAL			
OPERATING SYSTEM		MICROSOFT WINDOWS 10 PROFESSIONAL 64-BIT	
PROCESSOR		INTEL CORE i9 (10-CORE, 20M CACHE), 3.8 MHz	
MEMORY	GB	64	2x32 GB, DDR4, 2933 MHz
GRAPHICS CARD	GB	8	GCCR6
INTERNAL OPTICAL DRIVE		BD	
INTERNAL OPTICAL DRIVE		DVD	
INTERNAL OPTICAL DRIVE		CD	
HARD DRIVE	TB	2	M.2 PCIeNVME SSD + 2TB SATA 7200 RPM
KEYBOARD	keys	105	Advanced ergonomic design
MOUSE			Optical 2 button and wheel
NETWORK INTERFACE CARD			Dual Ethernet
SOFTWARE			
MICROSOFT OFFICE PROFESSIONAL	VERSION	2019	
ADOBE ACROBAT PROFESSIONAL	VERSION	2020	
SYSTEM APPLICATION PROGRAMS		HDMI	

DATA SHEETS: **PDCS HMI** **PROJECT:** CTG-7 **CP #:** 1419 **CLIENT:** SEWERAGE & WATER BOARD OF NEW ORLEANS	**EQUIP NAME:** Server **TAG NO.** **P.O. NO.** BY CONTRACTOR **LOCATION:** New Orleans, LA

DESCRIPTION	Units	SPEC DATA	SELLER DATA
Manufacturer	-	By Contractor	
Factory Location	-	By Contractor	
Quantity	-	By Contractor	
INTERNAL			
OPERATING SYSTEM		WINDOWS SERVER 2019 STANDARD, 16 CORE, MULTI LANGUAGE	
PROCESSOR		REDUNDANT, INTEL XEON 4208 2.1G, 8C/16T, 9.6GT/s, 11M, CACHE, TURBO, HT (85W), DDR4-2400	
MEMORY	MT/s	3200	RDIMMs
RAID	LEVEL	1	
HARD DRIVE	TB	4	7.2k RPM DATA 6 Gbps 512n 3.5in Hotplug
INTERNAL OPTICAL DRIVE		DVD +/-RW, SATA, Internal	
POWER SUPPLY		DUAL, HOT-PLUG, REDUNDANT POWER SUPPLY (1+1)	
PASSWORD		FORCED CHANGE OF FACTOR PASSWORD	
COMMUNICATIONS		DUAL NETWORK INTERFACE CARD	
MOUNTING		RACK SLIDING RAILS	
DOCUMENTATION		ELECTRONIC FILES	

SECTION 40 94 25
PDCS DATA EXCHANGE INTERFACE

PART 1 GENERAL

1.01 SUMMARY

A. This Specification, together with applicable Data Sheets and/or Supplements, covers the technical requirements for the design, materials, equipment, programming, testing services, and construction services required to provide totally functional data exchange interface(s) (DEI) between the Power Distribution Control System (PDCS) and other control systems required to interface with the PDCS to enable the PDCS and the interfaced control systems to be fully functional in their intended purpose.

1.02 REFERENCES

A. The latest edition for all codes and standards referenced in this Specification shall be the edition in effect at the time of Contract Award.

B. Industry Standards:

1. International Electrotechnical Commission (IEC):
   a. 60529, Enclosure Protection from Environment.
   b. 61000-4-11, Electromagnetic Compatibility.
   c. 61131, Programmable Controllers.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 1050, Generating Station I&C Equipment Grounding.
   b. C37.90.1, Electrical Surge Withstand Capability.
   c. C37.90.2, Radio Frequency Interference.
3. International Society of Automation (ISA):
   a. 71, Environmental Conditions for Process Measurement and Control Systems.
   b. 62443-2-1, Security for Industrial Automation and Control Systems.
   c. ANSI/ISA 12.12.01-2000, Hazardous Location Certification.
4. National Electrical Manufacturers Association (NEMA): NEMA 250, Enclosures for Electrical Equipment.
5. National Fire Prevention Association (NFPA): NFPA 70, National Electrical Code (NEC).
6. UL:
   a. 508, Safety Standard for Industrial Control Equipment.
   b. 840, Electrical Equipment Insulation Coordination.
   c. 1604, UL Certification for Existing Products.

C. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 61 00, Common Product Requirements.
3. Section 01 58 53, Project Equipment Identification.
4. Section 26 00 00, Electrical General Requirements.
5. Section 26 00 10, Electrical Summary of Work.
6. Section 26 05 75, Basic Electrical Materials and Methods.
7. Section 40 94 23, PDCS Electrical Control System.
8. Section 40 94 24, PDCS Human Machine Interface.

D. Key Project Drawings are listed in Supplement KPD – Key Project Drawings (to be provided by Supplier).

1.03 DEFINITIONS

A. BOP: Balance of Plant.

B. Drawings: Include all technical drawings and documents used to define the system(s) and equipment specified herein.

C. ECS: Electrical Control System.

D. FAT: Factory Acceptance Test.

E. HMI: Human-machine interface; a computer-based operator interface for a control system.

F. PAC: Programmable Automation Controller.

G. PCS: Plant Control System.

H. PDCS: Power Distribution Control System.

I. PLC: Programmable Logic Controller.

J. SAT: Site Acceptance Test.

1.04 SUBMITTALS

A. Supplier shall provide the following information:

1. Drawing list and submittal schedule.
2. Overall system communications diagram.
3. All standard product literature pertinent to the hardware in their design.
4. Bill of materials (BOM) for all equipment in their design, which shall use actual manufacturer names and part numbers.
5. Installation drawings, instructions, product bulletins, and manuals.

6. Operation and maintenance manuals for all hardware and software.
7. Communication configuration programming documentation.

B. Communication configuration at 75 percent completion for Owner/Engineer review and comment.

C. Input/Output (I/O) list for all I/O required for a fully functional interface. The I/O list shall contain all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner/Engineer, as well as the final controller program native file.

1.05 QUALITY ASSURANCE

A. The Supplier shall maintain a quality manual/system which meets the requirements of the applicable international quality system standard appropriate to the contracted Scope of Work throughout the duration of this Purchase Order as well as ISO 9000 requirements.

B. The Supplier quality plan shall be issued for review and for monitoring during the Project. Reporting requirements must include the Owner/Engineer requirements and additional requirements as stated below.

C. Requirements covered by this Purchase Order/Specification shall apply to lower tier suppliers, including Owner/Engineer’s access (accompanied by Supplier) to facilities and records.

D. All materials and hardware to be furnished and all Work to be performed under this Specification shall be subject to review, inspection, and testing as described below.

1.06 WARRANTY AND GUARANTEES

A. Furnish Manufacturer’s extended guarantee or warranty with Owner named as beneficiary in writing as special guarantee.

B. The Manufacturer shall warrant that the equipment shall be supplied in accordance with these Specifications and shall perform as described herein.

C. The Manufacturer shall warrant that the equipment provided shall be free from defects in materials and workmanship for a period of 12 months after acceptance by Owner.

D. The Manufacturer shall repair or provide a replacement for any defective component under the warranty provided that any such defect was not the result of misuse of the equipment by the Owner or the Owner’s representative. The Manufacturer must be able to provide Owner with training and support service during the first year of operation.

PART 2 PRODUCTS

2.01 EQUIPMENT AND SERVICES TO BE FURNISHED BY SUPPLIER

A. All communication hardware, software, programming to establish communication interfaces shown on the Data Sheets and Drawings.

B. All fiber optic cable, media converters, patch panels, patch cords, power supplies to support the communication.

C. Configuration of the system based on datalink list developed in the format defined herein and as necessary to provide a fully functional interface to perform the intended purpose. Configuration shall include controller configuration, datalink configuration, communication equipment configuration, and all other system configuration required to provide operational interface communication links. Configuration shall comply with the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems to ensure system resilience against cyber threats.

D. During execution of the Contract, Owner and Engineer shall select the points required for interface communication based on the Data Sheets and Drawings. Supplier shall be responsible for obtaining the detailed data from the interfaced equipment necessary to perform the interface configuration. An allowance for programming and configuration of an additional 100 points or 35 percent of designed point quantity, whichever is less, during actual commissioning.

E. Supplier shall obtain services from demonstrated established experienced, a minimum of 100,000 points and ten projects experience, selected hardware Systems Integrator and Supplier(s) to provide field support to establish interface communication links.

F. All data files and software tools used for setup and programming. Software licenses shall be provided by Supplier to support initial configuration and site commissioning.

G. Integrating, commissioning, and startup of interface equipment, data links, and all related accessories and equipment.

2.02 COMMUNICATIONS

A. All interface data communication shall be managed by the common PDCS communications scheme.

B. All interface system communications shall be evaluated against the Risk Management Framework (RMF) and be considered Operational Technology (OT) category RMF Level 1 or 2.

C. Where technologically feasible interface system communications links shall be deterministic and utilize cybersecure methods to ensure system resilience against cyber threats.

D. Any taps, terminators, patch cords, patch panels, fiber optic cable, media converters, configuration and diagnostic software, repeaters, or adapters required for communication design shall be provided by the Supplier.

E. Any Ethernet connections outside buildings or longer than 100 meters shall be via fiber optic cable. The Supplier shall provide all required fiber optic patch panel and patch cables as required with the equipment.

F. All dynamic data communications rates shall be sufficient to support safe reliable control and supervision holistically applied to both the interfaced equipment and the PDCS.

2.03 HUMAN MACHINE INTERFACE

A. The Human Machine Interface (HMI) requirements are specified in Section 40 94 24, PDCS HMI Specification.

B. Coordination between the PDCS Interface design and the PDCS HMI design shall ensure sufficient interface capabilities are supplied to support the PDCS HMI design.

2.04 CONFIGURATION SOFTWARE

A. Supplier shall provide and configure the interface equipment with Supplier recommended software. Any other software specifically required for programming of interfaces shall be supplied by Supplier.

B. Software licensing shall be planned and structured such that the Owner shall not incur additional costs, beyond those of the Contract cost, necessary to operate and maintain the permanent installation after turnover from Supplier. All Project specific software licensing for the benefit of the Project shall be in the Owner’s name and remanded to the Owner upon turnover of the Project.

2.05 SPARE PARTS

A. Spare parts and special tools required for one year of operation shall be provided per manufacturer’s recommendations. Supplier shall submit list of these spare parts and special tools.

B. Spare parts and special tools for construction, commissioning, and startup shall be included. Any such parts used during construction or startup shall be replaced.

C. Spare parts and special tools are to be packaged separately from the equipment and shipped along with the equipment. A tag shall be attached to each part showing equipment tag number, part name or description, Drawing reference, and part item number.

D. All spare parts and special tools shall be supplied new and unused.

E. Supplier shall submit a list of recommended spare parts for long-term, reliable operation including pricing. Pricing shall be valid until Project closeout and acceptance.

2.06 EQUIPMENT IDENTIFICATION

A. Equipment identification shall comply with Section 01 58 53, Project Equipment Identification, as well as any additional identification requirements listed in this article.

B. White engraved nameplates with black letters on cabinets and devices. As a minimum and per the Drawings, name plates shall indicate:

1. Tag Number.
2. Circuit Number (where applicable).
3. Name.
4. Reference document number.

C. This article is included more to inform the DEI development process with Project standardized tagging and continue the Project standardized tagging within the DEI “programmed” infrastructure.

PART 3 EXECUTION

3.01 SOURCE QUALITY CONTROL

A. Testing and Inspection:

1. The Owner/Engineer reserves the right to witness all tests and shall be notified at least 21 days in advance of the tests.
2. The communication software shall be subject to Owner/Engineer witnessed factory and Site acceptance tests. The software shall not be shipped from the place of configuration until the factory acceptance tests have been deemed to have been passed by the Owner/Engineer.
3. For testing of the communication links between the PDCS and any existing general or purpose-based control or data interface systems, Supplier can use emulator software to demonstrate the successful communication.

B. An Inspection and Test Plan (ITP) shall be provided that identifies the inspections and tests to be performed during manufacture. Based on this ITP the Owner or his representatives may elect to witness shop testing. Notify Owner 3 weeks (or as otherwise specified) prior to testing.

3.02 MANUFACTURER'S SERVICES

A. Provide manufacturer's services.

B. Site Acceptance Testing (SAT):

1. Site Acceptance Testing (SAT): 6 days, three trips.
2. Initial Power-Up and Functional Verification: Upon completion of PLC communication links installation at the Project Site, the Supplier shall conduct the initial power-up and on-site system diagnostic and functional tests to verify system functionality and make the system operational.
3. Communication and Operation Verification: After the system is installed at Project Site and made operational, the Supplier shall exercise all hardware, communication links, software, and configuration programs to ensure proper operation and prove compliance with the Specifications.
4. The Supplier shall supply all special tools or special equipment for erection and commissioning of the communication links.
5. Supplier shall submit a SAT procedure 30 days in advance of the SAT for review and approval.
6. Minimum Items to be tested during SAT:
    a. Demonstration of all interconnections and communication between interfaced equipment and the PDCS.
    b. Demonstration of power/fail restart.
    c. Demonstrating operation of the application software.
    d. Demonstrating of all displays, logs, reports, and operator/user procedures associated with the interface under test.
    e. Demonstrate the interface system to be fully integrated into the PDCS, including hardware and software.

3.03 SUPPLEMENTS

A. The supplements listed below, included following "End of Section," are part of this Specification.

1. Key Project Drawings List.
2. Data Exchange Table Example Format.
3. PDCS Interface Data Sheet(s).

END OF SECTION

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KEY PROJECT DRAWING LIST

To Be Provided by Supplier

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DATA EXCHANGE TABLE
Example Format

PLC to PLC communication and Data Exchange Table format example.

1) Messages will be transferred between PLCs over the Ethernet networks. Message transfer will utilize CIP Data Table Reads only. No CIP Data Table Writes will be used.
2) Two each source data tables will be generated in each controller:
    a. One data table will be an array of 50 DINT's for transferring Integers and Boolean data.
    b. One data table will be an array of 50 REAL's for transferring floating point data.
3) The array tags will be controller scoped tags.
4) The tags for each of the source tables will have the following form.
    a. DINT – *SourcePLC_TypeNumber*
        i. Example – SrcPLC41_DINTn01
    b. REAL – *SourcePLC_TypeNumber*
        i. Example – SrcPLC41_REALn01
5) Each Array will contain a minimum of 20% spare space at program completion; if any array is 80% filled then the next numerical array will be created until all tags to be exchanged are allotted.
6) The first word of each array will be reserved for a passive watchdog value. This watchdog will be a constantly changing value, either the second timer from the PLC or some independently generated value. The receiving PLC will evaluate the watchdog value contained in the first word of each table, and should the value have not changed in a set time (three times the messaging scan time) then the reading PLC can be programmed to act appropriately and generate a communications alarm. Two PLC watchdog timer and communications fail alarm examples are attached for supplier reference.
7) Data will be packed and unpacked into the generic transfer tags utilizing structured text in the processor. The structured text file will contain comments on each line documenting the information passed in each tag. Refer to the following figures for examples.

Packing Data into Message Transfer Tags

```
(* Message Transfer Source Tag *)

(*************************************************************************************************************)
(* BOOL and INTEGER *)
(* Packed BOOL *)

SrcPAC41_DINTn01[0] := pxxxPACxx41xn01;      (* Watchdog Timer, varies by second, 0-59 seconds *)

SrcPAC41_DINTn01[1].0 := p02xPALx202xn02;    (* Pressure Alarm High, Pump 02202 Sludge Discharge, False = Alarm *)
SrcPAC41_DINTn01[1].1 := p02xPALx203xn01;    (* Pressure Alarm High, Pump 02203 Sludge Discharge, False = Alarm *)
(* Continue with Pattern *)

(* Packed INTEGER *)

SrcPAC41_DINTn01[5] := p01xFQIx001xn1;       (* Headworks Influent Distribution Channel, Total Today, MGD *)
(* Continue with Pattern *)


(*************************************************************************************************************)
(* Packed REAL *)

SrcPAC41_REALn01[0] := pxxxPACxx41xn01;      (* Watchdog Timer, varies by second, 0-59 seconds *)
SrcPAC41_REALn01[1] := h01xAITx311xn1sPV;    (* Headworks Influent Distribution Channel Methane Concentration, Span 0-10 mg/l *)
```

Unpacking Data from Message Transfer Tags to Controller Tags

```
(* Message Transfer to Target Tag *)

(*************************************************************************************************************)
(* BOOL and INTEGER *)
(* Packed BOOL *)

pxxxPACxxx5xn02 := TgtPAC5_DINTn01[0];       (* Watchdog Timer, varies by second, 0-59 seconds *)

p02xPALx206xn02 := TgtPAC5_DINTn01[1].0;     (* Pressure Alarm High, Pump 02206 Sludge Discharge, False = Alarm *)
p02xPALx206xn01 := TgtPAC5_DINTn01[1].1;     (* Pressure Alarm High, Pump 02206 Sludge Discharge, False = Alarm *)
(* Continue with Pattern *)

(* Packed INTEGER *)

p01xFQITx001xn1 := TgtPAC5_DINTn01[5];       (* Headworks Influent Distribution Channel, Total Today, MGD *)
(* Continue with Pattern *)


(*************************************************************************************************************)
(* Packed REAL *)
pxxxPACxxx5xn03 := TgtPAC5_REALn01[0];       (* Watchdog Timer, varies by second, 0-59 seconds *)

h01xAITx312xn1sPV := TgtPAC5_REALn01[1];     (* Headworks Influent Distribution Channel Methane Concentration, Span 0-10 mg/l *)
```

4. Data Exchange List Development Procedure

The following procedure should be followed to finalize the data exchange list.

1. A spreadsheet containing the source tag names and array dimension will be issued by the PLC code developer in both printed and electronic format.

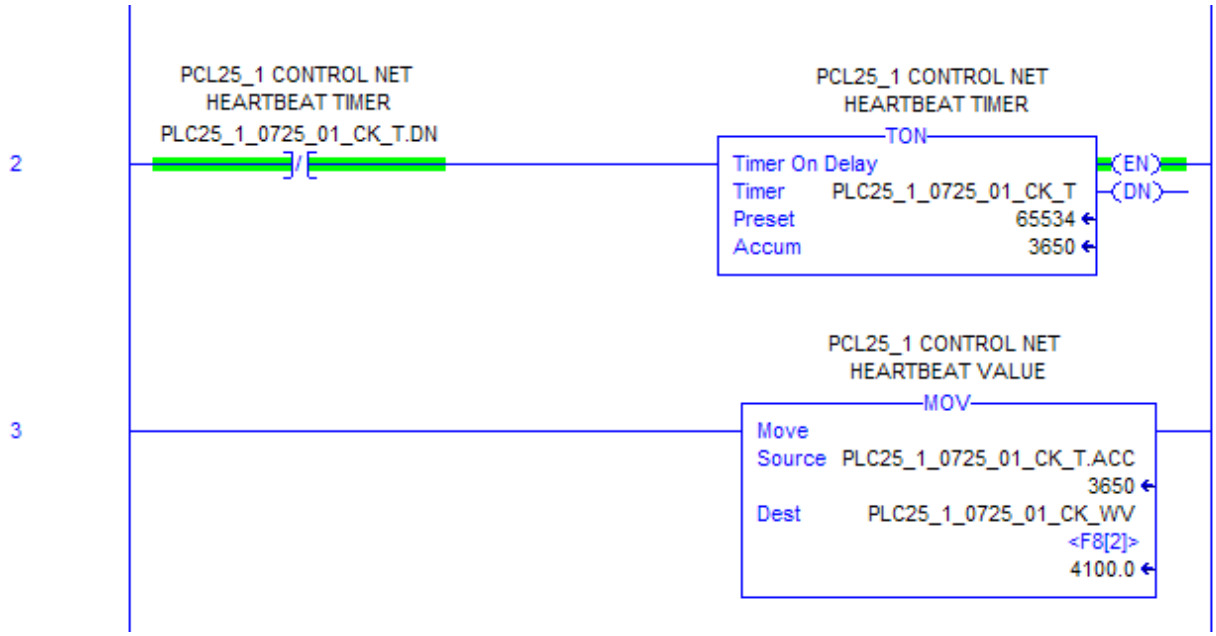
2. The spreadsheet will contain the following information:

    a. Source tag name and element in the array.
    b. Description for the point associated with the source tag name.
    c. Minimum value for integer or floats, False state for Booleans
    d. Engineering units for integer or floats
    e. Comments as appropriate for clarification of data transferred.

5. PLC Watchdog Timer and Communication Fail Alarm Example 1.

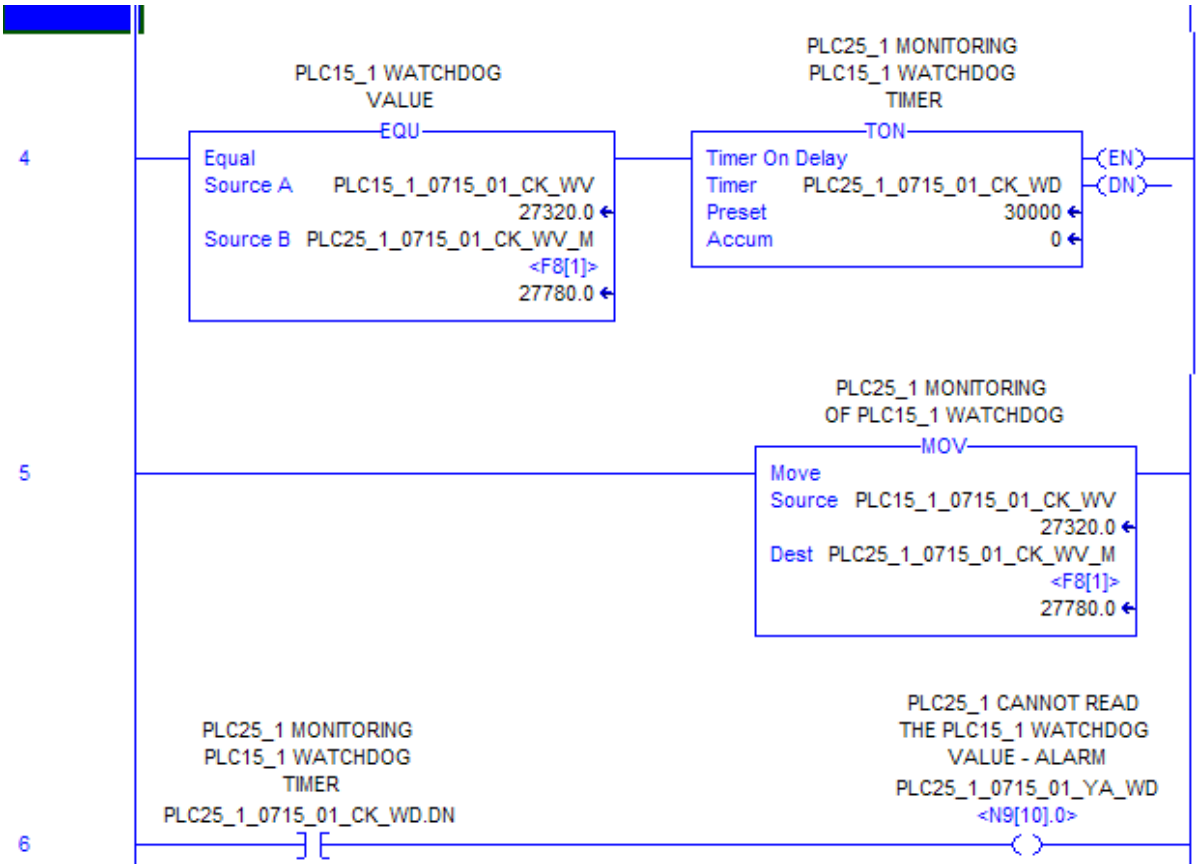
This example does not use specific tag naming standards, but has been presented here to illustrate the specified concept.

In this example PLC25_1 is generating a PLC Watchdog Value from a timer that automatically resets and restarts. The Watchdog Value Tag PLC25_1_0725_01_CK_WV is placed in the first element of the array where another PLC has access to read the Watchdog Value.



6. PLC Watchdog Timer and Communication Fail Alarm Example 2.

In this example PLC25_1 is reading the PLC15_1 Watchdog Value and starting a timer to determine a communication failure with PLC15_1.



The compared value is the last known value of the Watchdog Value received from PLC15_1 (rung 5).

Rung 6 shows the communication alarm when PLC25_1 does not receive an updated Watchdog Value in the maximum time, as specified by the timer in Rung 4. On a communication alarm, the user program will alarm on the HMI and take appropriate action, based on the process, to protect personnel, equipment and the environment.

PDCS INTERFACE DATA SHEET

To be Provided by Supplier

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SECTION 43 12 00
FUEL GAS COMPRESSOR

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specifications for one 100 percent capacity Fuel Gas Compressor ("FGC") package including electric motor driver, attendant controls, required auxiliaries, and accessories.

B. There are a number of requirements within this Specification that may be considered more stringent than what is typically encountered in the industry. The intent is an FGC package that will require minimal maintenance and down time over a 25 year life.

C. The FGC package shall include features needed for safe, highly reliable, efficient, long-term operation. Design shall be in accordance with good engineering practice, applicable standards, and shall meet the strict demands typical of industrial power plants for safety and reliability, as well as those imposed by the Owner and all regulatory agencies having jurisdiction in the State of Louisiana.

D. Related Sections: This Specification section does not stand alone and is a part of the entire Specification which is the sum-total of all the sections. Related Sections listed below are listed for emphasis and do not preclude the applicability of any part of the entire Specification requirements. Related Sections of particular emphasis are as follows:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.

1.02 REFERENCES

A. The design, equipment, material and installation of the Work shall conform to requirements of the latest edition of the following codes and standards:

1. API (American Petroleum Institute):
   a. 618, Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services (as applicable).
   b. 619, Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries (as applicable).

2. ASME (American Society for Mechanical Engineers):
   a. B31.1, Power Piping.
   b. B31.3, Process Piping.
   c. Boiler and Pressure Vessel Code Section VIII – Rules for Construction of Pressure Vessels.
3. American Welding Society (AWS):
   a. D1.1, Structural Welding Code.
4. NESC – National Electric Safety Code.
5. National Fire Protection Associations (NFPA):
   a. 54, National Fuel Gas Code.
   b. 70, The National Electric Code (NEC).
6. UL: 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.

B. While a number of applicable sections of the aforementioned codes and standards have been identified in portions of this Specification, the Supplier has the ultimate responsibility for the complete identification and execution of all applicable sections of the aforementioned codes and standards.

C. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this Document.

D. These codes and standards set forth the minimum requirements. These may be exceeded by the Supplier if, in its judgment and with Owner's acceptance, superior or more economical designs or materials are available.

E. The most severe requirements shall prevail in the event of conflict between requirements, specifications and applicable and governing codes. All conflicts among the Codes, specifications and/or purchase order shall be brought to the Owner's attention for written resolution prior to release for fabrication.

F. It is the Supplier's responsibility that all equipment and materials furnished and installed be in strict conformity with all current, applicable codes and regulations of the state of Louisiana. Violations resulting from stipulations in the existing codes shall be corrected by the Supplier at its own expense.

G. The Supplier shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

1.03 QUALIFICATIONS

A. Only bidders with demonstrated experience in the manufacturing, testing, and servicing of FGC units will be considered. If the bidder is a packager or independent representative, a letter shall be provided from the FGC OEM authorizing the bidder to sell and service the proposed FGC package. Bids shall include a complete list of customers of the FGC OEM.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures.

B. Submit Shop Drawings and product data under provisions of Section 01 33 00, Submittal Procedures.

C. Submit Operation and Maintenance data under provisions of Section 01 78 23, Operations Maintenance Data.

D. Submittal Drawings and Catalog Data:

1. Contractor shall provide the following information:
2. General Data Requirements
    a. Overall scope of supply and equipment description.
    b. Drawing list and submittal schedule.
    c. Schedule for engineering, fabrication and delivery.
    d. Experience and reference list.
    e. Commercial and technical clarifications.
    f. Listing of all sub-suppliers and subcontractors.
    g. Description of training program included.
    h. Description of site support included.
    i. Completed performance data sheets and guarantees.
    j. Shipping details and weights.
    k. Equipment lifting and rigging drawings and details.
    l. Description of Noise Mitigation Provisions
    m. Shop testing procedures.
    n. Field testing procedures.
    o. Description of QA/QC program.
    p. Spare parts list with pricing.
    q. Special tools list.
    r. Trim List.
    s. General Arrangement (GA) Plans and Elevations.
    t. Code reports and certifications.
    u. Operation and Maintenance (O&M) Manuals.
    v. Bills of materials (BOM’s).
3. Mechanical Data Requirements.
    a. Process Flow Diagrams (PFD’s).
    b. Dimensional layout drawings.
    c. Piping drawings with connection/interface tables.
    d. Permissible nozzle loading.
    e. Expected thermal movements – equipment.
    f. Expected thermal movements – connection interface points.
    g. Supplier-furnished pipe support details.
    h. Clearance requirements for maintenance.
    i. Equipment design details and materials of construction.

j. Equipment data sheets.
k. Weld procedures and welder qualifications.
l. Performance correction curves, or performance model.
m. Accessory descriptions.
n. Utility requirements (air, water, fuel, lube oil, etc.).
o. Certified Material Test Reports (MTR's).
p. Equipment Nameplate photograph.

4. Electrical Data Requirements:
   a. Motor list and power requirements.
   b. DC system load requirements.
   c. Accessory descriptions.
   d. Motor data sheets.
   e. One line diagrams.
   f. Three line diagrams.
   g. Connection/Interconnection diagrams.
   h. Electrical Schematics.
   i. Wiring diagrams.
   j. Mounting details.
   k. Grounding details.
   l. Cable list.
   m. Certified test reports.
   n. Electrical cabinet dimensional drawings.
   o. Conduit entrance locations/plan drawings.
5. Instrumentation and Controls Data Requirements:
   a. Piping and Instrumentation Diagrams (P&ID's).
   b. Control system PLC description.
   c. Control system Architecture diagram.
   d. Control cabinet dimensional drawings.
   e. Control panel location drawings.
   f. SAMA/ISA (Analog) and discrete logic diagrams.
   g. Interconnection diagrams.
   h. Point-to-point wiring diagrams.
   i. Control loop diagrams.
   j. Control system power requirements.
   k. Cable list.
   l. Instrument list with process ranges and set points.
   m. Instrument installation details/drawings.
   n. Control valve list.
   o. Alarm list with setpoints in Excel format file.
   p. Component / Equipment list.
   q. Instrument data sheets (Supplier format acceptable).
   r. Control valve data sheets (Supplier format acceptable).
   s. Calibration records for all Supplier-furnished instruments.
   t. Graphical display screens (Screen shots).
   u. Graphical display screens – paging architecture.
   v. Engineering and configuration instructions.

w. Communication configuration at 75 percent completion for Owner/Engineer review and comment
x. Input/Output (I/O) list for all I/O in communication link required for a fully functional interface. The I/O list shall contain all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner/Engineer, as well as the final controller program native file.

6. Civil/Structural Data Requirements:
   a. Code calculations.
   b. Structural steel plans and elevations.
   c. Platform, ladder, and stair drawings.
   d. Foundation loading diagram (Static and Dynamic).
   e. Location, size, and projection of anchor bolts, sleeves, and/or imbeds.
   f. Equipment weights (dry and operating).
   g. Field erection drawings and details.
   h. Equipment grouting requirements and/or recommendations.

E. Routine Maintenance Schedule, Parts and Service:

1. Provide a complete schedule of normally required inspection, preventative maintenance, predictive maintenance, and overhaul tasks and the outage hours required for all of the equipment supplied under this purchase order, plus replacement parts associated with each task. Provide inspection and maintenance plan required to support a minimum on-line availability of 97 percent. List requirements by year with a list of recommended spare parts for each through one entire cycle.
2. Submit a line item price for recommended spare parts for 2 years of normal operation, including expendables, beyond first year of operation.
3. Submit an itemized list and pricing for all required tools including any special lifting fixtures to support on-site maintenance of FGC Package(s).
4. For each inspection, preventative maintenance and overhaul task, list the following:
   a. Tools required.
   b. Materials required.
   c. Associated warnings and cautions.
   d. Initial system conditions required.
   e. Procedure.

F. Software:

1. Provide licenses/copies of all proprietary software required for installation, testing, tuning, or operation of the equipment, instrumentation, and/or protective devices.
2. For any instrument or component which must be connected to a computer for testing, tuning, or programming and utilizes a proprietary cable, provide a minimum of two cables to the Owner.

1.05 QUALITY ASSURANCE

A. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

B. The Supplier shall have in place a complete and functioning comprehensive Quality Assurance program covering the design, procurement, fabrication, packaging and delivery of the specified equipment and materials. This program shall insure that the equipment and materials furnished by the Supplier meet the requirements of this Specification as well as the Supplier’s own procedures and processes.

C. It shall be the Supplier's responsibility to ensure that the Sub-Suppliers and Sub-Contractors meet the intent of this requirement and are able to demonstrate their compliance.

D. Owner or its representative shall be given opportunity to witness all testing.

E. The owner reserves the right to reject equipment and/or components which require major alteration to meet Specifications.

F. Non-conformances to this Specification and major equipment or component repairs that occur shall be documented and approved by the Owner in writing prior to testing and shipment.

G. Software Quality Assurance (SQA):

1. Establish an SQA plan that addresses software tests normally performed by programmers and tests performed to verify system operation.
2. Perform software tests to benchmark functional evaluations, including the following:
    a. Conformance to specification.
    b. Language deviation.
    c. Error handling.
    d. Operational speed.
    e. Maintain a software error log to record occurrence, solution, and corrected resolution.

f. Provide software programming as required to perform functions as specified. Provide annotations in the programming describing functions and changes such that the Owner and others in the future can understand the logic so that changes can be readily made.
g. Provide software licensed to the Owner in perpetuity.

1.06 APPLICATION

A. The FGC described herein will be installed as part of the Turbine 7 (T7) project. The FGC will boost the incoming fuel gas pressure from the local gas utility to that required to support operation of T7.

B. The FGC shall have the capability of automatic load modulation to accommodate varying T7 demand resulting from load variations as well as changes in ambient conditions. Normal control of the FGC shall be based on maintaining a pressure set point at the FGC discharge. The FGC shall be capable of supporting T7 load from 0-100 percent.

C. The FGC will be mounted outdoors in a Supplier-furnished acoustical enclosure. Available area for the FGC is limited; refer to Drawing 1419-M-SK02 for an overall site layout depicting the available space. The compressor package shall be skid-mounted, with the required noise attenuating enclosure.

D. Bidders are advised that multiple compressor technologies such as rotary screw, reciprocating, etc. will be considered if available in the specified operating range. The intent is for a unit which is optimized in terms of performance, efficiency, turn-down, and minimal noise generation.

E. Oil coolers, intercoolers, after-coolers, and other auxiliaries will be air cooled, with the required fans and heat exchangers included in the FGC package.

F. The FGC package shall be capable of sustained operation with utility pipeline natural gas fuel. Existing natural gas fuel analyses are included in Drawing 1419-M-SK03.

G. Asbestos, polychlorinated biphenyls (PCBs) and lead-based paint shall not be used anywhere in the equipment supplied by Supplier, including sub-suppliers. Use of ceramic fiber shall be noted where used.

H. Instrument Air will be available at 125 psig Maximum; 80 psig Minimum pressure.

I. Site ambient conditions and other design criteria are shown in Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Qualified entities submitting bids (Bidders) shall have extensive and successful experience providing units of the size and type specified.

B. Fuel Gas Compressor Package:

1. AG Equipment Company.
2. Ariel.
3. Compressor Systems, Inc.
4. Dearing Compressor & Pump Company.
5. Dresser Rand.
6. Emerson/Vilter.
7. Enerflex.
8. Kobelco.
9. “Or-equal.”

C. Miscellaneous Equipment:

1. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following. Any deviations must be approved by Owner in writing prior to purchase of items by Supplier:
2. Mechanical Seals:
   a. Flowserve.
   b. John Crane.

2.02 SCOPE OF SUPPLY

A. Components and systems within Supplier’s Scope shall be complete, including control valves, piping, equipment, instrumentation, controls, alarms, wiring, insulation, cladding and other items required for a complete, functional, highly reliable and highly-automated installation in accordance with good engineering practices and the rigorous demands of industrial power plant service. To the extent practical, equipment shall be delivered in modular form; pre-piped, pre-wired, pre-terminated and pre-tested.

B. Furnished by Supplier:

1. Freight, FOB job site.
2. Electric motor-driven fuel gas compressor package mounted in outdoor rated, sound attenuated, ventilated enclosure.
3. Programmable Logic Controller (PLC)-based package control system, interfaceable to Process SCADA System (PSS) and the Turbine Control System (TCS).

4. Steel base frame with full size, continuous drip pan.
5. Base plates, shims, alignment/leveling equipment, and any other special foundation imbeds required to set and align equipment.
6. Lube oil system and pumps.
7. Lube oil coolers and gas intercoolers/aftercoolers designed for air cooling.
8. Gas inlet filter, oil/gas separator, and outlet coalescing filter.
9. Interconnecting piping, tubing, and/or flexible hose connections as required between Supplier-furnished auxiliary skids and main package.
10. Gas suction and discharge manifolding to the edge of the package.
11. All valves, relief valves, drains, vents, and accessories required by applicable codes.
12. Gas detectors within the FGC enclosure, including exterior visual indication.
13. Ladders, platforms and safety rails (as needed) for maintenance.
14. 100 percent redundant ventilation fans for fuel gas compressor enclosure, designed to maintain Class I, Div. 2, Group D area classification inside enclosure.
15. Sound attenuation as necessary to meet noise criteria specified herein.
16. Instrumentation and controls required for fully automated startup, shutdown, operation, load/pressure control, temperature control, and remote monitoring of the equipment package.
17. Vibration monitoring, condition monitoring, and data management systems.
18. Real-time event recorder with first-out identification and reporting to the operator.
19. Safety rails as required in accordance with OSHA standards.
20. Safety guards on exposed rotating parts, in accordance with OSHA standards.
21. Painting per Section 09 90 01, Painting and Protective Coatings.
22. AC power/lighting system for inside of enclosure.
23. On-site support during offloading, setting, startup, commissioning, and performance testing.
24. Operations and maintenance personnel training at the job site, including travel and local living expenses as specified herein.

C. Furnished by Others:

1. Offloading, storage, erection and installation of the equipment at the job site.
2. Foundations, anchor bolts and grouting.
3. Piping, valves, fittings and supports outside the Supplier’s scope of supply.
4. Instrument and service air supply to the unit.
5. DC power for DC emergency power distribution system to be provided by the Combustion Turbine Generator DC system.

6. AC Power Supply from CTG station service to package AC power/lighting system.
7. Starter for main gas compressor motor to be provided by CTG Supplier.
8. Conducting on-site equipment performance test (Supplier shall provide oversight and support as specified herein).
9. Wiring of Supplier-furnished controls to Process SCADA System (PSS).
10. Classroom facilities for on-site training.
11. Building permits and environmental permits.

2.03 PERFORMANCE GUARANTEES

A. All performance guarantees shall be based on the operating points depicted in Sections 43 12 00, Fuel Gas Compressor Supplement Data Sheet. Bidder shall fill-in all performance data as indicated on the Attachment and submit with Bid. All performance values shall be verified during the on-site Performance Test.

B. Supplier shall furnish performance curves for the FGC showing impacts on performance as a function of inlet gas temperature, inlet gas pressure, outlet gas pressure, and gas flow, as a minimum.

C. FGC package shall be guaranteed to maintain the discharge set point pressure with a maximum allowable pressure pulsation not to exceed the allowable limits of the proposed combustion turbine.

D. Noise Limitations:

1. Noise levels for equipment furnished under this Scope of Work shall be guaranteed not to exceed 85 dBA (average) at 3 feet distance (from exterior of package limits) and 5 feet above grade under free field conditions over a reflecting plane measured at points spaced 6 feet apart around the equipment package.
2. Far field noise levels for equipment furnished under this Scope of Work is expected not to exceed 55 dBA (average) at the residences immediately to the West of the site. The residences are approximately 265 feet away from the closest point of the proposed CTG location. Refer to the Site Layout Drawing 1419-M-SK02 for more information.
3. The specified noise limits shall apply to all normal modes of operation.

E. The FGC package shall perform as specified over the full range of operating conditions with minimal vibration and noise.

2.04 DESIGN REQUIREMENTS

A. The intent of this Specification is to utilize Supplier's standard package design where possible. However, the specific design features discussed herein shall be included as a minimum.

B. Compressor Package:

1. Description: Skid-mounted fuel gas compressor package complete with motor driver, safety valves, ASME Code stamped pressure vessels (where required), instrumentation, controls, sound-attenuated and ventilated enclosure, and other features necessary to comprise a complete system.
2. Supplier shall assume responsibility for the engineering design and coordination of all equipment and for the performance of the entire compressor train consisting of compressor, driver, power transmission equipment, and all auxiliary equipment and systems included in the scope of the order and supplied by Supplier.
3. The FGC shall be designed for continuous operation over the full range of operating conditions listed in Section 43 12 00, Fuel Gas Compressor Supplement Data Sheet, as well as at CTG startup conditions. System shall be capable of variable gas flow and operation on a varying inlet gas pressure. Package shall include recycle control valve, slide valve, and/or other means as required to facilitate operation under all load conditions.
4. Where applicable, suction, interstage and discharge scrubbers and/or pulsation bottles shall be ASME coded and stamped, with mesh mist extractors, auxiliary equipment and level control instrumentation as follows:
    a. High-level and low-level switches.
    b. Level gauge.
    c. Level controller.
    d. Local pressure gauge and temperature gauge.
    e. Level control valve with block valves.
    f. Automatic dump assembly.
    g. Manual bypass drain valve.
    h. Scrubber sized for 100 percent gas duty.
    i. Double-wall, vented waste drain tank for collection of all liquids, including pump-out connection with quick-disconnect fitting as well as manual drain. Tank shall be designed in accordance with UL 142 specifications and so labeled. Vent size shall be sufficient to prevent over pressurization of waste drain tank in the event of fully-open discharge of gas from all connected drain lines.
5. Inlet filter/separator equipment shall be provided as required for protection of compression equipment from entrained particulate and moisture.

C. Lubrication System: A lubricating oil system shall be provided for the compressor package. Design of the lube oil system shall be per manufacturer's standard, but shall include the following features as a minimum:

1. 100 percent redundant lube oil pumps shall be provided. Motor-driven lube oil pumps shall be equipped with 460V 3-phase 60-Hz TEFC motors.
2. Duplex air-cooled oil coolers with transfer valve shall be provided with the capability of transfer to standby cooler during normal operation.
3. Integral lube oil tank.
4. Electric lube oil tank heater.
5. Duplex lube oil filters with transfer valve and ability to shift to the standby filter during normal operation.
6. Demister system suitable for maintaining vent area free from oil collection.
7. Drip pan.
8. Supplier shall furnish lubrication oil and other required fluids, in required types and quantities, sufficient for:
    a. Completion of initial lube oil flushing.
    b. Additional required for initial operation.

D. Cooling Systems:

1. Supplier shall furnish skid-mounted duplex air-cooled heat exchangers for lube oil cooling, intercooling, and aftercooling purposes.
2. Compressor package shall be equipped with necessary control valves and instrumentation for automated temperature control over the full range of anticipated operation.
3. Process coolers shall be ASME Code vessels with appropriate stamping. Coolers shall be sized for 100 percent gas duty.

E. Package Enclosure:

1. If required to meet the noise limitations and exterior ambient conditions specified herein, Supplier shall furnish an outdoor-rated, sound attenuating enclosure to house the FGC package and its auxiliaries.
2. Enclosure shall be equipped with man doors as necessary to access all maintenance-required items on the FGC package. Man-doors shall be a minimum of 3 feet wide by 8 feet high. Additionally, removable wall and/or roof sections shall be included for removal of any skid-mounted components that will not fit through the provided man doors.
3. Finish color for FGC package enclosure shall be approved by Owner.

F. Enclosure Ventilation and Gas Monitoring System:

1. 100 percent redundant ventilation fans shall be supplied for installation on the sound attenuating enclosure (if applicable). Fans shall be rated for Class I, Division 1, Group D area classification.
2. Ventilation fan(s) shall be controlled to maintain a maximum of 18 degrees F above ambient temperature.
3. Ventilation system shall be designed to maintain the interior FGC space at a Class I, Division 2, Group D rating. Supplier is responsible for furnishing required instrumentation, controls and equipment for compliance with NFPA and NEC requirements. FGC package enclosure shall include gas leak detection and monitoring instrumentation with interface capability to the Process SCADA System (PSS). Local, exterior visual indication of package gas levels within the enclosure shall also be provided.

G. Structural Skid:

1. The FGC package shall be furnished mounted on an individual heavy-duty structural steel skid. All the major equipment shall be mounted on the main structural members as a single fabricated steel unit.
2. The baseplate of the skid shall be provided with lifting lugs for at least a four-point lift.
3. The bottom of the baseplate between structural members shall be open. When the baseplate is installed on a concrete foundation, accessibility shall be provided for grouting under all load-carrying structural members. The members shall be shaped to lock positively into the grout.
4. Safety ladders, handrails, gratings, steps, external structural or support members shall be hot-dipped galvanized.

H. Piping and Valves:

1. Supplier furnished piping systems shall be constructed in accordance with ASME B31.1.
2. All welder qualification and pipe welding shall be done in accordance with ASME section IX.
3. All compressor piping materials shall be manufactured from domestic steel.
4. All connections and interfaces shall be brought to the edge of the skid package.
5. The main inlet and outlet gas connections shall be flanged or machined and studded and shall be of the appropriate working pressure.
6. Piping within Supplier’s scope shall be designed to permit servicing and maintenance.

7. Supplier-furnished piping shall conform to Section 40 50 20, Aboveground Power Plant Piping. The following minimum requirements also apply:
    a. No dissimilar metal field joints shall be allowed. Any carbon steel/Cr steel/stainless steel dissimilar welds required in fabrication shall be identified and approved by the Owner.
    b. All stainless steel materials shall be identified with Positive Material Identification and shall be controlled and traceable through the manufacturing process.
8. Supplier furnished valves shall conform to Section 40 55 00, Power Plant Valves. Where specific valve types are not indicated, the following requirements apply:
    a. Shut-Off Duty: Use ball or plug valves, compliant with API 607 or equivalent applicable standard.
    b. Throttling Duty: Use globe or angle valves.

I. Miscellaneous Electrical Equipment:

1. All instrumentation, control panels, motors, and electrical devices within Supplier's scope shall be rated for Class I, Div. 2, Group D hazardous area classification as a minimum. Provide intrinsic safety barriers for instruments and valve controllers. Provide Z-purge for all locally-mounted control panels. Control equipment/PLC's that require a conditioned space shall be located in an environmentally conditioned enclosure.
2. The following power supplies shall be provided:
    a. 4.16 kV ac power for the gas compressor motor fed from a motor starter provided by others.
    b. A 480V ac motor control center will be provided by others for supply and control of fans and pumps 1/2 Hp and larger. Local disconnect switches rated for Class I Div 2 areas shall be supplied by the Supplier for each motor load.
    c. 120V ac will be supplied for convenience power and lighting.
    d. 120V ac UPS backed power is available for controls.
    e. 125V dc is available if required.
    f. If 24V dc is required, power supplies should be included in the control enclosure provided by the Supplier.
    g. Supplier to advise if additional services are required.
3. Unless otherwise specified, all leads on terminal strips, switches, and instruments shall be permanently tagged for identification. All terminal boards in junction boxes and control panels shall have at least 20-percent spare terminal points.

J. Motors:

1. Motor voltage selection:
   a. Less than 1/2 Hp: 120V ac.
   b. 1/2 Hp through 300 Hp: 460V ac (nominal system voltage 480V ac).
   c. Larger than 300 Hp: 4000V ac (nominal system voltage 4.16kV ac).
2. Provide motors rated for continuous operation with 1.15 continuous service factor or greater. For constant speed motors, driven load shall not exceed motor brake horsepower nameplate rating, exclusive of service factor, under all operating conditions.
3. Motor shall be sufficiently sized to start and operate connected load at motor designated speed within installed environment, without exceeding nameplate ratings.
4. Motors shall meet or exceed NEMA Premium™ efficiency ratings.
5. Motors shall have copper windings and Class F or higher insulation but rated based on Class B temperature rise.
6. Select motors for low starting current, designed for continuous duty to provide the running torque and pull in torque required to send the load. Maximum kVA starting code letter shall be Code G.
7. Motors controlled via variable frequency drives (VFD) shall be inverter duty rated with an insulation system that meets NEMA MG1 Part 31 and are suitable for operation with pulse width modulated variable speed drives.
   a. Motors less than 100 Hp shall be provided with a shaft grounding ring.
   b. Motors 100 Hp and larger shall be provided with shaft grounding ring on one end and electrically insulated bearings on the opposite end.
8. The motor shall be suitable for operation up to 3300 feet elevation without de-rating.
9. Provide low surface temperature space heaters sized to prevent moisture condensation when motor is de-energized for motors 10 Hp and larger. Space heaters shall be rated for 240V ac and operating at 120V ac, with separate conduit box for heater leads only.

10. Motors shall be equipped with grease-lubricated, anti-friction ball or roller bearings with InproSeal bearing isolators on fan and drive end shaft extensions for IP56 protection. Bearings shall have an AFBMA L10 life of 100,000 hours or more. All bearings shall be constructed so as to prevent lubricant leakage into the motor under normal or excess lubrication. Permanently-lubricated bearings will not be acceptable. All ball or roller bearings shall be equipped with Alemite or Zerk grease and relief fittings. Lubrication instructions shall be furnished with each motor.
    a. Preferred bearing suppliers: FAG, Fafnir, SKF, Timken for rolling element bearings.
    b. Motors 100 Hp and larger shall be provided with ceramic or hybrid ceramic ball bearings.
11. Motor frame and end brackets shall be cast iron with non-sparking exterior fan and cast iron guard. Lifting eyes shall be provided. Include brass drain and breather to ensure drainage from lowest point of motor.
12. Motors shall have cast iron conduit terminal boxes of adequate size to support proper termination of supply conductors selected in accordance with the NEC. Minimum size shall be two sizes larger than required by the National Electrical Code (NFPA 70), latest edition.
13. Direction of rotation shall be permanently marked on motor where motor is suitable for only one direction of rotation.
14. Motors shall have steel sole plates. Maximum allowable no load vibration shall be 0.10 inches per second.
15. Select motors for quiet operation. Motor sound power level when measured at a no load condition shall not exceed 85 dBA when determined in accordance with IEEE Standard 85, latest edition.
16. Power factor shall not be less than 0.87 unless approved by Owner:
17. Motor nameplate shall be made of Type 316 stainless steel, mounted on the motor's enclosure with stainless steel fastening pins; nameplate shall have as a minimum, all information as described in NEMA Standard MG-1-20.60 and overall weight. Nameplates shall be indelibly stamped or engraved. Motor bearing numbers shall be included. Wiring diagram shall also be included on nameplate or attached to motor and easily readable.
18. Motor shall have an appropriate exterior coating/paint for the ambient conditions as described earlier.
19. Motor shall be UL or CSA approved.
20. For motors over 50 Hp, provide a main terminal box which is two sizes larger than NEMA recommendations. Junction box shall be fully rotational, diagonally split, including gasket between cover and box, and box and frame, with threaded hubs and grounding lug located within the main box for ground conductor connection as well as on the motor foot.
21. Medium Voltage Motor Requirements for Motors larger than 300 Hp:
    a. In addition to the requirements listed above, comply with API 541 and specific requirements listed below.

b. Three phase, continuously rated, squirrel-cage, random-wound copper, induction motors designed for nominal 4160 volt, 60 hertz.
c. As a minimum, motors shall be capable of not less than three cold starts and two hot successive starts per hour.
d. Maximum starting inrush of 650 percent of FLA.
e. Provide heavy duty stator bracing.
f. Insulation shall be VPI Class F with Class B temperature rise.
g. Core lamination material shall be C5.
h. Provide internal motor terminal compartment ground and external motor frame ground.
i. Provide a dust flinger on both ends of the shaft.
j. Provide a way for stray currents to safely leave the motor, such as Inpro/Seal current diverting ring or shaft grounding seal, or owner approved equivalent.
k. 300 series stainless steel hardware.
l. RTD's:
    1) Provide 100 Ohm platinum resistant temperature detectors (RTD's), two per phase, on the winding end turns.
    2) Motors shall be equipped with bearing RTD's. Provide for 100 Ohm Platinum RTD's, with leads in terminating in a separate auxiliary RTD terminal box.
    3) RTD leads should be brought out to a separate RTD terminal box and leads shall be terminated at terminal blocks and labeled with permanent wire labels.
m. Vibration monitoring:
    1) Motor shall be compliant with API 541 vibration limits.
    2) Provide continuous motor vibration monitoring to include:
        a) Vibration switches.
        b) Shaft vibration transmitter.
        c) Bearing vibration transmitter.
n. When provided, motor cooling fans shall be bi-directional, externally mounted, and non-sparking. Aluminum, bronze, or copper are not acceptable. Stainless steel hardware shall be provided. Fan housing shall be cast iron construction. Rotation shall be indicated by permanent, legible marker mounted on motor.
o. The shaft shall be 1045 Carbon steel "Or-equal," Owner approval.
p. The rotor shall be constructed with copper or copper alloy.

22. Voltage and Frequency:
    a. Motors shall start and run successfully at rated load and frequency with plus or minus 10 percent variation in supply voltage.
    b. Motors shall start and run successfully at rated load and voltage with plus or minus 5 percent supply frequency variation.

c. Motors shall run successfully at rated load with combined variation of supply voltage and frequency that is not more than plus or minus 10 percent (sum of absolute values) of rated voltage and rated frequency provided 5 percent frequency variation is not exceeded.
d. Motors shall be capable of operating within design characteristics for system source voltage.
e. Motors started directly across the line shall accelerate to running speed with connected load, with maximum voltage drop of 20 percent at starting.

23. Motor Types:
a. Horizontal Drip-proof: Provide horizontal motors with an enclosure that meets NEMA Standard MG 1 for open, drip-proof construction. Provide screen over all air openings.
b. Horizontal Totally Enclosed Fan-Cooled: Provide totally enclosed fan-cooled (TEFC) motors with frame sizes 182 and larger with cast iron frames and end shields. Smaller frame sizes may be constructed of rolled steel with cast metal end shields. Provide motors with condensate drain holes. For frame size 286 and larger, provide automatic breather/drain device in drain hole.
c. Explosion proof: Provide all horizontal and vertical motors with TEFC explosion proof enclosures, UL listed for Class I, Division 1, and Group D hazardous atmosphere. Provide motors manufactured by Reliance Electric, “Or-equal.”
d. Horizontal, Totally Enclosed, Air-to-Air Cooled (TEAAC), Severe Duty:
1) Suitable for contaminated environments, include gasket conduit box, stainless steel drains, double-shielded bearings with cast iron bearing caps, and corrosion resistant paint.

K. Process Instrumentation and Controls:

1. General: The FGC package shall be equipped with Supplier’s standard redundant Programmable Logic Controller (PLC)-based control system including meters, gages, transmitters, alarms and controls, locally mounted in modular enclosure, suitable for interface with Owner’s Process SCADA System (PSS) and the Turbine Control System. A proposed network architecture drawing is shown on Drawing 1419-I-SK01. The FGC package shall include as a minimum a 17-inch Allen-Bradly PanelView Plus 7 Performance version or equivalent for local control. PLC shall be Allen-Bradley ControlLogix “Or-equal," Owner approval. PLC’s shall comply with Section 40 91 00, Instrumentation and Control Components.

2. The FGC controls shall be capable of interfacing with the overall Process SCADA System for High level commands to allow start/stop of the equipment, adjustment of process variables (set points, alarm limits, etc.). The local PLC shall perform all equipment and system protection, control and monitoring.
3. While the FGC control system must include all functions required to operate and maintain the FGC, it must also support integration with the PSS and the turbine control system while minimizing the engineering and support effort to perform the initial integration as well as ongoing maintenance and modifications. The interface between the FGC control system, the PSS and the turbine control system should follow the guidelines below:
    a. Cyber Security: All equipment shall conform to the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems and its associated datasheet.
    b. Interlocks: All safety and equipment protection interlocks are to be interfaced between the FGC and the PSS and TCS via individual hardwired I/O signals. All permissives/interlocks between systems shall be implemented with fail-safe design practices such that loss of circuit continuity will remove the permissive, and result in the appropriate protective action.
    c. Analog control to the FGC shall be via 4-20 mA isolated inputs.
    d. Non-critical interfaces between the FGC package and the PSS and TCS shall be implemented utilizing data communication interface. Loss of connection of this interface shall not result in shutdown of the unit but may limit the operating mode of the unit.
    e. PLC shall be equipped with a local panel-mounted Human-Machine Interface (HMI), Allen-Bradley Panelview Plus 7 Performance (15 inch) "Or-equal," Owner approved. The FGC control system shall include a means to remotely view/operate the FGC control system HMI from the PSS.
    f. The FGC Supplier shall provide graphic screen printouts which directly link the data link points to the graphic objects for duplication in the PSS.
    g. Alarms: The FGC control system shall support monitoring of alarm conditions within the FGC controller(s) by the PSS HMI. Access to FGC control processors shall not negatively impact the throughput or latency of the FGC controller communications with its I/O, the FGC HMI(s) or the PSS controller(s). The Supplier shall include a database listing of all FGC alarm conditions including: Tag/Address, Description, Alarm State.
    h. Historian: The FGC control system shall support collection of data by the PSS historian. Access to FGC control processors shall not negatively impact the throughput or latency of the FGC controller communications with its I/O, the FGC HMI(s) or the PSS controller(s).

4. Standard FGC control screens shall include all normal operator functions, including setpoints, alarms, startup and shutdown control. Engineering interaction with the FGC control system shall be accomplished through Supplier's standard interface. PSS interface to the FGC control system will include standard startup/shutdown, summary alarm acknowledge, pressure set points, etc. First-out indication shall be included as part of the information provided on the control interface system.
5. Communications link shall be provided via Ethernet TCP/IP to the PSS to allow monitoring and control of equipment at either local control panels/stations or from the primary control room located in the Old Main plant building. The communication link shall convey the following information as a minimum:
    a. Unit Status (shutdown, starting, on-line, etc.).
    b. Sensor Values (speeds, temperatures, pressures, vibration, flow, level, etc.), including package enclosure temperature.
    c. Electrical Values (amps, volts, watts, frequency, VAR's, Power Factor).
    d. Alarms and associated set points.
    e. Shutdowns.
    f. Sensor Failures.
    g. Status of Auxiliaries.
6. Provide redundant Ethernet connections to the FGC control system to the PSS and to the TCS if necessary, to control.
7. The FGC control system shall include the following features as a minimum:
    a. Complete control of FGC Package, including normal start, normal stop, emergency stop, pressure control, load following and manual load changes. The Control System shall display parameters such as pressures, temperatures, motor current, power, and status of all key auxiliary devices.
    b. A command from the PSS shall release the FGC controls to allow local operation of the equipment. Without this release, other than protective actions, local operation is not permitted.
    c. Start sequence shall allow for remote initiation of equipment startup, consistent with NFPA requirements and safe practices.
    d. Provide complete vibration and bearing temperature monitoring.
    e. Provide gas detection monitoring and alarms.
    f. Provide package ventilation control based on enclosure temperature.
    g. In the event of a unit upset or trip, the package control system shall record the sequence in which the alarm signals were received ("first-out" capability), for later analysis and troubleshooting by Plant personnel. Time stamps shall be 1msec accuracy minimum.
    h. Provide capability for automatic synchronization of PLC clock to PSS clock.

8. The FGC control system HMI shall support a multi-level user security system per the following user group permissions guidelines:
    a. Guest: View only access. Navigation to all process status windows.
    b. Operator: Permissions to operate equipment, enter process set points, and acknowledge/reset alarms.
    c. Maintenance: Permissions to tune control loops, calibrate instruments, modify process alarms, and modify process constraint parameters.
    d. Engineer: Access to all process and machine parameters.
    e. Admin: Edit control system and security configuration.
9. Process Instruments:
    a. Provide transmitters, local gauges, instrument piping, tubing, manual valves, supports, pipe and tube fittings, wire/cable, conduit, tray, terminations, racks, local displays, mounting stands, mounting plates, and other accessories as needed to allow complete control and monitoring of process equipment and components within Supplier's scope of supply. The instrumentation shall allow problem detection and diagnosis.
    b. All process instrumentation shall be in accordance with Section 40 91 00, Instrumentation and Control Components.
    c. Instruments and controls shall be rated for operation in a Class I, Division 2, Group D area classification.
10. Control Valves: All control valves selected shall be in accordance with Section 40 92 13, Process Control Valves and Regulators.
11. Actuators and Regulators: All actuators and regulators selected shall be in accordance with Section 40 92 13, Process Control Valves and Regulators.
12. Safety/Pressure Relief Valves:
    a. All Safety/Pressure Relief Valves selected shall be in accordance with Section 40 92 13, Process Control Valves and Regulators.
    b. Safety valves shall be furnished pre-set and sealed at the factory.
13. Instrument Valves:
    a. Provide instrument valves for isolation and calibration while the unit is on-line.
    b. Instrument valve manifolds shall be preferred over individual valves:
        1) 2-Way Manifold: Absolute or gauge pressure instruments.
        2) 3-Way Manifold: Differential pressure instruments
    c. All manifold valves shall be in accordance with Section 40 91 00, Instrumentation and Control Components.

L. Tagging and Marking:

1. Equipment numbering shall be as generally defined in Section 01 58 53, Project Equipment Identification with equipment unique identification requirements defined herein.
2. Each major piece of equipment shall have a standard nameplate securely affixed showing the tag number; the name and address of the Manufacturer; serial and model number; and such other information as the Supplier may consider necessary to complete the identification of the item.
3. The range of process numbers to be used for Supplier equipment shall be confirmed with Owner/Engineer prior to development of Supplier's P&ID's.
4. All FGC parts, components, assemblies and items shall be clearly and permanently match-marked for field assembly and installation. The match-marks shall be marked by letters or numbers and shall be cross referenced to the shipping paperwork and erection drawings and instructions.

M. Painting: Painting shall be in accordance with Section 09 90 01, Painting and Protective Coatings.

PART 3 EXECUTION

3.01 FACTORY TESTS AND INSPECTIONS

A. The Supplier shall test the equipment furnished under this Specification at the Supplier's shop prior to shipment. Factory tests and inspections shall demonstrate the performance, quality, accuracy and workmanship characteristics. A complete description of the proposed factory tests and inspections, including hydrotest, shall be submitted for the Owner review. Engineer or Owner's representative shall have the opportunity to witness the test and inspection in the manufacturer's factory. Engineer or Owner's representative shall neither participate nor interfere with the test, and travel costs associated with Engineer or Owner's representative attending the witnessed test will be Owner's responsibility.

B. All fabrication and shop testing shall be Supplier's standard and shall be in accordance with all applicable codes. The Supplier shall provide complete information regarding the materials used in the fabrication of the FGC package. Complete information shall include, but not be limited to, items such as material certificates, NDE results, X-ray certificates, boroscopic inspection results and test reports produced by Suppliers, Sub-Suppliers and Subcontractors.

C. A minimum of 10 percent of piping welds shall be subject to either radiographic or ultrasonic examination in accordance with API 1104 requirements. If weld failures are detected, additional welds may be selected for examination at Owner's option. All weld failures shall be repaired by Supplier at no additional cost to Owner.

D. All pressure parts shall be hydrostatic pressure tested in the shop to the maximum extent possible prior to shipment. Shipped loose piping spools, which are included in the Supplier Scope of Supply, will be hydrostatically tested by others as a part of external piping systems after piping installation. Hydrostatic testing of 300 series stainless steel systems shall be performed with water containing less than 50 ppm chlorides. After completion of testing, materials shall be thoroughly dried.

E. Supplier shall perform a 4-hour mechanical running test on the unit before shipment. The test shall prove mechanical operation of all auxiliary equipment and of the compressor, reduction gear (if any), and driver as a complete unit. The compressor does not have to be pressure loaded for this test. The Supplier shall submit the procedure for the running test for approval by the Owner.

F. The Supplier shall be responsible for proper protection of equipment to prevent damage during testing and shall bear all repairs or replacement cost of any item damaged as a result (directly and indirectly) of the tests.

G. Provide test procedures including conditions required for testing, method of correcting performance to guarantee conditions, instrumentation required, calibration procedures, and acceptance criteria for Owner approval. All procedures shall be accepted by all parties prior to start of tests.

H. Supplier shall provide factory calibration records for all Supplier-furnished instruments prior to final acceptance tests as noted below:

1. Calibration (five points, up and down scale for analog transmitters; for switches verify action two times for increasing and decreasing inputs) of all instrumentation required for both linearity and accuracy in accordance with standard industry practices or manufacturer's recommendations.
2. Test equipment accuracy shall be calibrated in accordance with the NIST, National Institute of Standards and Technology.
3. Field mounted instruments shall be bench calibrated and panel mounted instruments shall be calibrated in the panel.
4. Calibration and installation records with the following information shall be provided:
    a. Equipment tag number.
    b. Data component received.
    c. Purchase order number.
    d. Serial number.

e. Calibration data.
f. Date of calibration.
g. Person responsible for calibration.
h. Date component installed.

3.02 PREPARATION FOR SHIPMENT

A. Supplier shall submit procedures for the cleaning, preservation, packaging, handling, lifting, shipping, and storage of the material and equipment provided under this order.

B. Equipment and piping must be cleaned of all foreign material, dirt, scale, grease, oil, and chemical residues, etc., in accordance with the approved cleaning methods. Items will be inspected for compliance with approved cleaning procedures. Items which are not immediately packaged or shipped must be protected from contamination until preservation or packing is complete.

C. Prior to installation, the equipment will be stored outdoors. Equipment and materials shall be suitable for outdoor storage without adverse effects for a period of up to nine months at the job site, provided that suitable protection is provided. Sensitive equipment shall be stored in environmentally controlled locations. Supplier is responsible for the cost of repairing or replacing any component supplied which is affected adversely by weather conditions prior to acceptance.

D. Supplier shall provide all special tools for unloading, installation and maintenance of Supplier-furnished equipment. Special tools and handling equipment shall be packed separately and identified as included in the shipment. Spare gaskets shall not be bolted in place, but shall be packed separately and identified. Loose clips and similar small structural items shall be packed separately, marked, tagged, and attached to larger pieces.

E. All exposed machinery surfaces (threads, flange faces, gasket sealing surfaces, etc.) shall be coated with an easily removable protective coating. All weld bevels of carbon or ferritic alloy steel piping or equipment components that are to be welded by others shall be coated on the inside and outside surfaces for a distance of three inches from the end of the component.

F. All flange openings shall be protected and made waterproof with bolted full size metal covers and gaskets. Flanges shall be furnished with one bolt for every other hole (minimum of four bolts). Threaded openings shall be plugged with threaded plugs of the same material as the connected part and sealed with PTFE tape thread sealant. Beveled and plain edge openings shall be suitably closed with solid metal wedge type connectors.

G. Piping shall not be designated as attachment points for lifting equipment.

H. All tagged items need to be identified with permanent stenciled metal tags or a material not subject to deterioration from outdoor storage.

I. Ship units fully assembled including piping and control wiring factory installed. Disassemble units only as necessary for shipment or due to installation limitations at the site. Match mark disassembled components. Reinforce, brace and pack for shipment per applicable commerce requirements. Seal open ends subject to detrimental conditions with removable closures.

3.03 INSTALLATION SUPERVISION

A. Bidders shall furnish a list of Site Assistance hours needed for each of the required milestones. Bidders shall include the site assistance hours as a line by line detailed list for each task.

B. Provide full time (10 hours/day) field erection supervision for the duration of the tasks listed below by manufacturer's personnel. This erection shall include but not limited to:

1. Installation of FGC package, enclosure, and other items shipped loose.
2. Alignment of FGC and drive motor.
3. Installation of FGC foundation and anchors.
4. Receiving, unloading and moving all major components into place on foundations.
5. Installation of lube oil and other auxiliary skids.
6. Installation of wiring and interconnects.
7. Cleaning, connecting, and sealing all parts of the FGC package.
8. Electrical control and utility mechanical and fire system functional check-outs.
9. Any items that affect the warranty of the unit.

C. Balancing of rotating equipment shall be accomplished prior to shipment. Field balancing shall only be performed with the written approval of the Owner and the Engineer.

3.04 COMMISSIONING AND STARTUP SUPERVISION

A. Supplier shall provide qualified field representative(s) in required disciplines to supervise the commissioning checks and initial startup of the FGC package, including setting up and demonstration of controls, monitoring systems, performance/trending systems and auxiliaries in Supplier's supply, and interfaces with Owner's Process SCADA System (PSS). Bidders shall furnish a list of Site Assistance hours needed for each Commissioning and Startup activity.

3.05 FIELD TESTS AND ENGINEERING SUPPORT

A. The following Acceptance and Performance tests shall be performed in the field upon completion of the installation:

1. Functional Test(s) for purposes of demonstrating that the equipment and systems function as designed, operate safely, reliably, and as part of an integrated Plant system in accordance with good engineering practice. These tests shall include normal operations, such as startup, shutdown and load changes, as well as emergency operations, such as emergency shutdown. Fully automatic start sequences shall be made repetitively (three minimum) without manual control override, or failed start attempt.
2. Functional Test shall also include one hour of operation each at 25 percent, 50 percent, 75 percent, and four hours at 100 percent load.
3. Performance Test to demonstrate ability to maintain Guaranteed Flow, Pressure, and Efficiency.
4. Reliability Test to demonstrate ability to continuously run for five days without alarm or trip events. No alarm or trip devices may be bypassed during this test without Owner’s approval. The performance assessment may be conducted during the Reliability Test.
5. Performance tests shall be in accordance with API 618 or 619 standards, as applicable. Supplier shall include Torsional Vibration analysis and Compressor Package Digital Acoustical Pulsation Analysis per API 618.
6. Tests shall be performed with permanently installed Plant instrumentation unless such instrumentation is non-existent. Where special temporary instrumentation is required, Supplier shall furnish said instrumentation which shall be calibrated within one week before the tests, and the calibration sheets shall become part of the test documentation. No safety device (alarm or trip) shall be bypassed during or following the Reliability Tests.

B. At least 60 days prior to scheduled Acceptance Testing, the Supplier shall submit, for Owner’s and Engineer's review, a complete Acceptance Test procedure that defines details such as protocol, type of tests, measurements to be taken, sample calculations and correction formulas, and responsible parties.

C. Provide all procedures and supervision required for the Acceptance Tests. During testing, the Plant shall be operated and maintained by Owner’s operating personnel.

D. Supplier shall provide engineering support of and coordination with the Owner and Owner’s engineers for all tests.

3.06 TRAINING

A. Provide training, at the Owner's facility, for the personnel listed herein so that the Owner can operate, maintain, change system configuration, and repair the complete system.

B. Training for Operators shall be conducted to accommodate a multiple shift schedule.

C. Separate training sessions will be held for each of the following groups:

1. Engineers.
2. Plant Operators (Minimum of four sessions over 3 weeks).
3. Mechanical Maintenance Technicians (Minimum of two sessions).
4. Electrical/ Instrumentation Maintenance Technicians (Minimum of two sessions).

D. Prior to project closeout and field acceptance testing, provide training plan and schedule including the following information:

1. List of all classes/courses.
2. Description of course.
3. Duration of course.
4. Sequence of courses.

E. Provide competent, factory authorized personnel to provide instruction to O&M personnel. Include sufficient hours of training to provide complete training for operation and maintenance of the equipment and system.

F. Provide the name and resume of proposed instructor; instructor must have at least 5 years' experience teaching the designated course. Instructor's primary language must be English.

G. Provide training manual that includes, as a minimum, the following:

1. Course objective.
2. Course outline.
3. Theory of operation.
4. Case studies that demonstrate application, operation (including casualty control), troubleshooting, repair and maintenance of equipment.
5. Notes that supplement and enhance information provided in the manufacturer's operation and maintenance manuals.
6. Thorough review of applicable drawings, photos, tables, diagrams and schematics.
7. List of references for further independent study.

H. Owner reserves the right to require Supplier to repeat training classes if not satisfied objectives are met, at cost of Supplier.

I. Overview Training for all groups:

1. Course shall cover, as a minimum, the following topics for 15 to 20 persons:
    a. Describe FGC equipment, interconnections, functions and capabilities.
    b. Review system terminology, abbreviations and acronyms.

J. Operator Training:

1. Operator-training course shall be conducted at times that accommodate a multiple shift schedule. A minimum of four, 8-hour, on-site training sessions are required.
2. The course shall be an in-depth instruction on the FGC and Package equipment.
3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:
    a. Startup, Normal Operation and shutdown of equipment.
    b. Response actions to hardware and software failures.
    c. Response to system alarms.
    d. Modifying and locating setpoints.
    e. Review interface to plant control system.
    f. Control loop tuning concepts and methods.

K. Mechanical Maintenance Training:

1. Mechanical maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the FGC and Package equipment.
3. The course shall enable the Owner’s operators to be proficient in the following topics, as a minimum:
    a. Startup, Normal Operation and shutdown of equipment.
    b. Response actions to mechanical equipment failures.
    c. Response to System alarms.

L. Electrical/Instrumentation Maintenance Training:

1. Electrical/Instrumentation maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the FGC and Package equipment.

3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:
    a. Startup, Normal Operation and shutdown of equipment.
    b. Response actions to hardware and software failures.
    c. Response to system alarms.
    d. Modifying and locating setpoints.
    e. Review interface to plant control system.
    f. Control loop tuning concepts, strategies, and methods.

M. Provide certification in writing that this Training has been accomplished.

3.07 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this Specification.

1. Data Sheets.

END OF SECTION

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SECTION 43 12 00
FUEL GAS COMPRESSOR
SUPPLEMENT DATA SHEETS

Supplier shall furnish the performance data and utility requirements summarized in the following tables.

Note: Supplier shall submit completed performance data sheets for the proposed Fuel Gas Compressor.

LOAD POINT	CTG 100 Percent (Guarantee)	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	97°F/82.4°F	
	Required	Submitted
GAS FLOW RATE, SCFM	By CTG Supplier	
GAS INLET PRESSURE, PSIG (MIN/MAX)	180 / 230	N/A
GAS OUTLET PRESSURE, PSIG	By CTG Supplier	
GAS OUTLET TEMPERATURE, DEG. F	<120	
MOTOR LOAD, HP	BY MFG	
COMPRESSOR EFFICIENCY, %	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

LOAD POINT	Maximum Flow	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	28.1°F/24.8°F	
	Required	Submitted
GAS FLOW RATE, SCFM	By CTG Supplier	
GAS INLET PRESSURE, PSIG (MIN/MAX)	180 / 230	N/A
GAS OUTLET PRESSURE, PSIG	By CTG Supplier	
GAS OUTLET TEMPERATURE, DEG. F	<120	
MOTOR LOAD, HP	BY MFG	
COMPRESSOR EFFICIENCY, %	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

LOAD POINT	Average Ambient	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59.0°F/51.5°F	
	Required	Submitted
GAS FLOW RATE, SCFM	By CTG Supplier	
GAS INLET PRESSURE, PSIG (MIN/MAX)	180 / 230	N/A
GAS OUTLET PRESSURE, PSIG	By CTG Supplier	
GAS OUTLET TEMPERATURE, DEG. F	<120	
MOTOR LOAD, HP	BY MFG	
COMPRESSOR EFFICIENCY, %	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

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SECTION 48 00 10
MECHANICAL SUMMARY OF WORK

PART 1 GENERAL

1.01 MECHANICAL SCOPE OF WORK

A. The Turbine 7 (T7) Project, mechanical scope of work includes the components associated with the new combustion turbine generator (CTG) and associated auxiliaries, the fuel gas compressor, fuel gas conditioning equipment, and fuel oil conditioning equipment. The intent of the Project is to augment existing aging SWBNO generation sources with new reliable power.

B. The design and supply of equipment unique to the T7 Project or that which logically/materially impacts the T7 system design will be provided by the CTG Supplier. Reference Sections 43 12 00, Gas Compressor and 48 11 23, Combustion Turbine Generator for specific requirements. The various principle elements of the mechanical Work by the CTG Supplier include the following items:

1. Combustion Turbine Generator, including auxiliaries.
2. Fuel Gas Compressor System.
3. Fuel Gas Conditioning Equipment.
4. Fuel Oil Conditioning Equipment.
5. Additional auxiliaries required for Vendor specific equipment, including but not limited to demineralized water systems, exhaust system, and lube oil systems.

C. For information only, a separate contract will be awarded for the T7 Installation and Interconnection Work, where the installation and balance of interface design and equipment not unique to, nor supplied with the T7 system, will be completed.

1.02 CTG MECHANICAL SYSTEMS

A. The T7 Project is to augment and modernize the Sewerage & Water Board of New Orleans (SWBNO) electrical capacity.

B. The equipment supplied by the Supplier for the T7 project shall include a safe, reliable, and efficient combustion turbine generator suitable for typical use of an industrial power plant for long-term operation. The combustion turbine package shall include inlet air filter house, combustion turbine, exhaust system including silencer (if required) and exhaust stack, generator, lube oil system including pumps and coolers, generator cooling system, and other necessary auxiliaries for a complete functional unit. The combustion turbine will be capable of burning both natural gas and

number 2 fuel oil (diesel). Also included in the scope is the fuel gas compressor, and fuel gas conditioning skid as required to meet the Supplier's fuel gas pressure and cleanliness specifications. The fuel oil conditioning skid shall also be included to meet the Supplier's fuel oil specifications. Refer to Sections 43 12 00, Fuel Gas Compressor and 48 11 23, Combustion Turbine Generator for detailed requirements.

C. The equipment supplied under the Work is to be modularized in outdoor enclosures designed for all-weather access to operate and maintain the equipment in the extreme site operating conditions essential systems that must be able to operate reliably during extreme weather, such as hurricane, events for life critical SWBNO municipal system operation.

D. The equipment will be installed on a new concrete foundation(s) (by others) in an arrangement that facilitates coordination and integration with existing and future utilities.

E. Related Sections:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 61 00, Common Product Requirements.

1.03 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures and 01 33 00.1, Submittal Register.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 48 11 23
COMBUSTION TURBINE GENERATOR

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specifications for one Combustion Turbine Generator ("CTG") package including controls, required auxiliaries, fuel conditioning equipment and accessories.

B. The CTG package shall include features needed for safe, highly reliable, efficient, long-term operation. Design shall be in accordance with good engineering practice, applicable standards, and shall meet the strict demands typical of industrial power plants for safety and reliability, as well as those imposed by the Sewerage and Water Board of New Orleans and all regulatory agencies having jurisdiction in the State of Louisiana.

C. Related Sections: This Specification section does not stand alone and is a part of the entire Specification which is the sum-total of all the sections. Related Sections listed below are listed for emphasis and do not preclude the applicability of any part of the entire Specification requirements. Related Sections of particular emphasis are as follows:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 58 53, Project Equipment Identification.
3. Section 01 61 00, Common Product Requirements.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section and supplemental Data Sheets:

1. American Society of Mechanical Engineers (ASME):
   a. A13.1, Scheme for the Identification of Piping Systems.
   b. B31.1, Power Piping.
   c. PTC 22 - Performance Test Code on Gas Turbines.
2. National Fire Protection Agency (NFPA):
   a. 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   b. 70, The National Electric Code (NEC).
   c. 85, Boiler and Combustion Systems Hazard Code (2011).
3. ANSI B16.5, Pipe Flanges and Flanged Fittings.
4. AWS D1.1, Structural Welding Code.
5. NESC, National Electric Safety Code.
6. UL: 142, Aboveground Flammable Liquid Tanks.

B. While a number of applicable sections of the aforementioned codes and standards have been identified in portions of this Specification, the Supplier has the ultimate responsibility for the complete identification and execution of all applicable sections of the aforementioned codes and standards.

C. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this document.

D. Alternatives to these codes and standards may be proposed by the Supplier if, in its judgment and with Owner's acceptance, superior or more economical designs or materials are available.

E. The most severe requirements shall prevail in the event of conflict between requirements, specifications and applicable and governing codes. All conflicts among the Codes, specifications and/or purchase order shall be brought to the Owner's and Engineer's attention for written resolution prior to release for fabrication.

F. It is the Supplier's responsibility that all equipment and materials furnished and installed be in strict conformity with all current, applicable codes and regulations of the State of Louisiana. Violations resulting from stipulations in the existing codes shall be corrected by the Supplier at its own expense.

G. The Supplier shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

1.03 QUALIFICATIONS

A. Only bidders with demonstrated experience in the manufacturing, testing, and servicing of CTG units will be considered. If the bidder is a packager or independent representative, a letter shall be provided from the CTG OEM authorizing the bidder to sell and service the proposed Combustion Turbine Generator package.

B. Exceptions to the Specification are not allowed, meaning that non-conformance will result in rejection of bid.

1.04 SUBMITTALS

A. Documentation shall be submitted in accordance with Section 01 33 00, Submittal Procedures. In addition to the documents required by Section 01 33 00, Submittal Procedures, supply engineering data including, but not limited to, the information listed below.

B. Submittal Drawings and Catalog Data:

1. Supplier shall provide the following information:
   a. General Data Requirements:
      1) Overall scope of supply and equipment description.
      2) Drawing list and submittal schedule.
      3) Schedule for engineering, fabrication and delivery.
      4) Experience and reference list.
      5) Commercial and technical clarifications.
      6) Listing of all sub-suppliers and subcontractors.
      7) Description of training program included.
      8) Description of site support included.
      9) Completed performance data sheets and guarantees.
      10) Shipping details and weights.
      11) Equipment lifting and rigging drawings and details.
      12) Shop testing procedures.
      13) Field testing procedures.
      14) Description of QA/QC program.
      15) Spare parts list with pricing.
      16) Special tools list.
      17) General Arrangement (GA) Plans and Elevations.
      18) Code reports and certifications.
      19) Operation and Maintenance (O&M) Manuals.
      20) Cable List.
      21) Certified test reports.
      22) Electrical cabinet dimensional drawings.
      23) Conduit entrance locations/plan drawings.
   b. Mechanical Data Requirements:
      1) Process Flow Diagrams (PFD's).
      2) Dimensional layout drawings.
      3) Piping drawings with connection/interface tables.
      4) Permissible nozzle loading.
      5) Expected thermal movements – equipment.
      6) Expected thermal movements – connection interface points.
      7) Supplier-furnished pipe support details.
      8) Clearance requirements for maintenance.
      9) Equipment design details and materials of construction.
      10) Equipment data sheets.
      11) Bills of Material (BOM's).
      12) Weld procedures and welder qualifications.
      13) Performance correction curves, or performance model.
      14) Accessory descriptions.
      15) Utility requirements (air, water, fuel, lube oil, etc.).
      16) Certified Material Test Reports (MTR's).
      17) Equipment Nameplate photograph.

c. Electrical Data Requirements:
   1) Motor list and power requirements.
   2) DC system load requirements.
   3) Accessory descriptions.
   4) Motor data sheets.
   5) One-line diagrams.
   6) Three-line diagrams.
   7) Connection/Interconnection diagrams.
   8) Electrical Schematics.
   9) Wiring diagrams.
   10) Grounding details.
   11) Generator Ratings and Performance Curves.

d. Instrumentation and Controls Data Requirements:
   1) Piping and Instrumentation Diagrams (P&ID's).
   2) Control system PLC description.
   3) Control system Architecture diagram.
   4) Control cabinet dimensional drawings.
   5) Control panel location drawings.
   6) Interconnection diagrams.
   7) Point-to-point wiring diagrams.
   8) Control loop diagrams.
   9) Cable list.
   10) Instrument list with process ranges and set points.
   11) Control valve list.
   12) Alarm list with setpoints.
   13) Component / Equipment list.
   14) Instrument data sheets (Supplier format acceptable).
   15) Control valve data sheets (Supplier format acceptable).
   16) Calibration records for all Supplier-furnished instruments.
   17) Graphical display screens (Screen shots).
   18) Graphical display screens – paging architecture.
   19) Engineering and configuration instructions.
   20) Communication configuration at 75 percent completion for Owner/Engineer review and comment.
   21) Input/Output (I/O) list for all I/O in communication link required for a fully functional interface. The I/O list shall contain all information required to complete the database. A copy of the database in Microsoft Excel or Access shall be provided to the Owner/Engineer, as well as the final controller program native file.

e. Civil/Structural Data Requirements:
   1) Code calculations.
   2) Structural steel plans and elevations.
   3) Platform, ladder, and stair drawings.
   4) Foundation loading diagram (Static and Dynamic).

5) Location, size, and projection of anchor bolts, sleeves, and/or imbeds.
6) Equipment weights (dry and operating).
7) Field erection drawings and details.
8) Equipment grouting requirements and/or recommendations.

2. Include identifying symbols, tag names, and equipment numbers which are coordinated with the Process SCADA System (PSS) standards as defined herein to allow for full integration with the installation design documents for all equipment and material submitted.
3. Include in submittals sufficient plans, elevations, sections, performance data, dimensions, bolt locations, ratings, sound data, weights and schematics to clearly describe the equipment and to show compliance with these Specifications. Provide a cover or title sheet for the submittal containing the following:
   a. Name of Supplier originating the submittal.
   b. Name of project for which the submittal is made.
   c. An index of all items submitted including:
      1) Mark of equipment on drawings.
      2) Manufacturer.
      3) Catalog number.
      4) Specific section number.
      5) Date of submittal and date of each revision.
      6) Supplier's certification of review.
      7) Supplier's certification of compliance.

C. Operation and Maintenance Manuals:

1. Supplier shall provide Operations and Maintenance Manuals for all equipment and auxiliaries provided in accordance with Section 01 78 23, Operations and Maintenance Data. Cloud based documentation hosted by the turbine manufacturer is encouraged when live updates to the manuals are anticipated.
2. Organize binders to contain similar equipment such as piping, valves, transmitters, terminal boxes, sight glasses, relief valves, etc., in separate divisions. Provide a complete index for each binder to include:
   a. An alphabetized list of manufacturers whose products have been incorporated in the work.
3. For each section of product, equipment or system, organize the data as follows:
   a. Furnish a general description of the equipment or system listing the major components, intended service and other general data.
   b. Furnish technical data including nameplate data (on a separate excel file), design parameters, normal operating bands, ratings, capacity, performance data, operating curves, etc. Clearly distinguish between information which does and does not apply.

c. List warnings and cautions to be observed during both installation and operations.
d. Fully detailed installation and operation instructions including special tools required, alignment instructions, start up and shut down sequences, emergency and casualty step-by-step procedures, and extended lay-up step-by-step procedures.
e. Furnish maintenance, service and repair instructions including maintenance and service schedules, materials, and methods for performing routine and annual service.
f. Furnish a Cause and Effects matrix where the 'Cause' is in a row the reflects a process change, the 'Effect' is in the column that reflects a process action, and the 'Intersection' is marked to show the cause/effect relation.
g. Furnish a troubleshooting guide and check list indicating common failures, test methods and procedures for determining component fault or failure.
h. Furnish a spare parts list indicating part and order number with name, address, and telephone number of Supplier. Include current prices of replacement parts and supplies.
i. Furnish diagrams including controls, wiring, installation or operation of the equipment or system.
j. HMI Graphics screens (complete - listing and color screen shots).
k. Furnish cyber security controls procedure/methodology as to how the system is protected from cyber-attacks during production and how software upgrades are implemented post installation for future upgrades.
l. Furnish list of all Set points, Interlocks, Alarms and Trip Points in MS EXCEL file format.
m. Furnish copies of all final, approved submittal Drawings and documents.
n. Furnish all warranties and guarantees.

D. Routine Maintenance Schedule, Parts and Service:

1. Provide a complete schedule of normally required inspection, preventative maintenance, predictive maintenance, and overhaul tasks and the outage hours required for all of the equipment supplied under this purchase order, plus replacement parts associated with each task. Provide inspection and maintenance plan required to support the minimum on-line availability specified herein. List requirements by year with a list of recommended spare parts for each through one entire cycle. Spare parts list shall consist of total/in-service quantity, recommended spare quantities, lead times and criticality factor.
2. Submit line item pricing for recommended spare parts for 2 years of normal operation, including expendables, beyond first year of operation.

3. Submit an itemized list and pricing for all required tools including any special lifting fixtures to support on-site maintenance of CTG Package(s).
4. For each inspection, preventative maintenance and overhaul task, list the following:
    a. Tools required.
    b. Materials required.
    c. Associated warnings and cautions.
    d. Initial system conditions required.
    e. Procedure (step-by-step).

E. Software:

1. Provide licenses/copies of all proprietary software required for installation, testing, tuning, or operation of the equipment, instrumentation, and/or protective devices.
2. For any instrument or component which must be connected to a computer for testing, tuning, or programming and utilizes a proprietary cable, provide a minimum of two cables to the Owner.
3. Provide software patches (bug fixes) during the warranty term.

1.05 QUALITY ASSURANCE

A. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

B. The OEM shall have in place a complete and functioning comprehensive Quality Assurance program covering the design, procurement, fabrication, packaging and delivery of the specified equipment and materials. This program shall insure that the equipment and materials furnished by the OEM meet the requirements of this Specification as well as the OEM’s own procedures (step-by-step) and processes.

C. It shall be the Supplier’s responsibility to ensure that the Sub-Suppliers and Sub-Contractors meet the intent of this requirement and are able to demonstrate their compliance.

D. Owner or its representative shall be given opportunity to witness all testing.

E. The Owner reserves the right to reject equipment and or components which require major modification or alteration to meet specifications.

F. Non-conformances to this Specification and major equipment or component repairs that occur shall be documented and approved by the Owner in writing prior to testing and shipment.

G. Software Quality Assurance (SQA):

1. Establish an SQA plan that addresses software tests normally performed by programmers and tests performed to verify system operation.
2. Perform software tests to benchmark functional evaluations, including the following:
   a. Conformance to specification.
   b. Language deviation.
   c. Error handling.
   d. Operational speed.
   e. Maintain a software error log to record occurrence, solution, and corrected resolution.
   f. Provide software programming as required to perform functions as specified. Provide annotations in the programming describing functions and changes such that the Owner and others in the future can understand the logic so that changes can be readily made.
   g. Provide software licensed to the Owner in perpetuity.

1.06 APPLICATION

A. The CTG described herein, to be designated “WPCCTG-7-EMV60-CTG-7” alternately abbreviated as “T7”, will be installed at the West Power Complex, at the existing Carrollton Power Plant.

B. The CTG shall have the capability of load modulation via input from the Power Distribution Control System (PDCS) to accommodate varying electrical system requirements.

C. The CTG will be mounted outdoors. The Supplier shall furnish the required enclosure and inlet air filter housing for the unit.

D. The equipment provided by the Supplier must fit within designated area for T7 and auxiliaries. Refer to site plan drawings included in Reference Drawing 1419-M-SK02.

E. Based upon the anticipated power demand profiles for the CTG, the targeted electrical output is a minimum of 18,000 kW net of package, including fuel gas compressor and all other ancillary equipment that is provided by Supplier, at a power factor 0.85, and at site conditions of 97.0 degrees F, 54.2 percent relative humidity, and 14.69 psia barometric pressure. The design intent of the plant is to install a single CTG, not multiple smaller units.

F. Cooling for oil coolers and other auxiliaries will be accomplished with an air-cooled system.

G. If demineralized water is required for NOx emissions control, the Supplier shall provide the demineralized water treatment system.

H. The CTG shall be a dual-fuel unit capable of operation on both natural gas and number 2 fuel oil (diesel). Natural gas will be the primary fuel, with number 2 fuel oil serving as an emergency backup fuel. The CTG shall be capable of transitioning from natural gas to fuel oil while the unit is online, allowing continuous operation during the fuel transition without the changing of fuel system components.

I. The CTG shall be capable of sustained operation with utility pipeline natural gas. Supplier shall provide fuel gas compressor, if required, to meet the CTG inlet pressure required. Minimum fuel gas pressure at the inlet to the fuel gas compressor skid is anticipated to be 180 psig. Fuel Gas Compressor requirements are included in Section 43 12 00, Fuel Gas Compressor. Copies of existing fuel analyses are included in the Reference Document 1419-M-SK-03.

J. The CTG shall be capable of operating in an isochronous mode to satisfy SWBNO managed electrical network loads or synchronized to other 60-Hz electrical sources present on the SWBNO managed electrical network, up to and including the utility grid. The CTG governor response time shall be compatible with this operation. Controls and operation shall be suitable for operation with multiple 60-Hz electrical sources including the local utility, Entergy New Orleans, electrical grid.

K. Asbestos, polychlorinated biphenyls (PCBs) and lead-based paint shall not be used anywhere in the equipment supplied by Supplier, including sub-suppliers. Use of ceramic fiber shall be noted where used. Supplier shall comply with all Federal and State environmental regulations regarding the use of materials. Suppliers are encouraged to use sustainable materials where possible.

L. Instrument Air will be available from the owner at 125 psig maximum; 80 psig minimum pressure.

M. Site ambient conditions and other design criteria are shown in Section 01 61 00, Common Product Requirements.

N. The expected operating profile for the CTG is below:

Normal Operating Scenario	
100% Load	5%
75% Load	15%
50% Load	50%
25% Load	30%
5% Load	0%

Normal Operating Scenario	
Total	100%
Annual Operating Hours	
Natural Gas (hours/year)	2000
Diesel/Number 2 fuel oil (hours/year)	500
Startup/Shutdown Events Per Year	
Startups	170
Shutdowns	170

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Qualified entities submitting bids (Bidders) shall have extensive and successful experience providing units of the size and type specified. Other Bidders may be considered with the approval of the Owner.

B. Combustion Turbine Generator:

1. General Electric.
2. Mitsubishi.
3. Solar.
4. Siemens.
5. “Or-equal.”

C. Fuel Gas Preconditioning Package:

1. Relevant Solutions.
2. Monk Engineering.
3. Kingtool.
4. Integrated Flow Solutions.
5. Gaumer.
6. John Crane.
7. Boll Filter.
8. “Or-equal.”

D. Fuel Oil Filter-Coalescer Package:

1. Oil Filtration Systems (Clark-Reliance).
2. Precision Filtration Products.
3. Integrated Flow Solutions.
4. Parker Racor.
5. “Or-equal.”

E. Demineralized Water Treatment Package:

1. GE Water and Process Technologies.
2. Siemens Water Technologies.
3. Ecodyne/Liquid Process Technologies.
4. Newterra.
5. "Or-equal," Owner approval.

2.02 SCOPE OF SUPPLY – CTG PACKAGES

A. Components and systems within CTG Supplier's Scope shall be complete, including control valves, piping, equipment, instrumentation, controls, alarms, wiring, insulation, cladding and other items required for a complete, functional, highly reliable and highly-automated installation in accordance with good engineering practices and the rigorous demands of industrial power plant service. To the extent practical, equipment shall be delivered in modular form; pre-piped, pre-wired, pre-terminated and pre-tested. The general limits of the CTG package supply are summarized in Reference Drawing 1419-M-SK-04.

B. Furnished by Supplier (CTG Equipment Package Scope):

1. Freight, FOB Job Site.
2. Combustion turbine package mounted in outdoor rated, sound attenuated, ventilated enclosure.
3. Electric generator.
4. Computer-based turbine-generator control system.
5. Provisions made within the CTG electrical equipment enclosure to allocate space for Customer specified PDCS RTU and Customer supplied PSS operator panel. Estimated sizes are 4 feet wide by 4 feet high by 12 feet deep each.
6. Steel base frame with full size, continuous drip pan.
7. Base plates, shims, alignment/leveling equipment, and any other special foundation imbeds required to set and align equipment.
8. Electric/hydraulic or electric-only turbine starting system including variable frequency drive as required for starter motor.
9. Lube oil systems, pumps and coolers for turbine and generator.
10. Fully redundant demineralized water supply and storage system to support NOx water injection, if required.
11. Fuel system capable of burning utility pipeline natural gas or number 2 fuel oil.
12. Fuel gas compressor to meet CTG Supplier's required fuel inlet pressure. See Section 43 12 00, Fuel Gas Compressor for fuel gas compressor requirements. Fuel gas compressor outlet temperature should be determined by Supplier to be in compliance with the Supplier's CTG fuel specifications.

13. Fuel gas preconditioning equipment necessary to meet CTG Supplier's fuel specifications.
14. Fuel oil preconditioning equipment necessary to meet CTG Supplier's fuel specifications.
15. Compressor water wash system for offline and online washing, with pumps, tanks, valves, piping, and appurtenances.
16. Interconnecting piping, tubing, and/or flexible hose connections as required between Supplier-furnished auxiliary skids and main package.
17. Inlet air filter housing and filter media with ladders, platforms and safety rails (as needed) for maintenance.
18. One set of clean new combustion and ventilation air filters for startup and commissioning of the CTGs, and a complete second set of clean new filters upon turnover of the units to Owner.
19. Ventilation fans for generator and turbine compartments.
20. Sound attenuators and necessary filters for supply and exhaust ducts for ventilation of generator and turbine compartments.
21. Sound attenuators for combustion air and exhaust systems, as required to meet overall noise limits specified herein.
22. Anti-icing system, to prevent ice formation at compressor inlet down to the minimum ambient temperature conditions specified in Section 01 61 00, Common Product Requirements. Supplier shall specify method used for ice prevention and associated utility requirements; inlet heating coils requiring an external source of heat shall not be utilized.
23. Insulation and cladding for heat retention, noise reduction and personnel protection (140 degrees F maximum surface temperature, or as required by applicable codes and standards).
24. Heat trace for all piping and equipment necessary to support operation of the CTG in minimum ambient conditions specified in Section 01 61 00, Common Product Requirements.
25. Generator breaker and associated non-identical redundant generator electrical protection relays.
26. Low voltage electrical distribution and control infrastructure to support operation of electrical loads designed and supplied with the CTG Package.
27. Instruments and equipment required for interface with external electrical distribution system, such as potential and current transformers, neutral ground resistor and associated current transformer.
28. Safety rails as required in accordance with OSHA standards.
29. Borescope inspection ports.
30. Vibration monitoring, condition monitoring, and data management systems.
31. Real-time event recorder with first-out identification and reporting to the operator.
32. Turbine performance monitoring system.
33. Painting per Supplier's standard.

34. Safety guards on exposed rotating parts, in accordance with OSHA standards.
35. Complete automatic fire protection system including fire, heat and gas leakage detectors, manual disable switches on outside of enclosure, storage bottles or storage unit, automatic dampers, etc., per NFPA requirements. Package fire alarm control system shall be interfaceable with the plant fire alarm control panel.
36. Required lifting/moving equipment and tools to remove and replace turbine engine, generator (if required), and gear equipment (if required) within 24 hours.
37. DC emergency power system internal to package for controls, emergency lights, and pre/post lube oil pumps (if applicable) for a coast down and cool down period sufficient to prevent equipment damage after a full load trip.
38. AC power/lighting system for inside of enclosure.
39. On-site support during offloading, setting, installation, startup, commissioning, and performance testing.
40. Operations and maintenance personnel training at the job site, including travel and local living expenses as specified herein.

C. Furnished by Others:

1. Offloading, storage, erection and installation of the equipment at the job site.
2. Foundations, anchor bolts and grouting.
3. Piping, valves, fittings and supports outside the Supplier’s scope of supply.
4. Instrument and service air supply to the unit.
5. 480V, 3 Phase, 3W AC Power Supply from SWBNO site emergency power system to package AC power system in sufficient capacity to support CTG idle loads and CTG starting.
6. Conducting on-site equipment performance test (Supplier shall provide oversight and support as specified herein).
7. Wiring of Supplier-furnished ‘Customer’ controls to Process SCADA System (PSS) and PDCS, as well as communications wiring for Supplier-furnished remote operator terminal.
8. Classroom facilities for on-site training.
9. Building permits and environmental permits.

2.03 PERFORMANCE GUARANTEES

A. The following performance values shall be provided at guarantee base conditions as well as the other conditions indicated in Section 01 61 00, Common Product Requirements, and shall be verified during the on-site Performance Test.

B. Capacity and Fuel Consumption:

1. "Guaranteed Power" which is defined as the 100 percent power output of the CTG, as required to satisfy power output, expressed in kilowatts, net of CTG auxiliaries, fuel gas compressor, and other equipment supplied by the vendor, based on site specific factors, at guarantee ambient conditions and specified fuels.
2. "Guaranteed Fuel Consumption", which is defined as the fuel consumption of the CTG expressed in BTU/hr, lower heating value basis, at the 100 percent guaranteed power output level and guarantee ambient conditions, based on site specific factors and specified fuel.
3. Performance shall be based on inlet air pressure drop including filters, silencers and ductwork. Curves to allow correction of CTG performance for varying inlet pressure drop shall be provided for a range of 0 inch to 8-inch water gauge.
4. Performance shall be based on exhaust pressure drops, including exhaust stack, emissions control technology if required, and silencer if required. Curves to allow correction of CTG performance for varying exhaust pressure drop shall be provided.

C. CTG Emissions:

1. "Guaranteed Exhaust Emissions" for the following pollutants, expressed in 1) ppmv at 15 percent oxygen, and 2) total pounds per hour, for the specified fuel (taken at turbine exhaust):
   a. NOx.
   b. CO.
2. NOx emissions shall not exceed 25 ppmv and CO emissions shall not exceed 75 ppmv, taken at the turbine exhaust, when burning natural gas fuel, corrected to 15 percent oxygen from 50 to 100 percent load. NOx emissions shall not exceed 65 ppmv and CO emissions shall not exceed 50 ppmv, taken at the turbine exhaust, when burning number 2 fuel oil, corrected to 15 percent oxygen from 65 to 100 percent load. NOx emissions shall be controlled utilizing dry low NOx technology, or water injection.
3. Anticipated CTG exhaust emissions shall be provided for the following additional pollutants:
   a. VOC.
   b. PM 2.5/PM-10.
   c. SO2.
4. Part-load performance data shall also be provided for the load conditions included in the data sheets.

D. Noise Limitations:

1. Noise levels for equipment furnished under this Scope of Work shall be guaranteed not to exceed the requirements of OSHA 1910.95 at 3 feet distance and 5 feet above grade under free field conditions over a reflecting plane measured at points spaced 6 feet apart around the equipment.
2. Far field noise levels for equipment furnished under this Scope of Work is expected not to exceed 55 dBA (average) at the residences immediately to the West of the site. The residences are approximately 237 feet away from the closest point of the proposed CTG location. Refer to the Site Layout Drawing 1419-M-SK02 for more information.
3. The specified noise limits shall apply to all normal modes of operation.

2.04 DESIGN REQUIREMENTS

A. The intent of this Specification is to utilize Supplier's standard package design where possible. However, the specific design features discussed herein shall be included as a minimum.

B. Turbine Package:

1. CTG shall be designed for continuous operation at base load (100 percent) and shall also be capable of load-following operation between 15 percent and 100 percent load.
2. Combustion emissions control shall be via Dry Low NOx technology or water injection.
3. Turbine enclosure ventilation fans shall have a 100 percent backup installed.
4. Turbine performance monitoring system shall allow thermodynamic modeling of CTG for purposes of optimizing performance. Parameters to be monitored include:
    a. Compressor Inlet Dry Bulb and Wet Bulb Temperatures.
    b. Compressor Inlet Pressure.
    c. Compressor Discharge Pressure.
    d. Compressor Discharge Temperature.
    e. Combustor discharge (turbine inlet) temperature.
    f. Power Turbine Inlet Temperatures (where applicable).
    g. Exhaust Temperature.
    h. Fuel Flow and Pressure.
    i. Combustion Air Inlet Flow.
    j. Air Inlet Pressure Drop.
    k. Exhaust Back Pressure.
5. Inlet Air Filters:
    a. Inlet air filters shall be designed for particle removal sufficient to meet Supplier's specifications. Filter holders shall be stainless steel or aluminum.

b. Filtration system shall consist of a minimum of two stages of filtration, pre- and final-filtration, in order to extend the useful like of the final filtration elements.
c. Inlet air filter housing shall include mist/moisture eliminators to prevent moisture infiltration.
d. Differential pressure instruments and transmitters shall be provided across the filters on the inlet air housing to allow monitoring of the cleanliness of the filter bank section. For units with dual intake arrangements, this instrumentation shall be provided in both filter banks.

6. Inlet Anti-Icing System:
   a. If required, Supplier shall furnish necessary equipment, materials, and controls for prevention of ice formation or carry-over along the combustion and compressor inlet paths over the full range of ambient conditions specified herein. Exclusion of an anti-icing system shall be accompanied with documentation confirming that the exclusion will not result in warranty exclusions associated with damage incurred due to ice formation.
   b. Methodology and design of anti-icing system shall be specified by Supplier; however, inlet coils requiring a separate heating source and loop shall not be utilized (compressor bleed air system preferred). A description of the proposed anti-icing system along with associated utility requirements shall be included with Supplier's proposal.
   c. All piping, valves, equipment, and controls for the anti-icing system should be completely self-contained and within the Vendor's scope of supply and shall not require an external source of heat.
7. Lube Oil System(s):
   a. Lubricating oil systems shall be provided for both the turbine and the generator. Design of each lube oil system shall be per manufacturer's standard, but shall include the following features as a minimum:
      1) Main oil pump(s).
      2) Pumps, filters and strainers (excluding Turbine-driven pumps) shall be fail safe (i.e. pre-installed backups, ready for automatic or manual switchover or gravity fed rundown tanks). In addition to the main engine driven lube oil pump(s), the lube oil system shall include AC pre/post and DC backup driven lube oil pumps or gravity fed rundown tanks to provide safe turbine shutdown in the event of a pump failure. Where utilized, DC backup system shall have monitoring capability with status indication and alarm to the Process SCADA System (PSS) indicating readiness.
      3) Air-cooled oil coolers with the capability of transfer to standby cooler during normal operation.

4) Integral lube oil tank.
5) Electric lube oil tank heater.
6) Duplex lube oil filters with transfer valve and ability to shift to the standby filter during normal operation.
7) Demister system suitable for maintaining vent area free from oil collection.
8) Drip pan.

b. Supplier shall furnish lubrication oil, in required types and quantities, sufficient for:
1) Completion of initial lube oil flushing.
2) Additional required for initial operation.

c. Supplier shall furnish necessary materials, containment, controls, and safety procedures (step-by-step) to address specific toxicity characteristics for any synthetic lubricants that are utilized in their systems.

8. Safety ladders, handrails, gratings, steps, external structural or support members shall be hot dipped galvanized.

C. Demineralized Water Treatment System (If Required):

1. A fully redundant water treatment system capable of producing water compliant with the CTG Supplier's specification for combustion turbine injection water. Raw water specifications for influent water is included in the Reference Information 1419-M-SK05.
2. System shall be a complete system, including control valves, piping, equipment, instrumentation, controls, alarms, wiring, insulation, cladding and other items required for a complete, functional, highly reliable and highly-automated installation. System shall include the following at a minimum:
a. A treated water storage tank and transfer pumps, with a minimum storage volume to support operation of the CTG at full load for at least 4 hours.
b. Programmable Logic Controller (PLC)-based package control system.
c. Electric motor starters for all motors.
d. Power and control wiring. Power supply from Supplier's 480V auxiliary switch gear.
e. Structural steel skid, base plates, shims, alignment/leveling equipment, and any other special foundation imbeds required to set and align equipment.
f. Safety guards on exposed rotating parts, in accordance with OSHA standards.
g. All necessary gaskets, bolts, nuts, fasteners, and other hardware to erect the unit.
h. Two extra sets of all gaskets and seals.

i. Surface preparation and painting per Section 09 90 01, Painting and Protective Coatings.

D. Fuel Gas System:

1. A fuel system capable of operating on utility pipeline natural gas shall be provided. The fuel system shall include all necessary components (control valves, instrumentation, etc.) to control and monitor fuel flow and pressure to the CTG package. The unit control system shall automatically control and modulate fuel flow during start-up, shut down, and normal operation. All instrumentation and valves must be accessible and maintainable for maintenance and operation activities.
2. The fuel gas supply systems shall be equipped with duplex filters capable of being swapped to the standby filter during unit operation.
3. Supplier shall provide a complete skid-mounted fuel gas conditioning package to treat the incoming pipeline-quality fuel gas such that it meets Supplier's requirements for pressure, temperature, cleanliness and moisture content. Package shall include, but not necessarily be limited to, the following:
   a. Two 100 percent-capacity fuel gas filter separators. It is anticipated that operation of a single filter separator at a time will be sufficient for this application; however, if additional pre-treatment equipment (e.g. knockout drum, etc.) is required or recommended by Supplier to achieve the specified fuel gas quality on a continuous basis, this equipment shall be clearly identified in the proposal.
   b. One 100 percent-capacity electrically-powered fuel gas preheater, if required to meet fuel gas superheat requirements. Include skid-mounted local silicon controlled rectifier (SCR) power controller.
   c. Block valves for complete isolation of each individual vessel.
   d. Common structural steel skid for mounting of piping, valves, instrumentation, and vessels.
   e. All internals, nozzle connections, and accessories.
   f. Full-flow-capacity relief valves for protection of each pressure vessel, designed per ASME Section VIII requirements.
   g. Automated liquid drain valves and/or traps from each vessel chamber, piped to a common drain header. Drain system shall incorporate a means of preventing high pressure gas from being released into the drain tank.
   h. Double-wall, vented waste drain tank for collection of all liquids, including pump-out connection with quick-disconnect fitting as well as manual drain. Tank shall be designed in accordance with UL 142 specifications and so labeled. Vent size shall be sufficient to prevent over pressurization of waste drain tank in the event of fully-open discharge of gas from all connected drain lines.
   i. Continuously welded support legs for vessels.

j. Vent piping and valves to provide required venting for start-up and normal operation.
k. Instrumentation and controls as required to allow for complete control and monitoring of the preconditioning package by the turbine control system, wired to terminal boxes on the common structural steel skid-mounted package. Instrumentation shall include the following as a minimum, each provided with local indication:
    1) Liquid level site gauges and transmitters for each filter-separator vessel chamber.
    2) Liquid level site gauge and transmitter for waste drain tank.
    3) Differential pressure transmitters across each vessel.
    4) Gas preheater inlet, outlet, and vessel temperature transmitters.
l. All special tools required for routine operation and maintenance of the fuel gas conditioning assembly shall be provided. Tools shall be new and of first-class quality. Tools shall be shipped to the job site in containers clearly marked with the use for which they are intended.
m. Surface preparation and painting per Section 09 90 01, Painting and Protective Coatings.
n. Adequately sized and positioned lifting lugs for all furnished equipment.
o. Vessel testing per ASME Section VIII requirements.
p. Sets of spare filter elements as necessary for startup and commissioning based on past experience of similarly sized units.
q. All pressure vessels shall be designed, manufactured and tested in accordance with ASME Section VIII. Furnish ASME stamp and label in accordance with ASME code for required maximum working pressure.
r. All external piping associated with the preconditioning package shall be designed, manufactured and tested in accordance with ASME/ANSI B31.1, Power Piping.

E. Fuel Oil System:

1. This system shall consist of a skid mounted filtration and coalescing water separation vessels, interconnecting piping, valves, drains and instrumentation as specified herein. Each vessel shall include all required particulate filters, coalescing filters, and straining elements to provide the Supplier’s specified fuel quality at the outlet of the filtering skid.
2. Two 100 percent capacity filtration-coalescing trains shall be provided. One will be running and one will be standby.

3. Initial (clean) pressure drop shall be no greater than 5 psi with 40 degrees F number 2 fuel oil. Maximum (dirty) pressure drop will be limited to 30 psi or manufacturer's recommended filter change-out, whichever is less.
4. System Vessels:
    a. The body shall be welded carbon steel or stainless steel construction with a removable head. Inlets and outlets to accommodate flow.
    b. Heads, 50 pounds and lighter shall be simply removable; heads over 50 pounds. shall include davit and lifting mechanism. Heads shall be bolted in place with swinging eyebolts. Eyebolts shall be held in position with clevis nuts.
    c. The hand seal shall be Buna-N O-ring of standard size, readily available for purchase.
    d. The design shall be suitable for standard sized filter cartridges that are readily available for purchase. Additional structures shall be provided internally as required for holding the filters and maintaining separation between clean effluent, and dirty influent and water. A vessel shall be mounted vertically with the heads at the top to permit quick, easy, and efficient change-out of filter cartridges.
    e. Vessel shall include legs or suitable structure for floor mounting or for skid mounting.
    f. Provide lug with hole for electrically grounding the vessel.
    g. Provide lugs for lifting the vessel.
    h. Vessels shall be ASME Code Section VIII, Division 1, stamped and certified.
    i. Surface preparation and painting per Section 09 90 01, Painting and Protective Coatings.
    j. Openings Required:
        1) Fuel oil inlet: Raised faced flange, size and Class to be determined by Supplier.
        2) Fuel oil outlet: Raised faced flange, size and Class to be determined by Supplier.
        3) Drain: NPS 3/4-inch minimum with sockolet, Schedule 80 nipples, elbow and ball valve.
        4) Vent: NPS 3/4-inch minimum with sockolet, Schedule 80 nipple, and ball valve. This opening will be used for an automatic air vent.
        5) Purge Vent: NPS 3/4-inch minimum with sockolet, Schedule 80 nipple, and ball valve. This opening will be used for charging the unit with compressed air at filter change-out.
        6) Openings as required for instrumentation and accessories.

k. Instrumentation and controls as required to allow for complete control and monitoring of the preconditioning package by the turbine control system, wired to terminal boxes on the common structural steel skid-mounted package. Instrumentation shall include the following as a minimum, each provided with local indication:
   1) Differential pressure transmitters across each vessel.
   2) Sight glass for monitoring water level.
   3) Automatic Air Eliminator on Vent.
   4) Pressure relief valve.

l. Particulate Filters shall be cartridge type, with design as recommended by Supplier for the flow rates, service and performance indicated. Burst strength shall be a minimum of 2.0 times the recommended change out differential pressure.

m. Separator Filters shall be cartridge type, with design as recommended by Supplier for the flow rates, service and performance indicated. Burst strength shall be a minimum of 2.0 times the recommended change out differential pressure.

n. Provide common structural skid for mounting the vessels, valves, and interconnecting piping within Supplier's scope. The skid shall be fabricated of structural steel and painted per Section 09 90 01, Painting and Protective Coatings. The skid shall include gussets and mounting bolt holes for floor mounting. Provide lug with hole for electrically grounding the skid. Design the skid so that the top of the head mating surfaces for all the vessels is at the same elevations. Provide lugs for lifting and rigging the assembled skid into position.

F. Electric Generator:

1. The electric generator shall be provided as an integral part of the turbine-generator set. Supplier is responsible for the delivery, performance, control, and technical field support of the generator.
2. Generator shall be 13,800 volts, 3 Phase, 0.85 power factor, 60-Hz, Direct Air Cooled, with Supplier-selected capacity based on machine output.
3. The generator shall be capable of operating in standalone, paralleling, synchronous, isochronous and droop mode, with full P (real power / watts), Q (reactive power / vars), S (apparent power / volt-amps), speed, and voltage control. In standalone operation the CTG shall be able to "black-start" and connect to a 'dead-bus'.
4. The generator shall be rated for continuous (100 percent duty) operation, class F insulation, B-rated temperature rise, and meet the following requirements:
   a. Direct Air Cooled enclosure rated for outdoor installation.
   b. Automatic voltage regulation, plus or minus 0.5 percent.

c. Voltage adjustment of plus or minus 5 percent of rated voltage.
d. Load regulation of plus or minus 1 percent.
e. Full load efficiency of 97 percent or better.
f. Core losses not to exceed 100 KW.
g. Subtransient reactance of 0.25 or less.
h. Short circuit ratio of 0.43 plus or minus 5 percent.
i. Six RTDs in stator winding for monitoring and protection by the Turbine Control Panel. RTDs shall be redundant element type at each location or have redundant RTDs at each location.
j. Bearing RTDs for monitoring and protection by Turbine Control Panel.
k. The generator shall be provided with a 2/3 winding pitch.

5. The unit grounding system will be a high resistance system.
   a. System components shall limit line-to-ground fault to 200 amperes at 7968 Volts line-to-ground.
6. The high resistance ground unit shall be mounted in a metal enclosure suitable for installation in an area accessible to personnel.
7. Furnish a metal cubicle enclosing the generator neutral side terminals, with C400 current transformers with a minimum meter accuracy class of 0.3 at a burden of B-0.9 and a thermal overload rating of 1.5. Phase CT ratios shall be selected based on the generator maximum output current with a minimum rating of 1200:5. Wire the current transformer secondary connections to shorting type terminal blocks in an isolated terminal box on the rotating equipment baseplate. All CT leads shall be brought out to the shorting terminal block. One addition CT set, one per phase, shall be provided for Customer use and shall be located ‘inside’ of the CTG electrical zone of protection to enable ‘overlapping’ zone of protection coordination with the Customer.
8. Owner will supply wye ground-wye ground potential signals to the unit control panel for synchronization and control.
9. Furnish a metal cubicle enclosing the generator lineside terminals, lightning arresters, and surge capacitors. The cubicle shall have adequate provisions for cable terminations to be furnished and installed by the Owner.
10. Both line and neutral terminations will be cable in conduit. The load side termination cabinet should be adequately sized to accommodate Class 1 terminations (3 by 750 KCMIL conductors per phase minimum).

G. Generator control and protection:

1. Terminate current transformer leads at shorting type terminal blocks.
2. Provide FT-1 type test blocks for current and voltage inputs to the generator protective devices.

3. Wiring connections for current transformers within panels shall be #10 AWG yellow SIS type conductors and terminations shall utilize uninsulated ring tongue lugs.
4. Control power terminations should be terminated at pullout type fuse blocks.
5. Provide redundant non-identical generator protective relays and associated lockout relays installed in the generator control panel. Protective relays shall be Supplier standard and SEL-700G ("Or-equal").

H. Combustion Turbine-Generator Control System:

1. General: The CTG package shall be equipped with Supplier's standard redundant computer-based control system including meters, gages, alarms and controls, locally mounted in modular enclosure, suitable for interface with Owner's Process SCADA System (PSS) and Owner's Power Distribution Control System (PDCS). A preliminary network architecture is shown on 1419-I-SK01. Package shall include as a minimum a 17-inch Allen-Bradley PanelView Plus 7 Performance version HMI or equivalent for the local turbine/generator controls and a desktop HMI for placement in the Client's Central Control Room. While the CTG control system must include all functions required to operate and maintain the CTG, fuel conditioning equipment and gas compressor, it must also support integration with the PSS and PDCS while minimizing the engineering and support effort to perform the initial integration as well as ongoing maintenance and modifications. The interface between the CTG control system and the PSS and PDCS (or other direct impact units) should follow the guidelines below:
    a. Cyber Security: All equipment shall conform to the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems and its associated datasheet.
    b. Interlocks: All safety and equipment protection interlocks are to be interfaced between the CTG and PSS or PDCS via individual hardwired I/O signals. All permissives/interlocks between systems shall be implemented with fail-safe design practices such that loss of circuit continuity will remove the permissive and result in the appropriate protective action.
    c. Generator Control: Generator control to the CTG shall be hardwired isolated inputs from the PDCS node (normal source of commands) to include basic control commands (such as start, stop, control mode, raise/lower voltage, raise/lower power factor, etc. to achieve P, Q, S) locally and remotely via the CTG PDCS node.

d. Optimization: Various optimization control strategies may require interface between two or more Supplier control systems (CTG, Inlet Air, etc.). Non-critical interfaces which support these control strategies shall be implemented utilizing data communication interface. Loss of connection of this interface shall not result in shutdown of the unit but may limit the operating mode of the unit.
e. The CTG control system shall include a means to remotely view/operate the CTG control system HMI from the PSS and PDCS. The CTG Supplier shall provide graphic screen printouts which directly link the data link points to the graphic objects for duplication in the PSS and/or PDCS.
f. Alarms: The CTG control system shall support monitoring of alarm conditions within the CTG controller(s) by the PSS and/or PDCS HMI. Access to CTG control processors shall not negatively impact the throughput or latency of the CTG controller communications with its I/O, the CTG HMI(s) or the PSS/PDCS controller(s). The Supplier shall include a database listing of all CTG alarm conditions including: Tag/Address, Description, Alarm State.
g. Historian: The CTG control system shall support collection of data by the PSS historian. Access to CTG control processors shall not negatively impact the throughput or latency of the CTG controller communications with its I/O, the CTG HMI(s) or the PSS controller(s).

2. Standard CTG control screens shall include all normal operator functions, including setpoints, alarms, startup, and shutdown control. Engineering interaction with the CTG control system shall be accomplished through Manufacturer's standard interface. PSS/PDCS interface to the CTG control system will include standard startup / shutdown, summary alarm acknowledge, auto-synch permissive, MW / MVAR setpoints, raise / lower commands for speed / voltage, etc. First-out indication shall be included as part of the information provided on the control interface system.
3. Communications link shall be provided via Modbus TCP/IP (Category 6) to the PSS and PDCS to allow monitoring and control of equipment at either local control panels/stations or from the plant operations control room located remote from the CTG.
4. Provide redundant communications connections to the turbine control system.
5. The CTG control system shall include the following features as a minimum:
   a. Complete control of CTG Package, including normal start, automatic synchronization, operator manual synchronization, normal stop, emergency stop, base load, peaking, load following and manual load changes. The Control System shall display

parameters such as generator voltage, current, power, reactive power, frequency and kWh and status of all key auxiliary devices.

b. Start sequence shall allow rapid automatic start, purge, firing, and synchronization, consistent with NFPA requirements and safe practices.
c. Automatic, load-following operation between 15 percent and 100 percent of CTG output.
d. Complete vibration and bearing temperature monitoring.
e. Turbine Governor.
f. Microprocessor/Sequencer.
g. Fire and Gas Detection Controls.
h. Turbine performance monitoring, including transducers, wiring, software, monitor and hardware. System shall allow real-time computation of CTG heat rate, power output, GT efficiency and fuel consumption as a minimum.
i. Automatic and manual synchronizing and closing of the generator circuit breaker control shall be provided. Governor and Exciter shall accept raise/lower pulses from remote signals from Owner's PDCS and manual controls.
    1) Synchroscope shall be provided in both software and a hardwired meter.
j. KW load control input from load controller as a digital raise/lower pulse signal.
k. KVAR/power factor control input from load controller as a digital raise/lower pulse signal.
l. Turbine shall include two electronic overspeed trip devices, each completely independent of the other. Only one overspeed trip shall be required to shutdown unit.
m. Electronic Voltage Regulator with Automatic/Manual Control.
n. Generator Metering.
o. Turbine Control System shall include all data necessary for archiving and trending real time data from the CTG in the data link to so that the PSS can provide trending and archiving functionality.
p. In the event of a Plant upset or trip, the Control System shall record the sequence in which the alarm signals were received ("first-out" capability), for later analysis and troubleshooting by Plant personnel. Time stamps shall be 1msec accuracy minimum.
q. The plant will utilize a GPS based clock system. Turbine-generator controls and protective devices (as applicable) shall be connected to a satellite synchronized network clock with an antenna and surge protection provided as part of the turbine control package.

6. The unit control panel shall be designed to permit load control by Owner's Power Distribution Control System (PDCS) and monitoring by Owner's Process SCADA System (PSS). The unit control panel shall accept the following commands from voltage-free relay contacts (or analog as noted) in the PDCS/PSS:
    a. Turbine Start/stop.
    b. Raise/Lower Voltage.
    c. Raise/Lower Power Output (4-20 mA from load controller in Auto; dry contacts in manual).
    d. Raise/Lower VAR's (or Power Factor) (4-20 mA from load controller in Auto; dry contacts in Manual).
    e. Emergency Shutdown.
    f. Droop/Isochronous.
7. The unit control panel shall provide, as a minimum, additional hardwired control interface for electrical protection interfaces with the PDCS RTU to include as a minimum control of all medium voltages control devices, as generally listed below:
    a. Generator Circuit Breaker Control:
        1) close [CCL].
        2) block close [BCL].
        3) open [COP].
        4) protection trip [PRT].
    b. Generator Circuit Breaker Status:
        1) closed [52/a].
        2) open [52MOC/b].
    c. Generator Circuit Breaker Local Interlock Status [3/a].
    d. Generator Circuit Breaker Inserted Status [52TOC/a].
    e. Generator Circuit Breaker Local/Remote Status [43L/R/r].
    f. Generator Circuit Breaker LOR Status [86/b].
    g. Generator Circuit Breaker Control Power Status [74/a].
8. The unit control panel shall provide, as a minimum, a Modbus TCP/IP communication link to the PSS via CAT 6. In general, the PDCS will control start/stop and load dispatch while the PSS provides monitoring and historian functions. The communications link shall convey the following functions:
    a. Unit Status (shutdown, starting, on-line, etc.).
    b. Sensor Values (speeds, temperatures, pressures, vibration, flow, level, etc.).
    c. Electrical Values (amps, volts, watts, frequency, VAR's, Power Factor).
    d. Generator Circuit Breaker Status (closed/tripped).
    e. Alarms and associated set points.
    f. Shutdowns.
    g. Sensor Failures.
    h. Status of Auxiliaries.

9. The unit control panel shall display, as a minimum, the following parameters (signal source provided in parenthesis):
    a. Exciter Amps (Exciter Comm. Link).
    b. Exciter Volts (Exciter Comm. Link).
    c. Generator MW Output (Turbine Control Panel).
    d. Generator Amps (Turbine Control Panel).
    e. Power Factor (Turbine Control Panel).
    f. Generator and Bus Frequency (Turbine Control Panel, 4-20 mA Signal from Owner's Switchgear).
    g. Generator Voltage (Turbine Control Panel).
    h. Bus Voltage (4-20 mA Signal from Owner's Switchgear).
10. The CTG control system HMI shall support a multi-level user security system (least privileges basis) per the following user group permissions guidelines:
    a. Guest: View only access. Navigation to all process status windows.
    b. Operator: Permissions to operate equipment, enter process set points, and acknowledge/reset alarms.
    c. Maintenance: Permissions to tune control loops, calibrate instruments, modify process alarms, and modify process constraint parameters.
    d. Engineer: Access to all process and machine parameters.
    e. Admin: Edit control system, assign user access levels and security configuration.

I. Combustion Turbine-Generator and BOP Instrumentation:

1. Instruments furnished with this contract shall comply with Section 40 91 00 Instrumentation and Control Components.
2. Control valves, regulators and relief valves furnished with this contract shall comply with Section 40 92 13, Process Control Valves and Regulators.

J. Tagging and Marking:

1. Equipment numbering shall be as generally defined in Section 01 58 53 Project Equipment Identification with equipment unique identification requirements defined herein.
2. Each major piece of equipment shall have a standard nameplate securely affixed showing the tag number; the name and address of the Manufacturer; serial and model number; and such other information as the Supplier may consider necessary to complete the identification of the item.
3. The range of process numbers to be used for Supplier equipment shall be confirmed with Owner/Engineer prior to development of Supplier's P&ID's.

4. Label all piping.
5. All CTG parts, components, assemblies and items shall be clearly and permanently match-marked for field assembly and installation. The match-marks shall be marked by letters or numbers and shall be cross referenced to the shipping paperwork and erection drawings and instructions.

PART 3 EXECUTION

3.01 FACTORY TESTS AND INSPECTIONS

A. Supplier shall provide factory testing of CTG package(s) and all auxiliaries including certified test reports and witnessing of certain tests by Owner's representatives, as tabulated next page. Column headings are defined as:

1. "Witnessed Test" is a test conducted in manufacturer's factory, witnessed by Engineer or Owner's representative who shall neither participate, nor interfere with test. A certified test report will be provided by manufacturer. Travel costs associated with Engineer or Owner's representative attending the witnessed test will be Owner's responsibility. Supplier's proposal shall include details of all "Witness Tests", including location and duration of test.
2. "Certified non-Witnessed Test" is a test conducted in manufacturer's factory without Owner representative, but with a certified test report provided by manufacturer.

DESCRIPTION	WITNESSED TEST	CERTIFIED NON WITNESSED TEST
No load run test of combustion turbine	X	
Turbine, gearbox and generator vibration/mechanical	X	
Functional test of controls package, including demonstration of PSS interface	X	
Generator test, IEEE 115		X
Auxiliary packaged equipment skids		X

B. Provide step-by-step test procedures including conditions required for testing, method of correcting performance to guarantee conditions, instrumentation required, calibration procedures, and acceptance criteria for Owner approval. All procedures shall be accepted by all parties prior to start of tests. Procedures shall be in accordance with ASME PTC 22 – Gas Turbines Performance Test Code.

C. Supplier shall provide factory calibration records for all Supplier-furnished instruments prior to final acceptance tests as noted below:

1. Calibration (five points, up and down scale for analog transmitters; for switches verify action two times for increasing and decreasing inputs) of all instrumentation required for both linearity and accuracy in accordance with standard industry practices or manufacturer's recommendations.
2. Test equipment accuracy shall be calibrated in accordance with the NIST, National Institute of Standards and Technology.
3. Field mounted instruments shall be bench calibrated and panel mounted instruments shall be calibrated in the panel.
4. Calibration and installation records shall be documented digitally and submitted with the final records with the following information provided:
    a. Equipment tag number.
    b. Data component received.
    c. Purchase order number.
    d. Serial number.
    e. Calibration data.
    f. Date of calibration.
    g. Person responsible for calibration.
    h. Date component installed.

3.02 PREPARATION FOR SHIPMENT

A. Supplier shall submit step-by-step procedures for the cleaning, preservation, packaging, handling, lifting, shipping, and storage of the material and equipment provided under this order.

B. If extended layup of equipment is required due to the Supplier's production schedule, Supplier shall provide a detailed procedure for preservation, along with a list of utility requirements.

C. Equipment and piping must be cleaned of all foreign material, dirt, scale, grease, oil, and chemical residues, etc., in accordance with the approved cleaning methods. Items will be inspected for compliance with approved cleaning step-by-step procedures. Items which are not immediately packaged or shipped must be protected from contamination until preservation or packing is complete.

D. Supplier shall provide all special tools for unloading, installation and maintenance of Supplier-furnished equipment. Special tools and handling equipment shall be packed separately and identified as included in the shipment. Spare gaskets shall not be bolted in place, but shall be packed separately and identified. Loose clips and similar small structural items shall be packed separately, marked, tagged, and attached to larger pieces.

E. All exposed machinery surfaces (threads, flange faces, gasket sealing surfaces, etc.) shall be coated with an easily removable protective coating. All weld bevels of carbon or ferritic alloy steel piping or equipment components that are to be welded by others shall be coated on the inside and outside surfaces for a distance of three inches from the end of the component.

F. All flange openings shall be protected and made waterproof with bolted full size metal covers and gaskets. Flanges shall be furnished with one bolt for every other hole (minimum of four bolts). Threaded openings shall be plugged with threaded plugs of the same material as the connected part and sealed with PTFE tape thread sealant. Beveled and plain edge openings shall be suitably closed with solid metal wedge type connectors. Where required, based on the Supplier's production schedule, piping shall be filled with inert gas to prevent corrosion.

G. Piping shall not be designated as attachment points for lifting equipment.

H. All tagged items need to be identified with permanent stenciled metal tags or a material not subject to deterioration from outdoor storage.

3.03 INSTALLATION SUPERVISION

A. Supplier shall furnish a list of Site Assistance hours needed for each of the required milestones. Supplier shall include the site assistance hours as a line by line detailed list for each task.

B. Provide full time (10 hours/day) field erection supervision for the duration of the tasks listed below by manufacturer's personnel. This erection shall include but not limited to:

1. Installation of Turbine, Generator and other items shipped loose.
2. Alignment of generator and turbine.
3. Installation of air filter module and inlet transition ducting.
4. Installation of turbine/generator foundations and anchors.
5. Installation of lube oil and other auxiliary skids.
6. Installation of wiring and interconnects.
7. Cleaning, connecting, and sealing all parts of the CTG package.
8. Electrical control and utility mechanical and fire system functional check-outs.
9. Installation of CTG exhaust expansion joint and exhaust stack.
10. Receiving, unloading and moving all major components into place on foundations.
11. Any items that affect the warranty of the unit.

C. Balancing of rotating equipment shall be accomplished prior to shipment. Field balancing shall only be performed with the written approval of the Owner and the Engineer.

3.04 COMMISSIONING AND STARTUP SUPERVISION

A. Supplier shall provide qualified field representative(s) in required disciplines to supervise the commissioning checks and initial startup of the CTG package, including setting up and demonstration of controls, monitoring systems, performance/trending systems and auxiliaries in Supplier's supply, and interfaces with Owner's Process SCADA System (PSS) and PDCS. Supplier shall furnish a list of Site Assistance hours needed for each Commissioning and Startup activity.

3.05 FIELD TESTS AND ENGINEERING SUPPORT

A. The following Acceptance and Performance tests shall be performed in the field upon completion of the installation:

1. Functional Test(s) for purposes of demonstrating that the equipment and systems function as designed, operate safely, reliably, and as part of an integrated Plant system in accordance with good engineering practice. These tests shall include normal operations, such as startup, shutdown and load changes, as well as emergency operations, such as generator trip/overspeed and emergency coast down. Fully automatic start sequences shall be made repetitively (three minimum) without manual control override, or failed start attempt.
2. Functional Test shall also include one hour of operation each at 25 percent, 50 percent, 75 percent, and four hours at 100 percent load.
3. Performance Test to demonstrate ability to maintain Guaranteed Power and Guaranteed Fuel Consumption.
4. Reliability Test to demonstrate ability to continuously run for five days without alarm or trip events. No alarm or trip devices may be bypassed during this test without Owner's approval. The performance assessment may be conducted during the Reliability Test.
5. Performance tests shall be in accordance with the ASME Performance Test Code PTC22.
6. Tests shall be performed with permanently installed Plant instrumentation unless such instrumentation is non-existent. Where special temporary instrumentation is required, Supplier shall furnish said instrumentation which shall be calibrated within one week before the tests, and the calibration sheets shall become part of the test documentation. No safety device (alarm or trip) shall be bypassed during or following the Reliability Tests.

B. At least 60 days prior to scheduled Acceptance Testing, the Supplier shall submit, for Owner's and Engineer's review, a complete Acceptance Test step-by-step procedure that defines details such as protocol, type of tests, measurements to be taken, sample calculations and correction formulas, and responsible parties.

C. Provide all step-by-step procedures and supervision required for the Acceptance Tests. During testing, the Plant shall be operated and maintained by Owner’s operating personnel, the Owner’s consultant or a third party vendor.

D. An Emissions Test will be performed by Owner’s consultant, with Supplier’s assistance. The Emissions Test will be designed to demonstrate and document satisfactory levels of air emissions in accordance with Supplier’s guarantee and air permit limits at turbine exhaust. Demonstrate and document satisfactory levels of air emissions in accordance with Supplier’s guarantee and air permit limits at turbine exhaust.

E. Supplier shall provide engineering support of and coordination with the Owner and Owner’s engineers for all tests.

3.06 TRAINING

A. Provide training, at the Owner's facility, for the personnel listed herein so that the Owner can operate, maintain, change system configuration, and repair the complete system.

B. Training for Operators shall be conducted to accommodate a multiple shift schedule.

C. Training sessions will be held for each of the following groups:

1. Engineers.
2. Plant Operators (Minimum of four sessions over 3 weeks).
3. Mechanical Maintenance Technicians (Minimum of two sessions).
4. Electrical/ Instrumentation Maintenance Technicians (Minimum of two sessions)

D. Prior to project closeout and field acceptance testing, provide training plan and schedule including the following information:

1. List of all classes/courses.
2. Description of course.
3. Duration of course.
4. Sequence of courses.

E. Provide competent, factory authorized personnel to provide instruction to O&M personnel. Include sufficient hours of training to provide complete training for operation and maintenance of the equipment and system.

F. Provide the name and resume of proposed instructor; instructor must have at least 5 years' experience teaching the designated course. Instructor's primary language must be English.

G. Provide training manual that includes, as a minimum, the following:

1. Course objective.
2. Course outline.
3. Theory of operation.
4. Case studies that demonstrate application, operation (including casualty control), troubleshooting, repair and maintenance of equipment.
5. Notes that supplement and enhance information provided in the manufacturer's operation and maintenance manuals.
6. Thorough review of applicable drawings, photos, tables, diagrams and schematics.
7. List of references for further independent study.

H. Owner reserves the right to require Supplier to repeat training classes if not satisfied objectives are met, at cost of Supplier.

I. Overview Training for all groups:

1. Course shall cover, as a minimum, the following topics for 15 to 20 persons:
   a. Describe CTG equipment, interconnections, functions and capabilities.
   b. Review system terminology, abbreviations and acronyms.

J. Operator Training:

1. Operator-training course shall be conducted at times that accommodate a multiple shift schedule. A minimum of four, eight-hour, on-site training sessions are required.
2. The course shall be an in-depth instruction on the CTG and Package equipment.
3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:
   a. Startup, Normal Operation and shutdown of equipment.
   b. Response actions to hardware and software failures.
   c. Response to system alarms.
   d. Modifying and locating setpoints.
   e. Review interface to process control system.
   f. Control loop tuning concepts and methods.

K. Mechanical Maintenance Training:

1. Mechanical maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the CTG and Package equipment.

3. The course shall enable the Owner’s operators to be proficient in the following topics, as a minimum:
    a. Startup, Normal Operation and shutdown of equipment.
    b. Response actions to mechanical equipment failures.
    c. Response to System alarms.

L. Electrical/Instrumentation Maintenance Training:

1. Electrical/Instrumentation maintenance shall be conducted in two separate and identical sessions in order to train half of the workforce at one time.
2. The course shall be an in-depth instruction on the CTG and Package equipment.
3. The course shall enable the Owner's operators to be proficient in the following topics, as a minimum:
    a. Startup, Normal Operation and shutdown of equipment.
    b. Response actions to hardware and software failures.
    c. Response to system alarms.
    d. Modifying and locating setpoints.
    e. Review interface to process control system.
    f. Control loop tuning concepts, strategies, and methods.

M. Provide certification in writing that this Training has been accomplished.

3.07 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this Specification.

1. Data Sheets.

END OF SECTION

SECTION 48 11 23
COMBUSTION TURBINE GENERATOR
SUPPLEMENT DATA SHEETS

Supplier shall furnish the performance data and utility requirements summarized in the following tables. In addition, Supplier shall provide a set of Performance Correction curves illustrating the impacts on CTG net power output and net heat rate of the following parameters as a minimum:

Ambient temperature
Ambient relative humidity
Intake pressure drop
Exhaust backpressure
Any other relevant parameters specific to Supplier's equipment

As an alternative, Supplier may furnish performance software (or access to Supplier's online software) which allows for calculation of unit performance corrections for parameters noted above.

Note: Supplier shall submit completed performance data sheets for the proposed CTG.

PERFORMANCE DATA		
LOAD POINT	100 Percent (Guarantee)	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	97.0ºF / 82.4 ºF	
TYPE OF FUEL	Natural Gas	
	Required	Submitted
NET POWER OUTPUT, kW	18K	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR (Guaranteed)	<25ppm	
CO, PPMV/LB/HR (Guaranteed)	<75ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	100 Percent (Low Ambient)	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	28.1°F / 24.8°F	
TYPE OF FUEL	Natural Gas	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	<25ppm	
CO, PPMV/LB/HR	<75ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG		
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	100 Percent (ISO)	
AMBIENT TEMPERATURE ºF, DB / WB	59°F / 51.5°F	
TYPE OF FUEL	Natural Gas	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	<25ppm	
CO, PPMV/LB/HR	<75ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT VENDOR INTERFACE, PSIG		
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	75 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Natural Gas	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	<25ppm	
CO, PPMV/LB/HR	<75ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	50 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Natural Gas	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	<25ppm	
CO, PPMV/LB/HR	<75ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	25 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Natural Gas	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	BY MFG	
CO, PPMV/LB/HR	BY MFG	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	100 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Diesel	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR (Guaranteed)	<65ppm	
CO, PPMV/LB/HR (Guaranteed)	<50ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	75 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Diesel	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	<65ppm	
CO, PPMV/LB/HR	<50ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	50 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Diesel	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	<65ppm	
CO, PPMV/LB/HR	<50ppm	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

PERFORMANCE DATA		
LOAD POINT	25 Percent	
AMBIENT TEMPERATURE ºF, DB/ºF, WB	59ºF / 51.5 ºF	
TYPE OF FUEL	Diesel	
	Required	Submitted
NET POWER OUTPUT, kW	BY MFG	
GROSS POWER OUTPUT, kW	BY MFG	
NET HEAT RATE (LHV) BTU/kW-hr	BY MFG	
FUEL FLOW, LB/HR	BY MFG	
FUEL FLOW, MMBTU/HR LHV	BY MFG	
INLET AIR MASS FLOW, LB/HR	BY MFG	
COMPRESSOR AIR INLET TEMPERATURE, ºF	BY MFG	
EXHAUST GAS MASS FLOW, LB/HR	BY MFG	
EXHAUST VOLUME FLOW, FT3/SEC	BY MFG	
EXHAUST TEMPERATURE, ºF	BY MFG	
EXHAUST HEAT, MMBTU/HR	BY MFG	
EXHAUST Cp, BTU/lbm- ºR	BY MFG	
INLET PRESSURE LOSS, IN H20	BY MFG	
EXHAUST PRESSURE LOSS, IN H2O - CTG PACKAGE	BY MFG	
EMISSIONS: (At turbine exhaust flange) Corrected to 15% O_2		
NOx, PPMV/LB/HR	BY MFG	
CO, PPMV/LB/HR	BY MFG	
UHC, PPMV/LB/HR	BY MFG	
VOC, PPMV/LB/HR	BY MFG	
PARTICULATE, LB/HR	BY MFG	
PM10, LB/HR	BY MFG	
OPACITY, PERCENT	BY MFG	
SO2, PPMB/LB/HR	BY MFG	
REQUIRED FUEL GAS PRESSURE AT CTG INTERFACE, PSIG	BY MFG	
	Start up	Normal Operating
AUXILIARY POWER REQUIREMENTS, KW (Respondent to identify and fill-in: attach separate sheet(s) if necessary)		

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SECTION 48 58 68
WELDING OF POWER PLANT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Specification includes welding and inspection requirements for shop fabrication and field installation of piping under ASME BPVC Section I or ASME B31.1.

B. This Specification does not include pipe welding performed for piping covered by other Specifications such as building services, drainage, or fire protection systems.

1.02 REFERENCES

A. The following is a list of codes and standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. B16.25, Butt Welding Ends.
   b. B31.1, Power Piping.
   c. BPVC Section I, Rules for Construction of Power Boilers.
   d. BPVC Section II, Materials Specifications.
   e. BPVC Section IX, Welding and Brazing Qualifications.
   f. BPVC Section V, Nondestructive Examination.
2. American Welding Society (AWS): QC 1, Standard for Certification of Welding Inspectors.
3. American Society of Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Non-destructive Testing.

1.03 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedure.

B. Action Submittals:

1. Welding procedures; including procedure qualification records.
2. Detailed written pre-heat and post-heat treatment procedures indicating method of heating (direct flame heating not to be used), locations of thermocouples/pyrometers, and method of recording temperatures.
3. Induction Bending procedure including post bending heat treatment procedure.
4. WPS includes information required by ASME BPVC Section IX.
5. PQR’s includes information required by ASME BPVC Section IX.
6. Visual inspector’s qualifications.

7. Nondestructive examination procedures.
8. Quality Control Plan.
9. Weld repair procedures.
10. Copy of Certificate(s) of Authorization for appropriate Code Symbol Stamp(s).
11. Filler metal product data. Show on welding procedure specification (WPS) and procedure qualification records by American Welding Society (AWS) classification, except that submerged arc wire and flux combinations shall be shown by AWS classification and manufacturers designation.
12. Preparation details for weld joint end preparation.

C. Informational Submittals:

1. Inspection, Test, and Examination Results.
2. Weld Maps.

D. Welding shall not begin until review and approval of documents required prior to start of fabrication is complete.

1.04 QUALITY ASSURANCE

A. Welding procedure specifications and procedure qualification records shall be in accordance with ASME Section IX as amended by ASME Section I or B31.1, as applicable.

B. Welder Qualifications:

1. Welders, welding operators, and brazers to be qualified in accordance with ASME BPVC Section IX as amended by ASME BPVC Section I or ASME B31.1.
2. Maintain certified copies of qualification records at shop facility or Site. Submit if requested.
3. Maintain welders' qualification log outlining range of each welder's qualifications and dates qualified.
4. Each qualified welder shall be assigned a unique and unduplicated identifying symbol or number. Individual welders shall exclusively employ their own identifying mark. In event welder is terminated or leaves before completion of Project, identifying mark shall be retired and shall not be reassigned to another welder.
5. Renew performance qualification of welder if welder has not used the process for 6 months or more. Refer to ASME BPVC Section IX for additional items affecting requalification.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handling and storage of electrodes and fluxes to be in accordance with requirements of ASME BPVC Section II, Part C and manufacturer's recommendations.

B. Low hydrogen electrodes to be provided in hermetically sealed containers. Once removed from hermetically sealed containers, store electrodes in holding ovens or portable heated rod caddies. Electrodes not stored accordingly shall be used within the time frame of 4 hours for E70XX electrodes or either discarded or rebaked in reconditioning ovens in accordance with ASME BPVC Section II Part C.

PART 2 PRODUCTS

2.01 MATERIALS

A. Filler Metal: Welding and brazing filler metals to meet requirements of ASME BPVC Section II, Part C.

B. Submerged arc fluxes that manufacturer recommends for single pass welds shall not be used for multiple pass welds, unless amperage and voltage restrictions are established to prevent excessive manganese and silicon content, and shall be approved by the Engineer.

C. When welding similar metals, deposited weld metal to match chemistry and mechanical properties of base metal as closely as possible.

D. When welding two different ferritic steels, filler metal to conform to steel with higher alloy contents.

1. When welding austenitic stainless to ferritic steels filler metal shall be:
   a. For service temperatures less than or equal to 500 degrees F ER309/E309 or ERNiCr-3/EniCrFe-3.
   b. For service over 500 degrees F filler metal to be ERNiCr-3/EniCrFe-3.
2. When welding nickel alloys to ferritic steels, filler metal to be ERNiCr-3/EniCrFe-3 unless otherwise approved by Engineer.

E. Unless specifically authorized by Engineer, filler metal is to be used only for primary material and process applications recommended in ASME material specification or by its manufacturer (e.g., filler metals designed for single pass welding shall not be used for multiple pass welds, filler metals designed for gas metal arc welding shall not be used for submerged arc welding, etc.).

F. For shielded metal arc welding, electrodes to be of low-hydrogen type when welding on either carbon steel or low alloy steels with exception that E6010 may be used for root pass welding on carbon steel pipe for service codes designated in the Power Plant Pipe Index.

2.02 FABRICATION

A. Gas Metal Arc (GMA) and Submerged Arc Welding (SAW) are acceptable only in specific shop applications and when approved by Engineer.

1. The short circuit transfer mode of gas metal arc welding process is not allowed.

B. Fabrication Controls:

1. Perform in accordance with ASME B31.1, ASME Section I, and this section.
2. Preheat in accordance with ASME BPVC Section I or ASME B31.1 as applicable and as amended herein.
3. Backing rings and consumable inserts shall not be used.
4. Longitudinal seams in adjoining lengths of welded pipe shall be staggered and located so not to intersect openings and external attachments.
5. Threaded connections welded into lines shall have threads “chased” after welding with proper size pipe tap to remove scale and weld spatter, and to ensure full engagement of threads and a tight joint.
6. Welded Joints: In accordance with Section 40 50 20, Aboveground Power Plant Piping, as applicable.
7. Use electric (resistance or induction) or gas heat sources that provide uniform application of heat over weld area on carbon steel and low alloy steel materials (direct flame heating not to be used). Check preheat and interpass temperatures using temperature indicating crayons, thermocouple, or contact or optical pyrometers with current calibration.
8. Maximum Interpass Temperature:
   a. Austenitic Stainless Steels and Nickel Alloys: 350 degrees F.
9. Maximum heating and cooling rates to be in accordance with ASME BPVC Section I and ASME B31.1.
10. Application of heat to correct weld distortion or dimensional deviation without written approval from Engineer is prohibited.
11. Austenitic Stainless Steel: The following requirements will apply when fabricating austenitic stainless steel or nickel alloy components:
    a. Fabricate stainless and nickel alloy pipe in a separate area from carbon and alloy steel pipe fabrication.
    b. Control tools used in fabrication in such a way as to minimize contact with steel alloys or free iron. Brushes shall be identified and controlled for stainless steel use only.

c. Perform grinding with resin or rubber bonded aluminum oxide or silicon carbide grinding wheels which are identified and controlled for their use on these materials only.
d. Block sequence welding and peening of welds are prohibited.
e. Acceptable cleaning solvents are new or redistilled acetone (acetone reclaimed by other methods shall not be used), alcohol (ethyl, methanol, or isopropanol), or toluene (toluol). Halogenated cleaning solvents shall not be used for cleaning or degreasing.

PART 3 EXECUTION

3.01 GENERAL

A. Maintain Welder Qualification Log in format as approved by Engineer.

B. No welding shall be performed until WPS's and PQR's have been approved by Engineer.

C. Safety measures for the protection of welders and operators involved in welding and cutting shall be in accordance with the practices specified in AWS Z49.1, plus all local, state, federal, and other governing regulations.

D. Remove scale, rust, dirt, or other foreign matter from ends of pipe before tacking or welding.

E. Clean pipe interior to remove dirt, debris, and other foreign matter before joints are aligned for welding.

F. Use caution in fitting up pipe and components for tack welding to ensure proper gap for full-penetration welds. Bridge tacks, if used, shall be removed.

G. Remove scale, slag, and other foreign material by chipping, grinding, and wire brushing after application of each bead. Observe interpass temperatures as required per WPS.

H. Welding Process:

1. Only shielded metal arc, gas tungsten arc, and flux cored arc welding will be permitted in the field.
2. Welds on pressure retaining joints (including socket welds) to be minimum of two passes. Root passes (including socket welds) on boiler proper welds or boiler external piping to be made with gas tungsten arc welding process.
3. Submerged arc multi-pass welding in carbon steels, and corrosion resistant steels shall use an essentially neutral flux.
4. Flux core arc welding of pressure retaining welds to be allowed only with an external shielding gas.
5. Manual gas tungsten arc welding shall be done with addition of filler metal.

6. Welding processes using coatings or flux not to be used for root pass welding on stainless steels, or nickel alloys unless slag can be removed from underside of root pass and area inspected.
7. Shielding and Purge Gases:
    a. When shielding gases are used, welding procedure specification shall indicate gas composition and flow rate.
    b. Stainless steels, nickel alloys, of 2 percent Cr or higher shall have root pass purged with Argon. Maintain purge until minimum of three passes have been completed. P22 piping may have root pass welded without purge when specifically approved by Engineer.

I. Repairs:

1. Basemetal:
    a. Repair of base metal shall be allowed only with prior written approval by Engineer.
    b. Should laminations or split ends be discovered in pipe, joints containing such defects shall be cut back to point where these defects no longer exist.
2. Arc Strike:
    a. Pipe that is arc burned during welding shall, at Engineer's option, be cut out and replaced in accordance with applicable WPS.
    b. Repair by grinding and welding.
    c. Inspect cavity by liquid penetrant or magnetic particle examination, as applicable.
    d. Weld per the WPS and verify minimum pipe wall thickness is maintained.
3. Weld Defect:
    a. Remove by flame, cutting, grinding, arc gouging, chipping, or machining.
    b. Inspect cavity by liquid penetrant or magnetic particle examination.
    c. Weld per approved WPS, unless otherwise approved by Engineer.
    d. Examination and inspection of completed weld repair shall be as required for original weld or Engineer's approved alternate method that provides equal or greater soundness of weld.

3.02 WELDING QUALITY CONTROL

A. Weld Inspection, Examination, and Testing:

1. Visual Examination: Welds to receive 100 percent visual examination and be documented.

2. Nondestructive Examination:
   a. Welds, as applicable shall be subjected to a nondestructive examination in accordance with ASME BPVC Section I or ASME B31.1. Records of examinations shall be available to Engineer upon request.
   b. Perform NDE (RT, UT, MT, and PT) as required in ASME BPVC Section I, and project specific requirements.
   c. Perform NDE as required by B31.1 and project specific requirements.
      1) NDE of welds in Carbon Steel piping may be performed before or after Post Weld Heat Treatment.
      2) Radiography of piping welds with 6 percent Chrome or less may be performed before or after Post Weld Heat Treatment. The completed weld shall be Magnetic Particle examined after Post Weld Heat Treatment.
      3) Acceptance Radiography of welds in P91 piping shall be performed after Post Weld Heat Treatment.
   d. Nondestructive examinations shall be documented in accordance with applicable code. Personnel performing nondestructive examinations to be qualified and certified in accordance with ASNT SNT-TC-1A.
   e. Engineer may order nondestructive examinations by independent testing laboratory in addition to those required by applicable codes. If weld is defective, laboratory cost, repair, and re-examination shall be at the expense of fabricator/Contractor. Acceptable standards shall be in accordance with applicable codes.
   f. Welding Inspectors: Personnel performing or supervising visual examination shall be qualified as Senior (SCWI) or Certified Welding Inspector (CWI) in accordance with AWS QC 1 or equivalent qualification approved by Engineer.
3. Provide records of inspection, NDE, PWHT, Hardness and other activities identified by the Engineer.
4. Retain records of inspection, nondestructive examination, post-weld heat treatment, hardness testing, material certification, radiographic film, and other records for 5 years after completion of Work.

END OF SECTION

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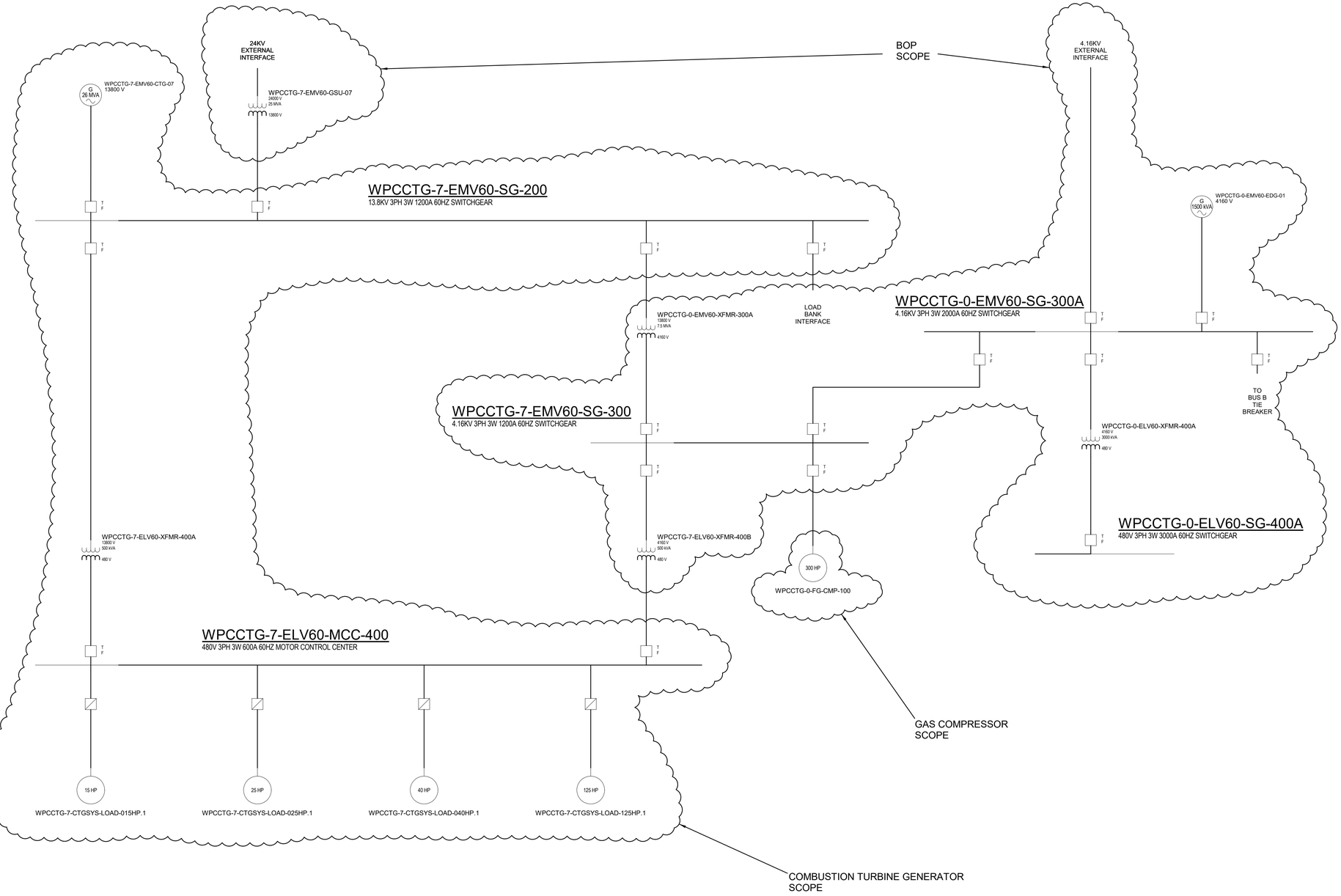
REFERENCE INFORMATION

1419-E-SK01
CTG-7 OVERALL ONE LINE DIAGRAM



NOTES:

1. * = REPLACE WITH CIRCUIT NUMBER.
2. UNLESS OTHERWISE NOTED ALL DEVICES ARE LOCATED IN PDB.
3.

REFERENCES:

SWBNO-E-A-001	ELECTRICAL LEGEND NOTES & SYMBOLS GENERAL
SWBNO-E-A-002	ELECTRICAL LEGEND NOTES & SYMBOLS NON-PHYSICAL
SWBNO-E-A-003	ELECTRICAL LEGEND NOTES & SYMBOLS PHYSICAL
SWBNO-E-S-<LTR>	CABLE SCHEDULE
SWBNO-E-S-<LTR>	ELECTRICAL EQUIPMENT / CIRCUIT LIST
SWBNO-E-S-<LTR>	PSS/PDCS INPUT/OUTPUT LIST

VENDOR REFERENCES:

VENDOR DRAWING

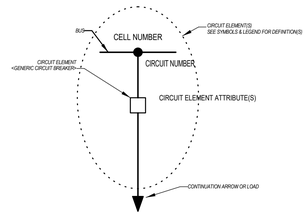
LEGEND:

BPT	BUS POTENTIAL TRANSFORMER
CT	CURRENT TRANSFORMER
SPD	SURGE PROTECTION DEVICE
SPT	SOURCE POTENTIAL TRANSFORMER
XFMR	TRANSFORMER
–	–
–	–
–	–

CIRCUIT NUMBER
EQUIPMENT NUMBER WITH DASHES REMOVED
SEE EQUIPMENT / CIRCUIT LIST FOR DETAILED CIRCUIT INFORMATION

CELL NUMBER
PDB BUS NUMBER SUFFIXED BY CELL ID

ONE LINE DIAGRAM CELL LAYOUT



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REV	DATE	DESCRIPTION	BY
A	6/18/2021	ISSUED FOR CLIENT REVIEW	YB

SEWERAGE AND WATER BOARD OF NEW ORLEANS

CONTRACT No. CP-1419

COMBUSTION TURBINE GENERATOR (UNIT 7)
HAZARD MITIGATION GRANT PROGRAM (HMGP)
MAIN WATER PURIFICATION PLANT WEST POWER COMPLEX

ELECTRICAL ONE LINE DIAGRAM -- SKETCH
WEST POWER COMPLEX COMUBSTION TURBINE GENERATION AREA
WPCCTG-7-EMV60-CTG-07 OVERALL ONE LINE

PROFESSIONAL ENGINEER
M YORK BROGDEN PE#

Jacobs
1555 POYDRAS STREET, SUITE 1625
NEW ORLEANS, LA 70112

JOB NO:	469936
DWG NO:	1419-WPCCTG-E-SK-01.02
DESIGNED BY:	Y BROGDEN
FILE NAME:	

DR:	Y BROGDEN
CK:	E WARF
AP:	S REISER
LAST EDIT:	
SCALE:	NONE
DATE:	JUNE 2021

DWG. No.

SET NO: SHEET NO: OF

CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

REFERENCE INFORMATION

1419-I-SK01A_Network Overview

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GENERAL SHEET NOTES

1. DIAGRAM IS FUNCTIONAL REPRESENTATION OF SYSTEM ARCHITECTURE. FINAL CONFIGURATION DEPENDENT UPON ACTUAL SYSTEM EQUIPMENT SELECTED.
2. FUNCTIONS MAY BE COMBINED WITH OTHERS ONLY IF SYSTEM REDUNDANCY & SECURITY FEATURES ARE MAINTAINED.
3. REFER TO SPECIFICATIONS FOR DETAILED DESCRIPTION OF THE PROCESS SCADA SYSTEM, MATERIALS AND METHODS FOR CONSTRUCTION.
4. ACTIVE SECURITY/AUTHENTICATION, NETWORK SECURITY MANAGER, AND DOMAIN CONTROLLER ARE WITHIN SWBNO'S ENTERPRISE SYSTEM.
5. ITEMS SHOWN ON LEVEL 2 AND ABOVE ARE CONCEPTUAL ONLY.
6. ITEMS SHOWN BOLD ARE PART OF CTG SCOPE (CP-1419).

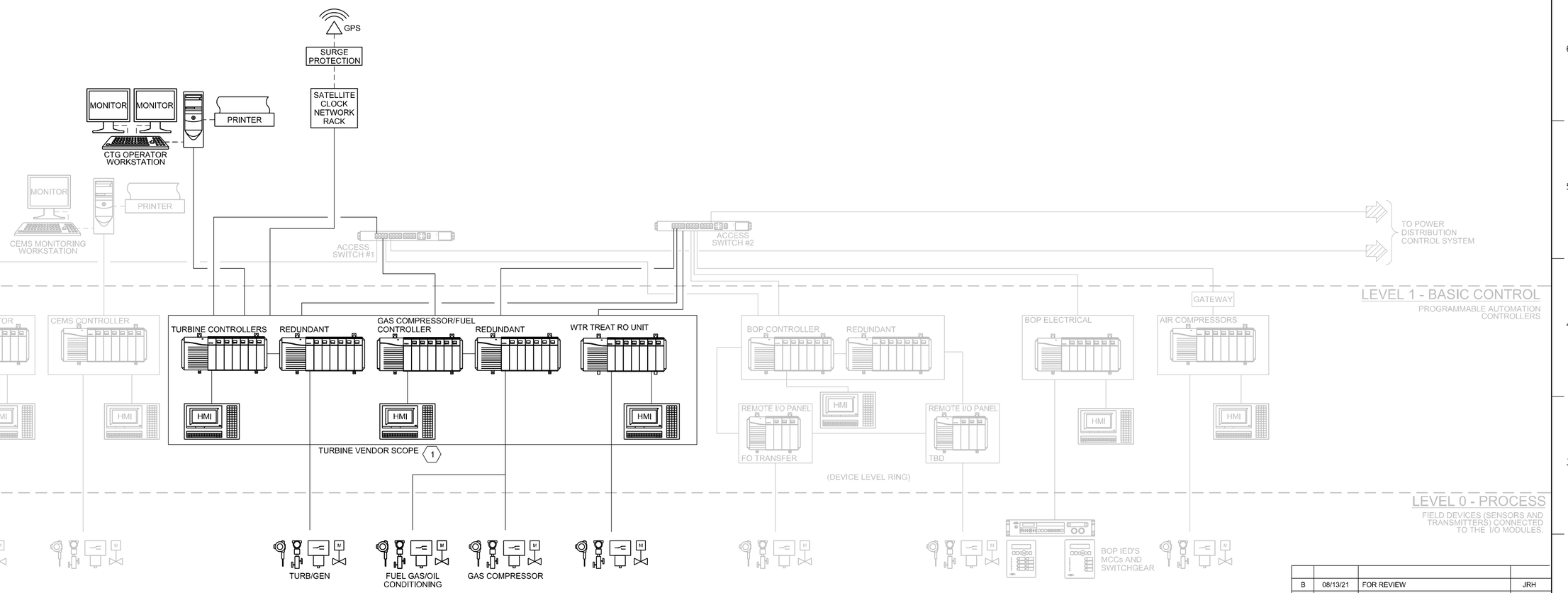
SHEET KEYNOTES

1. CONFIGURATION SHOWN IS CONCEPTUAL ONLY ACTUAL CONFIGURATION BY CTG VENDOR.

LEVEL 4-5 - ENTERPRISE
ENTERPRISE LEVEL APPLICATIONS AND ACCESS TO THE INTERNET.

DEMILITARIZED ZONE (DMZ)
FIREWALLS FOR SEGMENTATION, INTER-ZONE TRAFFIC CONTROL, DATA SHARING VIA REPLICATION / TERMINAL SERVICES.

LEVEL 2/3 - OPERATIONAL/SUPERVISORY CONTROL
NETWORK AND SECURITY MANAGEMENT (AUTHENTICATION, USER ACCESS), SYSTEM APPLICATIONS, CONTROL ROOM WORKSTATIONS.



REV.	DATE	DESCRIPTION	BY
B	08/13/21	FOR REVIEW	JRH
A	06/18/21	FOR REVIEW	JRH

SEWERAGE AND WATER BOARD OF NEW ORLEANS

CONTRACT No. 1419
TURBINE 7 DESIGN
CTG-7 EQUIPMENT PROCUREMENT

INSTRUMENTATION AND CONTROL

WEST POWER COMPLEX PROCESS SCADA SYSTEM CONCEPTUAL NETWORK DIAGRAM

Jacobs

DR:	A PASTRANA
CK:	J BEAUDRY
AP:	SEALNAME
LAST EDIT:	2021\08\24
SCALE:	NTS
DATE:	MAY 2021
SET NO:	CUSTOM1
SHEET NO:	ShtNum ShtTot

DATE | JOB NO. D3483600
DESIGNED BY: J HANDWORK
FILE NAME: 1419-I-SK01A_D3483600.dgn

DWG. No. 1419-N-SK01A

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PRELIMINARY DESIGN

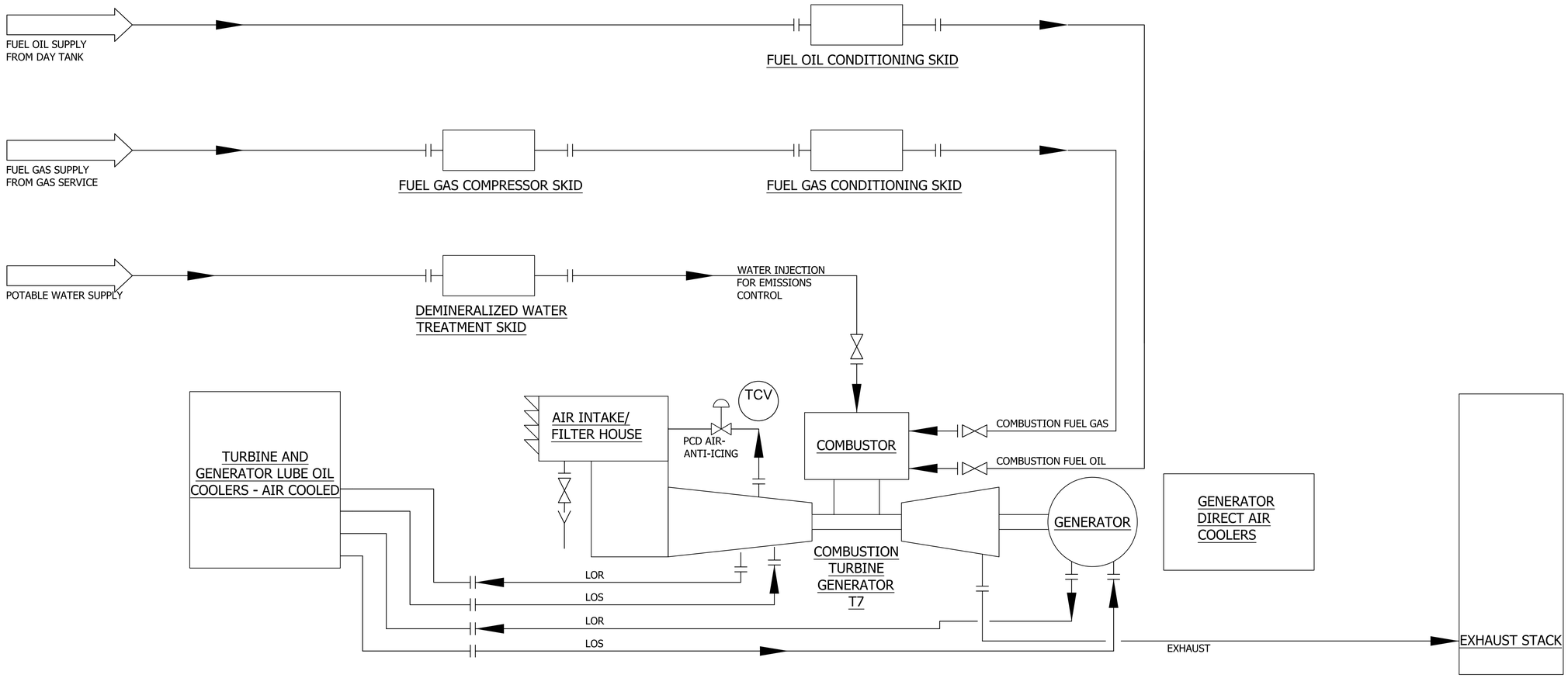
$PWPATH

PLOT TIME: 8:51:06 AM

REFERENCE INFORMATION

1419-M-SK01_PFD

NOTES:
1. DRAWING IS INTENDED TO DEFINE THE BASIC SCOPE. ADDITIONAL COMPONENTS MAY BE REQUIRED TO MEET THE SPECIFICATION.



REV.	DATE	DESCRIPTION	BY
B	8/26/21	FOR REVIEW	BJH
A	6/18/21	FOR REVIEW	BJH

SEWERAGE AND WATER BOARD OF NEW ORLEANS

CONTRACT No. CP-1419

COMBUSTION TURBINE GENERATOR (UNIT 7)
MAIN WATER PURIFICATION PLANT WEST POWER COMPLEX

PROCESS FLOW DIAGRAM
WEST POWER COMPLEX COMBUSTION TURBINE GENERATION AREA

Jacobs

DR:	B. HALL		
CK:	B. ROMERO		
AP:			
LAST EDIT:	$PLOTDATE	1419-M-SK01	
SCALE:			
DATE	AUGUST 26, 2021	SET NO:	SHEET NO: 1 OF 1

DATE	8/26/21	JOB NO.	D3483600
DESIGNED BY:	B. HALL		
FILE NAME:			

PRELIMINARY DESIGN

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

REFERENCE INFORMATION

GENERAL ARRANGEMENT SKETCH

Scale : 1" = 30'

CENTERLINE OF LEVEE

TOP OF SLOPE

TOE OF SLOPE

TOP OF SLOPE (ELEV. 12 FT)

TOE OF SLOPE

APPROXIMATE DISTANCE FROM PROPOSED SITE TO NEAREST RESIDENCE 237'–0"

PROPOSED AREA FOR STATIC FREQUENCY CONVERTER EQUIPMENT

CMP DETENTION SYSTEM (UNDERGROUND)

CMP DETENTION SYSTEM (UNDERGROUND)

PROPOSED HIGH VOLTAGE AREA

PROPOSED LOW VOLTAGE AREA

50'–0"

150'–0"

110'–0"

PROPOSED AREA FOR T7 AND AUXILIARIES (GROUND ELEVATION 4 FT.)

90'–0"

SWBNO DISTRIBUTION SUBSTATION AND OPERATIONS CENTER

CENTERLINE OF PASSAGE

LEGEND: WEST POWER COMPLEX AREA SKETCH

- 60HZ GENERATION AND AUXILIARIES
- SFC EQUIPMENT AREA
- UTILITY SUBSTATION AREA

LEGEND:

- — — — DRAINAGE BOUNDARY

REV.	DATE	DESCRIPTION	BY
B	8/26/21	FOR REVIEW	BJH
A	6/18/21	FOR REVIEW	BJH

SEWERAGE AND WATER BOARD OF NEW ORLEANS

CONTRACT No. CP-1419

COMBUSTION TURBINE GENERATOR (UNIT 7)
MAIN WATER PURIFICATION PLANT WEST POWER COMPLEX

SITE LAYOUT
WEST POWER COMPLEX COMBUSTION TURBINE GENERATION AREA

Jacobs

DATE	8/26/21	JOB NO.	D3483600
DESIGNED BY:	B. HALL		
FILE NAME:			

DR: B. HALL
CK: B. ROMERO
AP:
LAST EDIT: $PLOTDATE
SCALE:
DATE: AUGUST 26, 2021
SET NO:
SHEET NO: 1 OF 1

1419-M-SK02

PRELIMINARY DESIGN

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

REFERENCE INFORMATION

1419-M-SK03A
HIGH PRESSURE FUEL GAS
FUEL ANALYSIS

Element Material Technology
2129 West Willow Street
Scott, LA
70583-5301 USA

P 337 232 3568
F 337 232 3621
T 888 786 7555
info.scott@element.com
element.com

Gas Analysis Report No: 261317-5 -18

Date: 3/30/2021

For: ENTERGY OPERATIONS
Attn: MATTHEW LONG
1600 PERDIDO STREET
NEW ORLEANS , LA 70113

Sample Identification:
Company: ENTERGY OPERATIONS
Field: NP
Lease: C. G. 1
STA # : NP

Sample Data: Date: 3/8/2021 By: C.W.
PSIG: 200 Temp: 60 DEG. F. DP: 1.0 LBS H20

Remarks: H2S (DETERMINED IN FIELD) = 0.0 PPM

CYL #: 18

Sample Type: COMPOSITE

Hydrocarbon Analysis - Method GPA 2261-13 Lab Analyst: TS

Component Name		Mol Percent	GPM @ 15.025 PSIA
Carbon Dioxide	(CO2)	0.951	
Nitrogen	(N2)	0.297	
Methane	(C1)	96.890	
Ethane	(C2)	1.586	0.434
Propane	(C3)	0.172	0.048
Iso-Butane	(IC4)	0.038	0.013
N-Butane	(NC4)	0.031	0.010
Iso-Pentane	(IC5)	0.012	0.005
N-Pentane	(NC5)	0.007	0.003
Hexanes Plus	(C6+)	0.016	0.007
Total		100.000	

Mol Weight: 16.67
BTU/LB: 23104.68

Ethane + GPM: 0.520
Propane + GPM: 0.086
Iso-Pentane + GPM: 0.015

Compressibility Factor: 0.9979
Specific Gravity @ 60 Deg. F. (Air = 1) : 0.576

BTU/Cuft. (Real) 60 Deg. F. - PSIA:	14.650	14.696	14.730	15.025
Dry:	1013.8	1017.0	1019.3	1039.8
Sat:	996.4	999.6	1001.9	1022.0
ACT	1013.7	1016.9	1019.3	1039.7

Tina Venable, Customer Service Representative

Testing performed by Element Materials Technology Scott :: 2129 W. Willow St., Scott, LA 70583 :: 337-232-3568
This document shall not be reproduced, except in full, without the approval of the testing laboratory. Our letters and reports apply only to the sample tested and/or inspected, and are not indicative of the quantities of apparently identical or similar products.

REFERENCE INFORMATION

1419-M-SK03B
LOW PRESSURE FUEL GAS
FUEL ANALYSIS

Element Material Technology
2129 West Willow Street
Scott, LA
70583-5301 USA

P 337 232 3568
F 337 232 3621
T 888 786 7555
info.scott@element.com
element.com

Gas Analysis Report No: 258423-4 -6

Date: 12/28/2020

For: ENTERGY OPERATIONS
Attn: MATTHEW LONG
1600 PERDIDO STREET
NEW ORLEANS , LA 70113

Sample Identification:
Company: ENTERGY OPERATIONS
Field: NP
Lease: C. G. 15
STA # : NP

Sample Data: Date: 12/14/2020 By: SASEVADO
PSIG: 80 Temp: 62 DEG. F. DP: 0.0 LBS H20

Remarks: H2S (DETERMINED IN FIELD) = 0.0 PPM

CYL #: 21

Sample Type: COMPOSITE

Hydrocarbon Analysis - Method GPA 2261-13 Lab Analyst: AR

Component Name		Mol Percent	GPM @ 15.025 PSIA
Carbon Dioxide	(CO2)	0.969	
Nitrogen	(N2)	1.876	
Methane	(C1)	94.337	
Ethane	(C2)	2.685	0.734
Propane	(C3)	0.101	0.028
Iso-Butane	(IC4)	0.012	0.004
N-Butane	(NC4)	0.013	0.004
Iso-Pentane	(IC5)	0.004	0.002
N-Pentane	(NC5)	0.003	0.001
Hexanes Plus	(C6+)	0.000	0.000
Total		100.000	

Mol Weight: 16.96
BTU/LB: 22466.32

Ethane + GPM: 0.773
Propane + GPM: 0.039
Iso-Pentane + GPM: 0.003

Compressibility Factor: 0.9979
Specific Gravity @ 60 Deg. F. (Air = 1) : 0.587

BTU/Cuft. (Real) 60 Deg. F. - PSIA:	14.650	14.696	14.730	15.025
Dry:	1002.9	1006.1	1008.4	1028.6
Sat:	985.7	988.8	991.1	1011.0
ACT	1002.9	1006.1	1008.4	1028.6

Tina Venable, Customer Service Representative

Testing performed by Element Materials Technology Scott :: 2129 W. Willow St., Scott, LA 70583 :: 337-232-3568
This document shall not be reproduced, except in full, without the approval of the testing laboratory. Our letters and reports apply only to the sample tested and/or inspected, and are not indicative of the quantities of apparently identical or similar products.

REFERENCE INFORMATION

1419-M-SK03C
NO 2 FUEL OIL
FUEL ANALYSIS

Marathon Petroleum Company LP

Product: No. 2 Diesel Fuel / Heating Oil
Grade:

Certificate of Analysis
Louisiana Refining Division

4663 West Airline Highway
Garyville , LA 70051
Phone No: (985) 535-2100
Fax No: (504) 535-7445
Date: 3/4/2021 3:13:44 PM

Sample Description:	GVL: TK 300-8	**Sample Date:**	3/3/2021 12:01:00 AM
Tank:	300-8	**Date Analyses Completed:**	3/3/2021 4:51:51 AM
Batch Number:	ULD210062	**LIMS ID:**	4780645
Railcar #:			

2MV15

Test Method	Property	Result	Units	Lower Limit	Upper Limit
D4176	Appearance (at 77F)	Clear and Bright			Clear and Bright
D4176	Workmanship (at 77F)	Pass			Pass
D4176	Visual Particulates (at 77F)	L 0			L 10
D6304	Moisture	24	wt. ppm		400
Physical Properties					
D4052	API Gravity (at 60F)	38.5	deg.	30.0	
D445	Viscosity at 104F (40C)	2.3	cSt	1.9	4.1
D93A	Flash Point	148	deg. F	140	
D130	Copper Strip Corrosion	1A			1B
TM0172-86	NACE Corrosion - Note: This statistical result was dated 3/01/2021	*A*			B+
D6468	Thermal Stability (90 minute aging) - Note: This statistical result was dated 3/01/2021	*96*	%	80	
D6045	ASTM Color	<1.0			2.5
D4176	Colonial Haze Rating (at 77F)	1			2
D2624	Conductivity	37	ps/m	25	250
	Conductivity Test Temperature	70	deg. F		
D482	Ash - Note: This statistical result was dated 3/01/2021	*<0.010*	wt. %		0.01
Chemical Analyses					
D5453	Sulfur	7.4	wt. ppm		11
D524	Carbon Residue, 10% Bottoms - Note: This statistical result was dated 3/01/2021	*0.05*	wt. %		0.35
D976	Cetane Index (2 var) [3]	49.5		40.0	
Distillation					
D86 Predicted	50%	484	deg. F		
D86 Predicted	90%	600	deg. F	540	640
D86 Predicted	FBP	657	deg. F		690
Cold Flow Properties					
D5773	Cloud Point	1	deg. F		15
D5949	Pour Point	-11	deg. F		0
Combustion Properties					
D4737A	Cetane Calc. (4 var) LSD	49.7		40.0	
Quality					
	Homogeneity	Pass			

[1] Pre-dated analyses are performed on a statistical basis.
[2] Testing reflected on this COA could have been performed by another MPC Laboratory or authorized independent lab. Specific information is available upon request.
[3] D976 can be < 40 provided Aromatics by D1319 is <= 35%

Reviewed By:
Cass Stevens
Shift Foreman
LRD-Prod Cntrl-Laboratory-Shift D
(51221943)
985-535-7875

Signed

Reviewed By:
Jing Liang
Refining Engineer II
LRD-Prod Cntrl-Economics & Planning
(50453565)
985-535-7981

Signed

Marathon Petroleum Company LP

Certificate of Analysis

Louisiana Refining Division

4663 West Airline Highway
Garyville , LA 70051
Phone No: (985) 535-2100
Fax No: (504) 535-7445
Date: 4/20/2020 5:37:02 PM

Product: No. 2 Diesel Fuel / Heating Oil
Grade:

Sample Description:	GVL: TK 300-18	**Sample Date:**	4/20/2020 8:30:00 AM
Tank:	300-18	**Date Analyses Completed:**	4/20/2020 2:02:37 PM
Batch Number:	ULD200078	**LIMS ID:**	3912879
Railcar #:			

2MV15

Test Method	Property	Result	Units	Lower Limit	Upper Limit
D4176	Appearance (at 77F)	Clear and Bright			Clear and Bright
D4176	Workmanship (at 77F)	Pass			Pass
D4176	Visual Particulates (at 77F)	L 0.5			L 10
D6304	Moisture	42	wt. ppm		400
Physical Properties					
D4052	API Gravity (at 60F)	38.0	deg.	30.0	
D445	Viscosity at 104F (40C)	2.5	cSt	1.9	4.1
D93A	Flash Point	146	deg. F	140	
D130	Copper Strip Corrosion	1A			1B
TM0172-86	NACE Corrosion - Note: This statistical result was dated 4/12/2020	*A*			B+
D6468	Thermal Stability (90 minute aging) - Note: This statistical result was dated 4/12/2020	*99*	%	80	
D6045	ASTM Color	0.5			2.5
D4176	Colonial Haze Rating (at 77F)	1			2
D2624	Conductivity	54	ps/m	25	250
	Conductivity Test Temperature	70	deg. F		
D482	Ash - Note: This statistical result was dated 4/12/2020	*<0.001*	wt. %		0.0100
Chemical Analyses					
D5453	Sulfur	8.2	wt. ppm		11
D524	Carbon Residue, 10% Bottoms - Note: This statistical result was dated 4/12/2020	*0.06*	wt. %		0.35
D976	Cetane Index (2 var) [3]	50.7		40.0	
Distillation					
D86 Predicted	50%	499	deg. F		
D86 Predicted	90%	627	deg. F	540	640
D86 Predicted	FBP	682	deg. F		690
Cold Flow Properties					
D5773	Cloud Point	12	deg. F		20
D5949	Pour Point	0	deg. F		10
Combustion Properties					
D4737A	Cetane Calc. (4 var) LSD	50.6		40.0	
Quality					
	Homog(Sulf)	Pass			Pass

[1] Pre-dated analyses are performed on a statistical basis.
[2] Testing reflected on this COA could have been performed by another MPC Laboratory or authorized independent lab. Specific information is available upon request.
[3] D976 can be < 40 provided Aromatics by D1319 is <= 35%

Reviewed By:
Chad Bankston
Laboratory Foreman
Louisiana Ref-Laboratory (50379240)
985-535-7875

Chad Bankston
Signed

Reviewed By:
Chad Bankston
Laboratory Foreman
Louisiana Ref-Laboratory (50379240)
985-535-7875

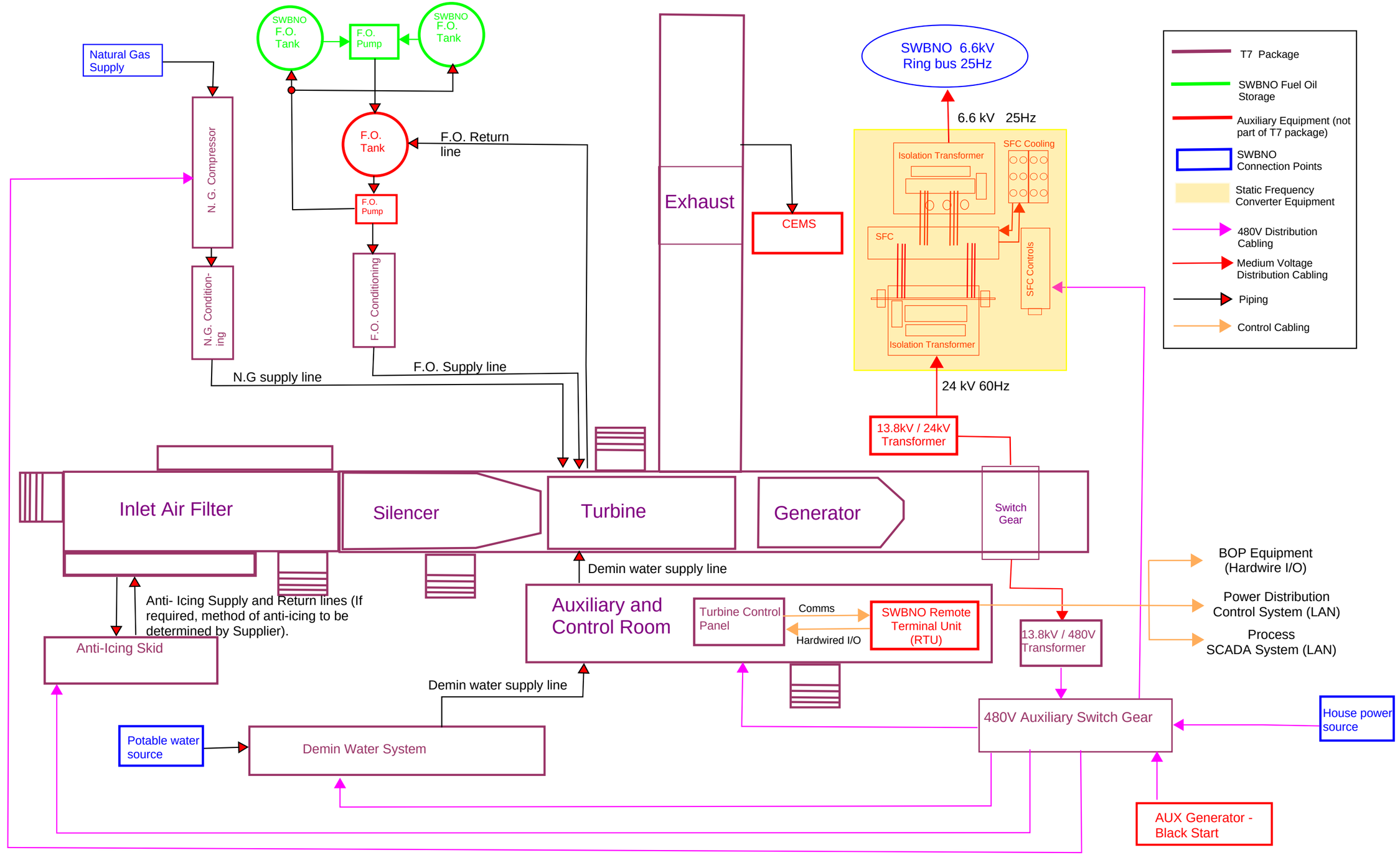
Chad Bankston
Signed

REFERENCE INFORMATION

1419-M-SK04
T7 INTERCONNECT SKETCH

1419-M-SK04
Interconnect Sketch
Revision B, 08/26/21

Jacobs



REFERENCE INFORMATION

1419-M-SK05
RAW (POTABLE) WATER ANALYSIS

SEWERAGE AND WATER BOARD OF NEW ORLEANS

TABLE VII

FIVE YEAR ANALYSIS COMPOSITE DATA (2016 - 2020) FOR NEW ORLEANS CARROLLTON DRINKING WATER PURIFICATION SYSTEM

PARAMETER	MISSISSIPPI RIVER (Before Purification)			FINISHED WATER (After Purification)		
	MAX	MIN	AVG	MAX	MIN	AVG
Total Alkalininty (ppm as $CaCO_3$)	201	65	121	210	82	134
Total Hardness (ppm as $CaCO_3$)	272	100	158	300	116	181
Noncarbonate Hardness (ppm as $CaCO_3$)	86	12	38	104	14	46
Calcium Hardness (ppm as $CaCO_3$)	167	40	101	200	90	124
Magnesium Hardness (ppm as $CaCO_3$)	118	22	52	151	14	56
Nephelometric Turbidity (NTU)	345	6.2	61	0.28	0.02	0.11
pH	8.34	6.88	7.73	9.41	7.76	8.91
Chloride (ppm)	50	14	27	58	19	30
Fluoride (ppm)	0.34	0.10	0.19	0.95	0.26	0.71
Total Dissolved Solids (ppm)	298	13	142	325	192	255
Total Suspended Solids (ppm)	266	19	149	------	------	------
Free Chlorine Residual (ppm as Cl_2)	------	------	------	0.6	0.0	0.1
Total Chlorine Residual (ppm as Cl_2)	------	------	------	5.0	0.0	3.3
Ammonia (ppm as N)	------	------	------	0.37	0.02	0.14
Nitrate + Nitrite (ppm as N) *	------	------	------	2.3	1.0	1.6
Sulfate (ppm) *	------	------	------	54.0	34.6	43.8
Conductivity (µS/cm)	685	238	443	700	244	494
Temperature (°F)	88	40	66	93	52	74
Aluminum (ppm) *	------	------	------	0.06	0.00	0.04
Antimony (ppm) *	------	------	------	0.000	0.000	0.000
Arsenic (ppm) *	------	------	------	0.001	0.000	0.000
Barium (ppm) *	------	------	------	0.1	0.0	0.1
Beryllium (ppm) *	------	------	------	0.000	0.000	0.000
Cadmium (ppm) *	------	------	------	0.000	0.000	0.000
Chromium (ppm) *	------	------	------	0.000	0.000	0.000
Copper (ppm) *	------	------	------	0.2	0.0	0.0
Iron (ppm) *	------	------	------	0.01	0.00	0.00
Lead (ppm) *	------	------	------	0.026	0.000	0.004
Manganese (ppm) *	------	------	------	0.00	0.00	0.00
Mercury (ppm) *	------	------	------	0.000	0.000	0.000
Nickel (ppm) *	------	------	------	0.0	0.0	0.0
Selenium (ppm) *	------	------	------	0.001	0.000	0.000
Silver (ppm) *	------	------	------	0.02	0.00	0.00
Thallium (ppm) *	------	------	------	0.000	0.000	0.000
Zinc (ppm) *	------	------	------	0.0	0.0	0.0
Potassium (ppm) *	------	------	------	4.0	2.6	3.0
Sodium (ppm) *	------	------	------	31.0	17.5	21.9
Cyanide (ppm) *	------	------	------	0.00	0.00	0.00
Haloacetic Acids (HAA5) (ppb) *	------	------	------	59.0	5.4	22.2
Total Organic Carbon (ppm) *	4.9	2.8	3.6	4.2	1.7	2.8
Total Trihalomethanes (ppb)	2.0	0.0	0.0	56.9	6.4	22.7
1,2-Dichloroethane (ppb)	0.0	0.0	0.0	0.0	0.0	0.0
Chloroform (ppb)	2.0	0.0	0.0	43.4	5.0	16.0
Carbon Tetrachloride (ppb)	0.0	0.0	0.0	4.0	0.0	0.0
Bromodichloromethane (ppb)	0.0	0.0	0.0	19.1	0.4	5.6
Tetrachloroethene (ppb)	0.0	0.0	0.0	0.8	0.0	0.0
BTX (Benzene, Toluene & Xylenes) (ppb)	7.4	0.0	0.0	1.1	0.0	0.0
Total Coliforms (CFUs/100 ml)	5700	28	604	200	0	0
E. coli (CFUs/100 ml)	------	------	------	0	0	0

The results for constituents indicated with asterisks are from the Louisiana Department of Health or an LDH certified contract laboratory.
All other results are from testing by the S&WB Water Quality Laboratory.
Lead and Copper results are from 2016 and 2019 Lead and Copper Rule compliance testing.
Concerning the chemical results, the S&WB Laboratory does not meet the higher criteria required by DHH to be classified as a "DHH-OPH *Certified* Chemical Laboratory/Drinking Water;" therefore, any results reported by this laboratory for chemical drinking water parameters which are required to be analyzed in a certified laboratory are officially deemed invalid.
The S&WB Laboratory is certified by DHH for Total Coliform and E. coli testing.