REQUEST FOR PROPOSAL

Grid Control System (GCS)

Solicitation # 2024-SWB-97

Proposal Due Date: November 12, 2024
Proposal Due Time: 11:00 AM CST

Sewerage and Water Board of New Orleans
Request for Proposal
Grid Control System (GCS)

The Sewerage and Water Board New Orleans (SWBNO) intends to acquire a Grid Control System (GCS) designed for use with SWBNO's electrical distribution assets within Orleans Parish, Louisiana. SWBNO is soliciting proposals from qualified vendors to provide a GCS.

RFP will be available **October 14, 2024** for download at the following websites:
SWBNO: https://www2.swbno.org/business_bidspecifications.asp
LAPAC: https://wwwcfprd.doa.louisiana.gov/OSP/LaPAC/dspBid.cfm?search=department&term=181

An **optional** pre-bid conference for this RFP will be held on **October 22, 2024** at **10:00 am CST** at the SWBNO Carrollton Water Plant Auditorium Room E202, 8800 S Claiborne Ave., New Orleans, LA 70118 or if you are unable to attend this in-person meeting, you can also join via teleconference call:

Microsoft Teams meeting

Microsoft Teams

Join the meeting now

Meeting ID: 256 154 191 12
Passcode: cLYAkL

Dial in by phone
+1 504-224-8698,,724309807# United States, New Orleans
Find a local number
Phone conference ID: 724 309 807#

At this meeting, staff will discuss the scope of work, proposal requirements and respond to questions from the attendees. A **voluntary** walkthrough of the equipment will follow at **01:00pm.** Location of walkthrough will be at the **SWBNO Carrollton Water Plant, 8800 S. Claiborne Ave., New Orleans, LA 70118**. Representatives of Owner and Engineer will be present to discuss the Project.

Inquiries and/or Requests for Clarification are due to **Connor Metcalf, on November 4, 2024, no later than 5:00 pm CST** via in writing or email to cmetcalf@swbno.org. All responses will be posted on or before **November 8, 2024.**

Proposals will be received by the Sewerage and Water Board of New Orleans Procurement Department by **November 12, 2024 at 11:00 am** local time. For submission instructions, see proposal documents.

LATE PROPOSALS WILL NOT BE ACCEPTED.

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PART I. ADMINISTRATIVE INFORMATION

1.1 Request for Proposals

SWBNO is soliciting proposals from qualified vendors to provide a Grid Control System (GCS), including configuration of system to meet SWBNO specific needs and integration/deployment of new system, as well as furnishing, installation, and commissioning of required hardware for the GCS.

1.2 Proposal Preparation

Proposals submitted for consideration should follow the format and order of presentation provided in Part IV - Proposal Submission Requirements.

1.3 Point of Contact/ Inquiries/ Requests for Information:

All correspondence and other communications regarding this RFP shall be directed to **Connor Metcalf, Procurement Specialist** , Sewerage and Water Board of New Orleans, 625 St. Joseph Street, Room 133, New Orleans, Louisiana 70165, **504-585-2428, cmetcalf@swbno.org**.

Inquiries and/or Requests for Information are due to the Board's Procurement Department via email to cmetcalf@swbno.org no later than timeline stated in the **Anticipated Proposal Timetable** . Any request received after that time may not be reviewed for inclusion in this RFP. The request shall contain the requester's name, address, and telephone number.

The Procurement Department will issue a response to any inquiry if it deems it necessary, by written addendum to the RFP, posted on Board's website, and issued prior to the RFP's Delivery Deadline. The Respondents shall not rely on any representation, statement or explanation other than those made in this RFP or in any addenda issued. Where there appears to be a conflict between this RFP and any addendum issued, the last addendum issued will prevail.

1.4 Questions and Answers

Inquiries and/or Requests for Clarification are due to **Connor Metcalf, on November 4, 2024, no later than 5:00 pm CST** via in writing or email to cmetcalf@swbno.org. All responses will be posted on or before **November 8, 2024.** Do not contact other SWBNO program personnel with questions regarding this RFP.

The Procurement Department will issue a response to any inquiry if it deems it necessary, by written addendum to the RFP, posted on SWBNO's website, and issued prior to the RFP's Delivery Deadline. The Proposers shall not rely on any representation, statement or explanation other than those made in this RFP or in any addenda issued. Where there appears to be a conflict between this RFP and any addendum issued, the last addendum issued will prevail.

1.5 Submission of Proposals

Proposers who are interested in providing services requested under this RFP can submit via email.

Ways to submit a response:

Electronic Submission:

(1) Digitally signed technical proposal and (1) digitally signed cost proposal in searchable PDF format to **bids@swbno.org**

Subject Line: **2024-SWB-97 Grid Control System (GCS)** [Proposer Name]".

If the file size of the email submission exceeds server requirements, the email submission may be broken into smaller emails with "Part 1 of #" included at the end of each original Subject Line (e.g. RFP# marked "**Installation and Implementation of a Grid Control System (GCS)**– [Proposer Name] – Part 1 of 3)".

Email: If the Proposer intends to submit the response by email, the date and time of the email received by the Procurement Dept. constitutes the time stamp of receipt. The date and time of the email sent by Vendor does NOT constitute a proof of receipt. The Procurement Dept. encourages Vendors to confirm that the response was received timely.

Board assumes no liability for assuring accurate/complete e-mail transmission and receipt. The responsibility solely lies with each Proposer to ensure their proposal is received at the specified email address prior to the deadline for submission. Proposals received after the deadline, corrupted files, and incomplete submissions (e.g. Part 1 and Part 2 of 3 are received, but Part 3 is not) will not be considered.

Fax submission will not be acceptable. Proposers e-mailing their proposals should allow sufficient time to ensure receipt of their proposal by the time specified.

Proposers must complete all required attachments and submit along with proposal submission. Failure to complete and submit the required documents and attachments may result in your proposal deemed non-responsive.

Proposals should clearly demonstrate the Proposer's qualifications to perform the needed services and attend all factors applicable in a professional relationship.

All proposals must be received by Board on or before the Delivery Deadline. Proposals delivered after the said deadline will not be accepted.

1.6 Changes, Addendum, or Withdrawal of Proposals

Any changes or addenda to a proposal must be submitted in writing, signed by an authorized representative of the proposer, cross-referenced clearly to the relevant proposal section, and received by SWBNO prior to the proposal due date and time. All changes and addenda must meet all requirements for the proposal. Any proposer choosing to withdraw its proposal must submit a written withdrawal request to SWBNO prior to the proposal due date and time.

The Board reserves the right to reject any and all responses to the RFP (with reasonable explanation) and/or to waive any informalities in evaluating the RFP responses if it deems this to be in the best interest of the Board, its customers, and the general public. The Board reserves the right to qualify Proposers as it deems in its best interest.

1.7 Prohibition of Communication

From the time of advertising, and until the final award, there is a prohibition on communication by Respondents (or anyone on their behalf) with Board's staff, Selection Committee members and elected officials. This does not

apply to oral presentations before selection committees, contract negotiations, or communications at any time with any Board employee or elected official regarding matters not concerning this RFP. Breaking the established prohibition on communication may result in a disqualification of the proposal.

1.8 Ownership

All Responses, including any submitted documents, to this RFP or any resulting solicitation are the property of the Board for all purposes. Respondents must clearly mark individual documents or information that the applicant claims are exempt from public record disclosure and specifically justify the exemption. The Board does not guarantee the confidentiality of submissions.

1.9 Effect

This RFP and any related discussions, evaluations, qualifications, or resulting solicitations by the Board or any person on its behalf create no rights or obligations whatsoever except as provided in this RFP. The Board may cancel or modify this RFP or any resulting solicitation at any time at will, with or without notice. Anything to the contrary notwithstanding, any professional services agreement executed by the Board will be issued the exclusive statement of rights and obligations extending from this solicitation.

1.10 Errors or Omissions

The Board will not be liable for any error in any proposal. Respondent will not be allowed to alter proposal documents after the deadline for proposal submission, except under the following condition: The Board reserves the right to make corrections or clarifications due to patent errors identified in proposals by the Board or the Respondent. The Board, at its option, has the right to require clarification or additional information from the Respondent.

1.11 Cost of Preparation

The Board is not liable for any costs incurred by prospective Respondents or Contractors prior to issuance of or entering into a Contract. Costs associated with developing the proposal, preparing for oral presentations, and any other expenses incurred by the Respondent in responding to the RFP are entirely the responsibility of the Respondent, and shall not be reimbursed in any manner by the Board.

1.12 RFP Schedule Summary

The events and dates summarized in Table 1 represent milestones in SWBNO's RFP process; however, SWBNO reserves the right to deviate from this schedule.

Table 1. Anticipated RFP Schedule Summary

Event	Date	Local Time
RFP Release	October 14, 2024	
Non -Mandatory Pre-Proposal Meeting	October 22, 2024	10:00am
Deadline for SWBNO receipt of written questions from prospective proposers	November 4, 2024	5:00pm
Responses to questions/clarification	November 8, 2024	
Proposal due date and time	November 12, 2024	11:00am
Evaluation Committee meeting, open to public	TBD	TBD
Award of Contract(s)	TBD	TBD

1.13 Bid Protest Procedures

Any formal protest against the recommendation of award which is to be made by an aggrieved Proposer must be submitted in writing to the Procurement Director, Cashanna K Moses at cmoses@swbno.org according to Sewerage and Water Board of New Orleans Policy 83(R): Procedural Rules for Bid Appeals.

1.14 Public Records Request

To request a public record for the proposal documents, please submit to the following website: https://swbno.nextrequest.com/

Sewerage and Water Board of New Orleans
Request for Proposals

Technical Consulting for Grid Control System (GCS)

2.1 Overview of the SWBNO

The SWBNO operates and maintains infrastructure through Orleans Parish to provide safe drinking water to support fire protection and the public health of all residents, improve sewerage collection services to support public safety and sanitation, and more effectively collect and convey stormwater out of the City of New Orleans to reduce the risk from flood events. The SWBNO remains diligent in improving public safety for the citizens of New Orleans continuously at a reasonable cost to the community.

Scope of Work

SWBNO is soliciting proposals from qualified vendors to provide a Grid Control System (GCS) for industrial and power generation applications, including configuration of system to meet SWBNO specific needs and integration/deployment of new system, as well as furnishing, installation, and commissioning of required hardware and software for the GCS. The primary function of the Grid Control System is to match generation to load through SWBNO's electrical distribution network, while maintaining stability utilizing both theoretical modeling and real-time data to aid in the control. Details of the system and additional requirements are described in Part V Appendix C of this document. Equipment to be included within the GCS is defined by the Scoping One Line, Appendix A, SWBNO-E-SK-20.00, and Appendix B, the GCS Implementation Plan Scoping tables. A sample contract for professional services in included in Appendix E.

This Scope includes;

1. All hardware required to interface with existing PDCS. Such GCS hardware includes, but is not limited to, control central processing units (CPU), Programable Logic Controller or other control modules, remote terminal units(RTU), serial port expanders, protocol converters, etcetera. GCS vendor is responsible for identifying and providing all required hardware for a fully functional GCS.

2. All communications networking, where not part of a shared PDCS network required for a fully functional GCS shall be included in this scope.

3. All input/output (IO) points, where not part of the shared PDCS network required for a fully functional GCS.

4. All software, programming, and settings required to implement the GCS functionality on the SWBNO and GCS hardware.

5. Configuration documentation including control narratives, control logics, Human Machine Interface(HMI) graphics, and etcetera for a fully functional GCS.

6. Automated system reports including but not limited to: Shift reports, Configuration, reports, Asset reports, Alarm/Event reports.

Detailed technical requirements are defined in technical specifications in Appendix C and as listed below. Specification requirements shall be considered to be RFP requirements.

40 94 23.PDCS PDCS ELECTRICAL CONTROL SYSTEM
40 94 24.PDCS PDCS HUMAN MACHINE INTERFACE
40 94 25.PDCS PDCS DATA EXCHANGE INTERFACE
40 94 26.PDCS PDCS GRID CONTROL SYSTEM

The Grid Control System (GCS) Project at the Sewerage and Water Board of New Orleans (SWBNO) is a modernization of the SWBNO managed electrical network control infrastructure to improve safety, resiliency, and stability through a scalable integrated time-domain capable proven electrical network control system. The intent is to incorporate the GCS into the SWBNO Power Distribution Control System (PDCS) in a phased approach incrementally adding functionality. The GCS, as envisioned by SWBNO per the Grid Control System Specification, has three primary control focuses -- (i) Generation Coordination and Control, (ii) Distribution Coordination and Control, and (iii) Load Management – to match generation to load via the SWBNO managed electrical network. Important considerations include:

- very diverse assets
- incremental (phased/part) implementation
- varying range of equipment age
- captive system with two operating frequencies; 25Hz and 60Hz

Control Philosophy

The Grid Control System control philosophy incorporates the three primary control focuses described elsewhere (generation, distribution, load) as it materially impacts the stability of the SWBNO managed electrical network. The system is a subsystem of the SWBNO Power Distribution Control System (PDCS), and the PDCS broadly controls the SWBNO managed electrical network primarily at the distribution voltage level with limited visibility of lower voltage levels. The principle SWBNO managed electrical network distribution levels are medium voltage: 24kV, 60Hz; 13.8kV, 60Hz; 4.16kV, 60Hz and 6.6kV, 25Hz. The age and configuration of the SWBNO managed electrical network often dictates self-generation islanded mode during critical operating conditions, such as 'rain events' and 'sustained weather disturbances', primarily hurricanes. Current SWBNO managed electrical network operating practices and Utility agreements do not allow the parallel/intertied operation of the SWBNO managed electrical network with the Utility bulk electric system. At the time of GCS deployment, parallel/intertied operation of the SWBNO managed electrical network with the Utility bulk electric system will be permitted based on the completion of other contracts. The GCS shall be capable of fully automatic control but shall allow for manual operator control of individual assets where feasible, while still maintaining overall system control.

SAFETY

A. The entire system shall be installed and commissioned to the standards set forth by 47 CFR Part 90 Standards for Public Safety and Industrial/Business Pool.

2.3 Contract Terms and Compensation

The contract period is eighteen (18) months with one (1) one (1) year renewal and is scheduled with initiation of the contract period following approval by the SWBNO Board of Directors (Board) and issuance of Notice to Proceed and Purchase Order.

Proposal prices shall be firm and shall not be amended after the date and time of the proposal opening. Any attempt by the proposer to amend proposal prices shall constitute default as outlined in this specification.

Prices quoted in the proposal response shall include all shipping and delivery costs.

2.4 Payment

The Board shall pay Proposer in accordance with the contracted prices. The Proposer will invoice the agency at the billing address designated by the agency. Payments will be made by the Agency within approximately forty-five (45) calendar days after receipt of a properly executed invoice, and approval by the Department or designee. Invoices submitted without the referenced documentation will not be approved for payment until the required information is provided.

2.5 Information

All reports, surveys, tables, charts, diagrams, product recordings and other data (including electronic, audio and video) or documentation prepared or compiled by Proposer in connection with the performance of its obligations under the contract, shall be the sole and exclusive property of the SWBNO. Proposer shall retain in its files, sufficiently detailed working papers relevant to its engagement with the SWBNO. Proposer further agrees that its working papers will be held in the strictest confidence and will not be disclosed or otherwise made available to outside sources, except as required by law, without the written consent of the SWBNO.

2.6 Non-Collusion Statement

The Contractor confirms that this Agreement is entered into with the Board without any connection with any person or persons making a proposal for the same services, and that it is in all respects fair and without collusion or fraud; also that no member of the Board or public official of the City, who are by law are excluded from participation herein, is directly or indirectly interested herein or in furnishing the services to which it relates or in any portion of the profits thereof.

2.7 Non-Solicitation Statement

The Contractor has not employed or retained any company or person, other than a bona fide employee working solely for it, to solicit or secure this Agreement. The Contractor has not paid or agreed to pay any person, other than a bona fide employee working for it, any fee, commission, percentage, gift, or any other consideration contingent upon or resulting from this Agreement.

2.8 Convicted Felon Statement

The Contractor confirms that no principal, member, or officer of the Contractor has, within the preceding 5 years, been convicted of, or pled guilty to, a felony under state or federal statutes for embezzlement, theft of public funds, bribery, or falsification or destruction of public records.

2.9 Insurance Requirements

Contractor shall maintain at his own expense and in good standing, such insurance as will protect the Board, the City of New Orleans, their officers, officials, employees, boards, commissions, and volunteers, and the Contractor himself, 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. The coverage shall contain no special limitations on the scope of protection afforded to the Board or the City. Both the Board and the City shall appear as "Additional Insured" on all Commercial General Liability and Business Automobile Insurance. Any failure to comply with reporting provisions of the policy shall not

affect coverage provided to the Board and the City, their officers, officials, employees, boards and commissions, and volunteers. The Contractor's insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

If this transaction requires the Contractor or subcontractor's employees to enter the Board's facilities or job sites, a senior employee of the Contractor and/or any subcontractor will review the Board's Safety Orientation Notice (Notice) and will explain this Notice to every employee who will enter Board facilities. This Notice is included as a part of the specifications for this contract.

Contractor and its insurers shall agree to waive all rights of subrogation, except on their Professional Liability Policy, against the Board, the City, and their officers, officials, employees, boards and commissions, and volunteers for losses arising from work performed by the Contractor for the Board and the City. Each insurance policy required by this contract shall be endorsed to state that coverage shall not be suspended, voided or canceled by either party, or reduced in coverage or in limits except after thirty (30) days prior written notice by certified mail, return receipt requested, that has been given to the Risk Manager of the Board. In general, insurance is to be placed with insurers with a Best's rating of at least A- V, although this requirement may be reviewed and modified by the Risk Manager of the Board in the best interest of the Board. The Risk Manager may also consider performing such review upon written request from Contractor. Contractor shall furnish the Board with certificates of insurance affecting coverage required by this contract. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf.

The certificates of insurance are to be received and approved by the Risk Manager of the Board before work commences. In the event of a claim, Contractor shall make applicable insurance policies available for review by the Board. Contractor shall retain its rights to restrict disclosure of Contractor's proprietary information.

The following are the types of insurance policies and the minimum limits of insurance coverage which shall be maintained by Contractor during the entire term of the Contract:

a) **WORKERS' COMPENSATION AND EMPLOYERS' LIABILITY INSURANCE**, as will protect him from claims under Workers' Compensation Laws. The Workers' Compensation section of the policy shall afford statutory limits and be in accordance with all Louisiana Workers' Compensation Statutes. The Employers' Liability limit shall not be less than $1,000,000 each accident for bodily injury by accident and $1,000,000 each employee/policy limit for bodily injury by disease. Whenever any vessel or floating equipment is involved, the insurance shall afford coverage under the Federal Longshoremen's and Harbor Workers' Act, and shall also include protection for injuries and/or death to Masters and Members of the crews of vessels with statutory limits in accordance with the Jones Act.

b) **COMMERCIAL GENERAL LIABILITY INSURANCE**, with a limit of not less than $1,000,000 each occurrence and $2,000,000 general aggregate, including Explosion, Collapse, and Underground Property Damage Hazards. The Products-Completed Operations aggregate limit shall not be less than $1,000,000 each occurrence. The general aggregate limit shall apply separately to this project.

c) **BUSINESS AUTOMOBILE INSURANCE**, which shall cover liability arising from any auto (including owned, hired, and non-owned vehicle). The limit of liability shall not be less than $1,000,000 combined with each accident for all injuries, property damage, and/or death resulting from one occurrence.

d) **ERRORS AND OMISSIONS/PROFESSIONAL LIABILITY INSURANCE**, whichever is applicable to the particular profession or service to be provided, with limit of not less than $1,000,000 each Claim, with a $2,000,000 annual aggregate, **without** any restrictive "negligent act, negligent error, or negligent omission" clause, and sufficient to protect the Contractor, the Board, and the City, for a five (5) year period from completion of this contract, against any and all claims which may arise from the Contractor's negligent performance of work described herein.

In addition, Contractor shall be required to furnish to the Risk Manager of the Board all copies of investigative reports with regard to any and all claims filed with the Contractor and his insurance carriers relative to the contract, with the exception of claims filed against his Workers' Compensation Insurance. Such reports shall include date, location, and description of loss as well as amounts of settlements or judgments in order that annual aggregate limits may be monitored by the Board for Contractor's compliance with these specifications.

The furnishing of insurance as provided above shall not relieve Contractor of its responsibility for losses not covered by insurance. Prior to the signing of the contract, evidence of all such applicable insurance satisfactory to the Board shall be filed with the Risk Manager of the Board. All policies shall be in insurance companies authorized to do business in Louisiana and shall remain in full force and effect until the final completion of the work and acceptance thereof by the authority of the Board. Contractor and/or his insurer shall notify the Risk Manager of the Board at least thirty (30) days in advance of any insurance coverage to be canceled or of any insurance coverage that will expire. Contractor shall simultaneously furnish the Board evidence of new coverage to be effective the same day and hour of the expired or canceled coverage. In the event Contractor fails to submit this evidence of new coverage five (5) days prior to cancellation date or expiration date of any policy or policies, the Board will obtain the required coverage to become effective on date of cancellation or expiration of said policies. The cost of such new coverage shall be at the expense of Contractor and any expenditure incurred by the Board of this coverage will be deducted from any balance due to Contractor.

2.10 Right to Audit

The Board shall have the right to audit by its personnel or its authorized representative at all reasonable times any and all records pertaining to the administration of this contract by the contractor, including its records of any subcontractor(s) employed on the contract. Such records shall be made and kept by the contractor in accordance with generally accepted accounting principles and practices. Records shall include, but are not limited to, accounting records, daily reports, correspondence and subcontract files (hard copies as well as computer readable data, if it can be made available). Records subject to audit shall also include but not be limited to those records necessary to evaluate and verify direct and indirect costs (including overhead allocations) as they may apply to cost and/or change order requests associated with this contract. The Board also reserves the right to interview employees, make photocopies, and inspect any and all records at a reasonable time for a minimum of three (3) years after completion of the project or formal acceptance of the contract by the Board. Contractors shall be required to retain such files of the project as described herein for a minimum of three (3) years after completion of the project or formal acceptance of the contract by the Board.

2.11 Confidential Information

Information contained in the Vendor's proposal that it deems proprietary or trade secret must be clearly identified in the proposal as described below in the Louisiana Revised Statute 44:3.2.D.(1). The Board will be free to use all information in the Vendor's proposal for the Board's purposes. Vendor proposals shall remain confidential until the Board's Proposal Selection Committee makes its recommendation to SWBNO Board of Directors. The Vendor understands that any material supplied to the Board may be subject to public disclosure pursuant to the Louisiana Public Records Law (LA R.S. 44:1, et seq.).

Louisiana Revised Statute 44:3.2 D.(1) All records containing proprietary or trade secret information submitted by a developer, owner, or manufacturer to a public body pursuant to Subsection A, B, or C of this Section shall contain a cover sheet that provides in bold type "DOCUMENT CONTAINS CONFIDENTIAL PROPRIETARY OR TRADE SECRET INFORMATION". The developer, owner, or manufacturer shall clearly mark each instance of information which is, in his opinion, proprietary or trade secret information.

2.12 Confidentiality Statement

Any information, including materials, drawings, designs, documentation, and other property or data, disclosed to the proposal responder shall not be used, reproduced, appropriated, or otherwise disseminated to anyone other than SWBNO.

2.13 Subcontractor

If the proposer intends to subcontract portions of the work or to satisfy any of the Proposer Requirements and/or Scope of Work through the use of a subcontractor, the proposer shall include the name of the subcontractor and specific designations of the tasks to be performed or Vendor requirements to be met by respective subcontractor(s). The information requested of the proposer under the terms of this RFP shall also be supplied for each subcontractor and shall be included in the proposal. The proposer will retain full control over this contract and will not assign or subcontract said contract without the prior written consent of SWBNO. Failure to request consent shall be grounds for default under this contract. The Proposer further agrees that assigning or subcontracting any portion or feature of the work shall not relieve the Proposer from its full obligations under this contract.

2.16 Living Wage

The Contractor agrees to abide by City Code sections 70-801, et seq., which requires payment of a wage to covered employees equal to the amounts defined in the Code ("**Living Wage").** If the Contractor fails to comply with the requirements of the Living Wage during the term of the Agreement, said failure may result in termination of the Agreement or the pursuit of other remedies by the Sewerage and Water Board.

Current Living Wage. In accordance with the Living Wage Ordinance, Living Wage shall be as follows:

- $11.19 per hour for any work performed on or before December 31, 2021;
- $13.25 per hour for any work performed on or before December 31, 2022;
- $15.00 per hour for any work performed on or before December 31, 2023; and
- $15.00 per hour plus any adjustment provided in subsection D below for any work performed during calendar year 2024 or thereafter.

The Contractor shall be responsible for confirming the Current Living Wage by visiting https://www.nola.gov/economicdevelopment/workforce-development

2.17 Economically Disadvantaged Business Program

To ensure the full participation of DBE's in all phases of SWBNO's procurement activities, all Proposers at time of proposal submission shall complete and submit an Economically Disadvantaged Business Participation Summary Sheet along with signed correspondence from SLDBE(s) on their letterhead. If the DBE Participation Summary Sheet and signed correspondence are not submitted, it shall be determined that the proposer is non-responsive and the proposal will not be evaluated by the Selection Committee.

2.18 Economically Disadvantaged Business Program

A DBE goal of **Twenty-five percent (25%)** has been established for this RFP. The Proposer shall agree to use its best efforts to assure that all Proposers comply with the factors set forth in the DBE Program, to meet the goal for DBE participation in the performance of this solicitation.

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 https://www.swbno.org/business_disadvantagedbusinessprogram.asp.

PART III. PROPOSAL EVALUATION AND SELECTION

3.1 Selection Committee

Pursuant to Policy Memorandum No. 95, SWBNO must establish a Selection Committee with relevant subject-matter expertise in reviewing and evaluating proposals to the RFP. Each proposal to the RFP must be evaluated by a committee of five individuals consisting of:

- General Superintendent, or designee
- Deputy Director, or designee
- Department Head requestor, or designee
- Employee who will manage and monitor the contract
- An Expert (Employee or Non-Employee) in the field as determined by the Executive Director

The Selection Committee will first evaluate the proposals on the basis of qualitative criteria rather than quantitative price. The members on the Selection Committee will complete the numerical grading and provide a written explanation stating the reasons for the rating for each criteria.

3.2 Technical Evaluation

SWBNO will select a Proposer generally according to the procedures described in Policy Memorandum No: 95. The Selection Committee will first evaluate and score responsive RFP Responses on the criteria listed below and provide an assessment of that score.

A composite scoring approach will be utilized, in which Committee Members will arrive at consensus scores in each category through discussion in order to score the proposals out of the possible 100 points.

The Selection Committee shall first evaluate the proposals on the basis of criteria other than price. The members on the Selection Committee shall utilize consensus scoring and discuss each proposal to complete the numerical grading.

A Proposer may receive the maximum points, a portion of this score, or no points at all, depending upon the merit of its response, as judged by the Selection Committee in accordance with the qualitative criteria below:

The Board reserves the right to reject any and all proposals. As part of the evaluation process, the Selection Committee may interview any Proposer references and other parties to confirm Proposer's performance on previous projects. The Board reserves the right to terminate this process at any time, and no guarantee is expressed or implied that obligates the Board to contract for the proposed project. The Board will negotiate its agreement with the highest evaluated proposer, as determined by the Selection Committee.

Proposers shall be treated fairly and equally with respect to any opportunity for discussion and revision of their offer. To obtain the best and final value offers, revisions may be requested after submissions and before award of the Contract.

Technical Criteria

For those vendors whose proposals pass the minimum criteria, the following categories of criteria will be used to further evaluate the proposals:

(0-20 points) Proposer Methodology/Approach
Clear understanding by the applicant of work to be performed and inclusion of the required scope. This will be measured on:

- Proper demonstration and presentation of the method of work to be performed.
- Evaluation of Delivery Schedule
- Section 4.3: Proposer Methodology/Approach

(0-25 points) Proposer Experience
Experience of the Key Personnel and other professional personnel. This will be measured on:

- Vendor experience in the grid control field and ability to provide cost effective services to the Board based on completion of prior similar work.
- Section 4.4 Proposer Experience

(0-20 points) Proposer Integrator Technical Value
Capability of the Proposer to implement a streamlined GCS that is customized for the specific needs of the SWBNO system that meets the minimum requirements and adds value to the SWBNO operations. This will be measured on:

- Appendices B and C.
- Section 4.5: Proposer Technical Value

(0-25 points) Technology Solution's Ability to meet Functional Requirements
Ability of chosen technology solution/OEM platform to meet functional requirements. This will be measured on:

- Responses to RFP 2024-SWB-XX Grid Control System(GCS) Software and Services.xlsx
- Section 4.5: Proposer Technical Value

(0-10 points) Proposal complies with contract DBE participation goal of 25% and is willing to promote full and equal business opportunities in accordance with the Board's State-Local Disadvantaged Business Enterprise Program

3.3 Price Evaluation

Cost proposals must be submitted in a separate envelope or file (if emailed) marked "Cost Proposal". A Proposer may receive the maximum points, a portion of this score, or no points at all, depending upon the merit of its Price Proposal:

The proposer with the lowest cost shall receive the highest cost evaluation score.
Other proposers will receive a cost score computed as follows:

CS = (LPC/PC)*20

Where:
CS = Computed cost score for Proposer

LPC = Lowest proposed cost of all Proposers
PC = Proposer's cost

In evaluating cost, SWBNO may evaluate on a fully loaded ten-year cost of ownership. Fully loaded is defined to include (but is not limited to): one time and ongoing costs.

3.4 Shortlist

SWBNO at its sole discretion may recommend a selection of Proposers for a short list based on the overall ranking by the Selection Committee.

During the review of any proposal, the Selection Committee may:

- Conduct reference checks relevant to the solicitation to verify any and all information, and rely on or consider any relevant information from such cited references or from any other sources in the evaluation of proposals;
- Seek clarification of a proposal or additional information from any or all proposers and consider same in the evaluation of proposals;
- Waive any requests or requirements if such waiver is in the best interest of the SWBNO; and
- Request interviews/presentations with any, some or all proposers to clarify any questions or considerations based on the information included in proposals, Proposals during the evaluation process, and consider any supplementary information from interviews/presentations in the evaluation

3.5 Best and Final Offer (BAFO)

Selection Committee, at its request, may ask for a Best and Final Offer from the top proposers.

Written notification is sent to the selected proposers that will include a list of the specific items to be addressed, instructions and deadline for submittal, and the evaluation criteria and scoring methodology, if different from the RFP.

If requested, when evaluating BAFO responses, if BAFO cost is requested, this will replace the original cost and the technical proposal may be re-evaluated.

3.6 Notification

Once the Selection Committee recommends a proposal, the Procurement Department notifies the selected firm by a Recommendation of Award letter. The unsuccessful proposer(s) will be notified as well. The Award Letter will contain the name and contact information of the representative of the department responsible for administering the future contract.

IMPORTANT: The Recommendation of Award letter is not a contract award notification. The contract award is subject to the successful satisfaction by the selected respondent of all additional requirements in the solicitation.

PART IV. PROPOSAL SUBMISSION REQUIREMENTS

To achieve a uniform review process and obtain the maximum degree of comparability, it is required that the proposals be organized in the manner specified below.

Proposals must be prepared in English on 8 ½ x 11inch paper with tabbed indexes separating the following sections in the following order:

4.1 TITLE PAGE

Title Page should contain the following information:

- RFP Number and Name
- Proposer's Name and Address
- Proposer's Contact Person and Information (email address, telephone number(s), etc.)

4.2 TABLE OF CONTENTS

Clearly identify the materials by section, page number, and tabs.

4.3 PROPOSER METHODOLOGY/APPROACH

4.3.1 General Implementation Approach

Provide a general overview of the implementation approach you plan to use for the Board that includes addressing the following items:

• Provide a detailed work plan or schedule in a work breakdown structure format as part of the proposal response. Owners preference is a schedule not to exceed eighteen (18) months.

• Describe key differentiators of the approach as it relates to implementing a solution on time, within budget and with the ability to meet the needs of a diverse client like the Board.

• Describe how you determine the preferred implementation phasing of software modules. Describe your recommended approach for this implementation. Describe your approach towards running parallel systems, if necessary. Any unique tools, techniques, or methods that you use should be described in this section.

4.3.2 Project Management Approach

As part of any significant engagement, the Board desires a well developed project management framework to ensure success. The Board would expect responding Vendors to adhere to proven successful project management methodologies as part of this project. The Board expects the Vendor to provide project management resources leading to the successful deployment of the system.

Briefly describe the contents and approach of each of these components:

• Project management plan
• Resource management plan
• Quality management plan
• Scope management plan
• Risk management plan
• Budget management plan
• Change control plan
• Describe the approach to managing the project, such as a collaboration tool for document management,

The project manager will work as a team member with the Board's project management office ("PMO"). This project manager can be an employee of the Vendor or a partner of the Vendor. In either case, the costs for the project manager should be clearly denoted in the pricing section of this RFP.

4.4 PROPOSER EXPERIENCE

Within the proposal, the Proposer must provide information about their company so that the Board can evaluate the Vendor's stability and ability to support the commitments set forth in response to the RFP. This information shall include a description of their experience in providing industrial, utility, and/or generation grid control systems and services. Additional Vendor information that should be provided in this section includes:

- The company's background includes a brief description (e.g., past history, present status, future plans, company size, etc.) and organization charts
- Vendor's experience, and underlying philosophy in providing the services as described. Description should include details such as the following:
    - Abilities and Qualifications (certifications, awards, licenses etc.)
    - Capacity
    - Skill and Training
    - Strengths
    - Number of years in business
    - Number of employees
    - References and performance evaluations
    - Services provided on previous projects (work samples)
- Within the proposal, the proposer must demonstrate capability in providing consistent, timely and cost-effective services as determined by information requested from references or the Board's actual experiences.
- Provide relevant project examples of a similar scope of work, listed in order of completion (most recent first).
- If the Vendor is proposing to use subcontractors on this project, provide a response to the Company Background Form for each subcontractor, Vendor relationship with that firm and the specific services and/or products that the subcontractor will be providing on the project. A complete list of subcontractors is required. The Board has the right to approve all sub-contractors of the Vendor at any time.

4.5 PROPOSER TECHNICAL VALUE

The proposal shall include a preliminary system block diagram or architecture drawing showing the proposed system configuration. At a minimum, Block or architecture drawing shall define major GCS hardware nodes and components and define the number and type of datalinks between GCS components and the existing PDCS system hardware. Diagram shall indicate the physical location of the required GCS components.

4.5.1 Testing

The Vendor should describe their recommended approach to the following types of testing that are anticipated to be performed on the project and the type of assistance they anticipate providing to The Board related to such testing:

- Hardware-in-the-loop Testing (HIL)
- Factory Acceptance Testing (FAT)
- Site Acceptance Testing (SAT)
- Stress/performance testing
- User Acceptance Testing (UAT)

4.5.2 Training

The Vendor should provide an overall description of the proposed training approach, including the following:

End User Training: All end-user training will be performed onsite through implementation and be performed by the Vendor. End user implementation training will be provided by the Vendor and include joint participation by the relevant SWBNO process owner team lead supporting the process area in the new software system.

Opportunities for on-going training: The Vendor should briefly describe the learning resources available for the chosen technology platform. This would include any available in-person courses, virtual and/or e-learning (self-guided and proctor led), Expert Support forums, Scheduled webinars, learning course catalogs, certifications, etcetera.

4.5.3 Ongoing Support Services

Vendor to specify the nature and conditions of any post-implementation support (minimum required of 3 months) options including:

- Post-go live support that is included in the proposal response
- Onsite support (e.g., system tuning, application configuration, interface issues, report development, network optimization, user training and tips to optimize the user experience)
- Telephone support,
- Help Desk services (If there is a service level agreement for your help desk, provide a copy with your RFP response.) Specify days, hours and escalation options
- Fee based vs. Non-fee based remote support
- User groups
- Online knowledgebase (i.e. – how it is accessed, who updates it, etc.)
- Describe your maintenance programs and options associated with pricing.

During evaluation, SWBNO may evaluate on a fully loaded ten-year cost of ownership. Fully loaded is defined to include (but is not limited to): one time and ongoing costs.

4.6 PRICING PROPOSAL

Proposer shall submit Cost Proposal in a separate file labeled with firm's name and RFP title- **2024-SWB-97 – Installation and Implementation of a Grid Control System (GSC) (Cost Proposal).**

Proposer shall submit itemized list of all materials and services.

Itemized material list for Cost Proposal must include

- Configuration of Grid Control System (GCS) System for SWBNO's needs, including system design, software, programming, and settings Unit name including Brand name if applicable
- Furnish hardware and equipment for GCS System
- Installation support for GCS System
- Commissioning for GCS System
- Expected post go-live costs years 1-5 (Mandatory licensing fees, infrastructure fees, etc.)

4.6 REQUIRED ATTACHMENTS

ATTACHMENT A – COVER SHEET
ATTACHMENT B – REQUIRED AFFIDAVITS
ATTACHMENT C – ECONOMICALLY DISADVANTAGED BUSINESS PARTICIPATION SHEET

RFP Submittal Document Checklist

_____Technical Proposal with required tabs

_____Cost Proposal (separate file)

_____Attachments A – C (Completed and Signed)

Proposers not submitting the required documents and attachments will result in your response being deemed non-responsive.

ATTACHMENT A

COVER SHEET

Request for Proposal: _____

Company Name: _____

Company Address: _____

_____

Please provide the key contact person's information who will be responsible during the active event:

Primary Contact Person:

Name: _____ Title: _____

Cell Phone: _____ Email Address: _____

Secondary Contact Person:

Name: _____ Title: _____

Cell Phone: _____ Email Address: _____

This RFP must be signed by an authorized Representative of the Company/Firm for proposal to be valid. Signing indicates you have read and comply with the Instructions and Conditions.

Name of Person Authorized to Sign: _____

Title of Person Authorized to Sign: _____

Signature of Person Authorized to Sign: _____

Email Address of Person Authorized to Sign: _____

Date: _____

ATTACHMENT B

CONFLICT OF INTEREST DISCLOSURE AFFIDAVIT

STATE OF _____

PARISH/COUNTY OF _____

Before me, the undersigned authority, came and appeared _____who, being first duly sworn, deposed and said that:

He/She is the _____ and authorized representative of _____

_____, hereafter called "Proposer."

The Proposer hereby confirms that a conflict(s) of interest **exists** /**does not exist**/**may exist** (**circle one**) in connection with this solicitation which might impair Proposer's ability to perform if awarded the contract, including any familial or business relationships that the Proposer, the proposed sub-vendors, and their principals have with the Board officials or employees. *(If a conflict(s) of interest exists and/or may exist, describe in a letter the nature of the conflict, the parties involved and why there is a conflict. Attach said letter to this form*).

_____
Proposer Representative (Signature)

_____
(Print or type name)

_____
(Address)

SWORN TO AND SUBSCRIBED BEFORE ME

THIS _____ DAY OF _____ 20_____.

_____ _____
NOTARY PUBLIC (Signature) NOTARY PUBLIC (Print Name)

Notary ID#/Bar Roll #_____

ATTACHMENT B

CORPORATE RESOLUTION

A meeting of the Board of Directors of _____a corporation organized under the laws of the State of_____ and domiciled in

was held this_____day_____,20 _ ___ and was attended by a quorum of the members of the Board of Directors.

The following resolution was offered, duly seconded and after discussion was unanimously adopted by said quorum:

BE IT RESOLVED, that _____ is hereby authorized to submit proposals and execute agreements on behalf of this corporation with the Sewerage and Water Board of New Orleans ("Board").

BE IT FURTHER RESOLVED, that said authorization and appointment shall remain in full force and effect, unless revoked by resolution of this Board of Directors and that said revocation will not take effect until the Purchasing Director of , shall have been furnished a copy of said resolution, duly certified.

I,_____, hereby certify that I am the Secretary of_____, a corporation created under the laws of the State of _____ domiciled in_____;

that the foregoing is a true and exact copy of a resolution adopted by a quorum of the Board of Directors of said corporation at a meeting legally called and held on the _____ day of_____20_____, as said resolution appears of record in the Official Minutes of the Board of Directors in my possession.

This _____day of _____, 20_____

_____

SECRETARY

ATTACHMENT B

PROPOSER ORGANIZATION

PROPOSER IS:

AN INDIVIDUAL

Individual's Name: _____

Doing business as: _____

Address: _____

Telephone No.: _____ Fax No.: _____ Email: _____

A PARTNERSHIP

Firm Name: _____

Address: _____

Name of person authorized to sign: _____

Title: _____

Telephone No.: _____ Fax No.: _____ Email: _____

A LIMITED LIABILITY COMPANY

Corporation Name: _____

Address: _____

Name of person authorized to sign: _____

Title: _____

Telephone No.: _____ Fax No.: _____ Email: _____

A CORPORATION

IF PROPOSAL IS BY A CORPORATION, THE CORPORATE RESOLUTION MUST BE SUBMITTED WITH PROPOSAL.

IF RESPONSE IS BY A JOINT VENTURE, ALL PARTIES TO THE PROPOSAL MUST COMPLETE THIS FORM.

ATTACHMENT B

CONVICTED FELON AFFIDAVIT

STATE OF _____

PARISH/COUNTY OF _____

Before me, the undersigned authority, came and appeared_____,

who, being first duly sworn, deposed and said that:

1. He/She is the_____and authorized representative of

_____, hereafter called "Contractor."

2. The Contractor complies with City Code Section 2-8 (c) for the City of New Orleans.

3. No Contractor principal, member, or officer has, within the preceding five years, been convicted of, or pled guilty to, a felony under state or federal statutes for embezzlement, theft of public funds, bribery, or falsification or destruction of public records.

_____
Proposer Representative (Signature)

_____
(Print or type name) (Address)

Sworn to and subscribed before me, in (CITY/STATE) _____

This ____day of (MONTH) _____, 20 ___.

_____
Notary Public

_____
Notary Identification No./Bar Roll No.

ATTACHMENT B

NON-SOLICITATION AFFIDAVIT

STATE OF _____

PARISH/COUNTY OF _____

Before me, the undersigned authority, came and appeared_____,

who, being first duly sworn, deposed and said that:

1. He/She is the _____ and authorized representative of _____hereafter called "Contractor."
2. The Contractor has not employed or retained any company or person, other than a bona fide employee working solely for him, to solicit or secure the subject contract. The Contractor has not paid or agreed to pay any person, other than a bona fide employee working for him, any fee, commission, percentage, gift, or any other consideration contingent upon or resulting from the subject contract.

_____
Contractor Representative (Signature)

_____
(Print or type name) (Address)

_____

Sworn to and subscribed before me, in _____, Louisiana,

this ___day of _____, 20 _____.

_____
Notary Public

_____
Notary Identification No./Bar Roll No.

ATTACHMENT B

NON-COLLUSION AFFIDAVIT

STATE OF _____

PARISH/COUNTY OF _____

_____, being first duly sworn, deposes and says that:

(1) He is (Owner) (Partner) (Office) (Representative) or (Agent), of:

_____

the Proposer that has submitted the attached Proposal:

(2) Such Proposal is genuine and is not a collusive or sham Proposal:

(3) Neither the said Proposer nor any of its officers, partners, owners, agents, representatives, employees or parties of interest, including this affiant, has in any way colluded, conspired, connived or agreed, directly, or indirectly with any other Proposer, firm or person to submit a collusive or sham proposal in connection with the Contract for which the attached Proposal has been submitted or to refrain from proposing in connection with such contract, or has in any manner, directly or indirectly sought by agreement or collusion or communication or conference with any other Proposer, or to fix any overhead, profit or cost element of the proposal price or the proposal price of any other proposer, or to secure through any advantage against the Sewerage and Water Board of New Orleans of any person interested in the proposed contract; and

(4) The price or prices quoted in the attached Proposal are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Proposer or any of its agents, representatives, owners, employees, or parties in interest, including this affiant.

_____ _____

Proposer Representative (Signature) Title

_____

(Print or type name)

SWORN TO AND SUBSCRIBED BEFORE ME

THIS _____ DAY OF _____ 20_____. Notary ID#/Bar Roll #_____

_____ _____

NOTARY PUBLIC (Signature) NOTARY PUBLIC (Print Name)

ATTACHMENT D

DISADVANTAGED BUSINESS ENTERPRISE POLICY

DISADVANTAGED BUSINESS ENTERPRISE PROGRAM

In accordance with the adoption of Resolution R231-97, the Sewerage and Water Board of New Orleans has established a race and gender-neutral Disadvantaged Business Enterprise (DBE) Plan. As part of that Plan, on any publicly bid goods and services (which shall include professional and non-professional services) project, not involving funds from a source other than the Sewerage and Water Board of New Orleans, the prime contractor shall be required to make a demonstrated good faith effort to award (25 %) percent of the amount of the contract to certified disadvantaged business enterprises as **service providers or suppliers performing commercial useful functions which are consistent with the services or supplies required on this contract.** The percent participation having been determined for this specific contract by recommendation of the **Staff Contract Review Committee (SCRC),** which is comprised of Sewerage and Water Board staff members. This percentage requirement shall be considered an informality which is subject to modifications and may be waived or adjusted by the Sewerage and Water Board of New Orleans if the prime contractor, after having demonstrated a good faith effort, is unable to comply with the requirement.

DEMONSTRATED GOOD FAITH EFFORTS

Before receiving an award of the contract, the Contractor must meet the DBE goals or prove that he/she has made demonstrated good faith efforts. To determine whether a particular contract bidder has made demonstrated good faith efforts to reach the DBE participation goal, the Board and its staff will consider the following:

a. whether the Contractor attended all pre-bid meetings that may have been scheduled by the Board to inform DBE firms of subcontracting opportunities and/or requested the Board Directory of Certified DBE firms.

b. whether the Contractor advertised in general circulation and trade association publications, concerning the DBE subcontracting opportunities, and allowed the subcontractors reasonable time to respond.

c. whether the Contractor provided written notice to a reasonable number of individually named DBE firms and allowed sufficient time for the DBE firms to participate effectively.

d. whether the Contractor followed up initial solicitations of interest by contacting DBEs to determine with certainty whether the DBEs were interested in bidding.

e. whether the Contractor selected specific portions of the work to be performed by DBEs in order to increase the likelihood of meeting the DBE goals (including breaking down contracts into smaller units to facilitate DBE participation).

f. whether the Contractor provided interested DBEs with adequate information about the plans, specifications and requirements of the contract.

g. whether the Contractor negotiated in "good faith" with interested DBEs and did not reject DBEs as unqualified without sound reasons based on a thorough investigation of their capabilities.

h. if the Contractor did reject a DBE as unqualified, the Contractor must state his or her reason for doing so in writing.

i. whether the Contractor has used the services of available community organizations and small and/or disadvantaged business groups; local, state and federal small or disadvantage business assistance offices; and other organizations that provide assistance in the recruitment and placement of DBE firms;

j. whether the Contractor has made sufficient efforts to negotiate with DBEs for specific sub-bids, including at a minimum:

(1) Names, addresses, telephone numbers of DBEs that the Contractor contacted,

(2) A description of information provided to those DBE firms, and

(3) A statement of why additional agreements with DBEs were not reached to include but not limited to proof the DBEs' price exceeded that of non-DBEs.

1. Policy:

It is the policy of the Board that DBE firms, as defined in the Board's Disadvantaged Business Enterprise Plan, shall have the maximum allowable opportunity to compete for the award of the participation in the performance of the Board's publicly bid contracts. Consequently, the SCRC and the Board have set the DBE participation goal applicable to this Professional Service and/or Goods and Service contract.

2. DBE Obligation:

The Board and its contractors agree to ensure that DBEs, as defined in the Board's Disadvantaged Business Enterprises Plan, shall have the maximum allowable opportunity to compete for the award of the participation in the performance of contracts and subcontracts provided under this agreement. In this regard, contractors shall take all necessary and reasonable steps in accordance with this DBE Plan to ensure that DBEs have the maximum allowable opportunity to compete for such contracts. The Board and its contractors shall not discriminate on the basis of race, color, national origin, or sex in the award and performance of the Board's publicly bid contracts.

3. Utilization of DBE Vendor Listings:

All bidders are required to utilize the most recent Sewerage and Water Board State-Local Disadvantaged Business Enterprise Program Approved Vendor Listings for **Goods & Services/Professional Services**, in their selection of DBE entities to meet DBE participation goals. **Bidders are required to utilize DBE's as service providers or suppliers only in the areas for which they are certified. A description of the areas of work that DBE's can provide is contained in these vendor listings.** In addition, an alphabetical list of vendors/contractors is provided indicating the name of the company, address, name of owner, telephone number, fax number, the date the company became certified, and a description of the work that these entities are certified to perform. **Companies that are already certified as a DBE cannot fulfill the DBE requirements by listing themselves as the subcontractor to meet the DBE goal. The prime contractor shall select another DBE from the Sewerage and Water Board's Approved Vendor Listing.**

4. **Contacting DBE's and Obtaining a Firm Price**

All prime contractors/vendors are required to contact DBE's and obtain a firm price before listing the DBE's on the Participation Summary Sheet.

5. **Failure to Comply with DBE Bid Specifications:**

All bidders for this Board contract are hereby notified that failure to comply with the above DBE specifications may constitute the bid as being non-responsive and sufficient cause for rejection.

6. **Failure to Carry Out DBE Policy:**

All bidders, potential contractors, or subcontractors for this Board contract are hereby notified that failure to comply with the DBE policy and DBE obligations, set forth above, shall constitute a breach of contract which may result in termination of the contract or such other remedy as deemed appropriate by the Board, to include excluding bidder from bidding on future Board contracts.

7. **Setting Minimum Participation Goals:**

The stated minimum percentage DBE participation goal recommended by SCRC and approved by the Board applies to the work of this contract. Bids which are not accompanied by a properly completed Schedule of DBE Participation Summary Sheet showing that at least the percentage goal of the total contract bid price will be subcontracted or otherwise awarded through procurement action to DBEs shall be considered unresponsive, unless:

a. An affidavit is furnished by the bidder with its bid showing that the DBE goals cannot be met for the following reasons:

(1) No DBE firms made offers. Here, it must be shown, documented and demonstrated that good faith efforts (as defined in Part III, D, 2. of the Board's DBE plan) were made by the bidder to obtain the participation of DBE firms and that they did not respond, or

(2) The DBE offers made and accepted for subcontract and/or material supplies do not total the stated goal for participation, but total a lesser percentage, and

(3) The bidder was unable to obtain DBE further participation, despite his or her demonstrated good faith efforts (as defined in Part III, D, 2 of the Board's DBE Plan) to obtain additional participation by DBE firms.

b. Each of the assertions made by the bidder must be supported by documentary evidence.

8. Other Clauses Unaffected:

Nothing contained herein shall invalidate, change, annul, release, restrict, or affect the liability on the bonds or insurance given by the Contractor, or the time required for completion of the contract.

9. Determination of Efforts to Meet Goals:

Initial determination of bidder efforts to meet the DBE participation goal shall be based on the DBE participation representations submitted with the bid. Bidders shall submit all the forms required herein with their bids, and the DBE office will examine the contents thereof. The Board's DBE Officer may, if deemed advisable, request further information, explanation, or justification from any bidder.

10. Contract Monitoring:

a. The Board's DBE Office will monitor contractor during the operation of the contract to ensure that the Contractor meets all of its DBE obligations as specified in the contract bid. The Board's DBE office shall establish rules and regulations, to be approved by the Board, for the ongoing monitoring of contractor compliance.

B. Disadvantaged Business Enterprise Program Office personnel or their designated representative shall be allowed to conduct periodic monitoring of contractors' compliance with the agreed to Disadvantaged Business Enterprise Program participation requirements. Contractors shall be required to complete and return to the Disadvantaged Business Enterprise Program Office in the time required all requests for information and data relative to the Contractors' activities in meeting the required Disadvantaged Business Enterprise participation goal. Additionally, Disadvantaged Business Enterprise Office personnel or their designated representative shall have access to contractor and subcontractor(s) records pertaining to, but not specifically limited to labor, costs and materials supplied and used on the Board contract, as well as inspection and photocopying of any and all contracts, agreements and correspondence relative to the Disadvantaged Business Enterprise contract participation requirements. Such inspection will be performed during normal business hours and will be conducted in such a fashion so as to minimize interference with production of the contract. Visits may be made to job sites, as well as to administrative offices of the Contractor and subcontractor(s) participants. Such inspection and on-site visits may be scheduled with or without prior notice to the Contractor or Disadvantaged Business Enterprise subcontractor participant. Contractors' failure to comply with these monitoring requirements may result in termination of the contract or such other remedy as deemed appropriate by Board.

11. Maintaining Records:

Subsequent to the completion of a contract, contractors are required to maintain for three (3) years such records as are necessary to determine compliance with their DBE obligations. During construction, or performance of the DBE obligations, contractors shall submit reports as requested to enable the DBE Office to monitor this compliance.

12. Umbrella Bonding:

On contracts where subcontracting exists and where practicable (i.e., when a substantial risk or financial hardship would not be incurred by the prime contractor), the Contractor may use an umbrella bond to encompass the DBE firm.

13. Board Action to Seek Compliance:

The Contractor consents to such appropriate actions taken to ensure that prime contractors and subcontractors comply with the DBE provisions, to include but not limited to:

A. desk audits to review all material, and information concerning the Contractor's compliance.

B. on-site reviews that may include interviews, visits to project locations, and inspection of documents and/or information not available at the desk audit that pertains to the Contractor's compliance.

c. any additional investigation that may be called for by a lack of proper record keeping, failure of the prime contractor to cooperate; failure of DBEs to cooperate; visible evidence unsatisfactory performance; other evidence as may warrant further investigation.

14. Non-Compliance Finding:

The Board staff will make compliance determinations regarding its prime contractors. Documentation of noncompliance will include the specific areas in which the Contractors failed to comply. In these instances, appropriate legal action consistent with the DBE and other contract provisions will be taken.

15. Contractor's Duties

a. Record Keeping

Successful bidders shall establish and maintain records and submit regular reports to the DBE office as required, which will identify and assess progress in achieving DBE subcontract goals and other DBE participation efforts.

b. Failure to Comply with EDBP Participation Requirements

Failure to comply with any of the EDBP requirements of this contract shall constitute a violation of the terms and conditions of this contract and a cause for the termination of the contract at the option of the Board.

Such violations shall include, but not limited to:

- Failing to meet the percentage participation requirements as set out in the contract documents.

- Failing to use certified EDBP contractors/vendors in performing the
- scope of work as identified in the contract documents (EDBP participation summary sheet).

- Failing to comply with the "monitoring of EDBP requirements" included herein as part of the contract, such as contractors:

- Failure to submit quarterly report and any other necessary reports
- timely and adequately as required by the EDBP Office.

- Failure to grant access to contractor/subcontractor records by
- EDBP Office personnel, and

- Failure to allow on-site investigations and visits, etc.

- Failing to report the removal or termination of a certified EDBP vendor/subcontractor.

- Failing to secure authorization for replacement of certified EDBP subcontractors from the Director of the Economically Disadvantaged
- Business Program.

- In Lieu of termination the Board, through the EDBP Office, may impose the following penalties:

- Withhold from the Contractor in violation up to 10% of all future payments due to the Contractor, until such time as the violations have been corrected.

- Withhold from the Contractor in violation, all future payments until such time as the violations have been corrected.

c. Subcontract Clause

All bidders and potential contractors must assure the Board that they will include the above clauses in all agreements, which offer further subcontracting opportunities.

d. Contract Award

Bidders are hereby advised that meeting DBE subcontract goals or making a demonstrated good faith effort to meet such goals are conditions of being awarded and maintaining construction, procurement, or professional services contracts by the Board.

e. Restrictions on DBE Subcontracting

No **DBE** subcontractor or vendor selected to perform work as a **DBE** on a Sewerage and Water Board contract will be allowed to subcontract any portion of its work to a Non-Board certified **DBE**, unless the work to be performed is necessary for the execution of the contract and there are no Board certified **DBE's** available to perform such work.

This process will require that each **DBE** participant performing work on a Sewerage and Water Board funded contract submit a request to subcontract out any portion of work deemed necessary for execution of the contract to the Board's **EDBP** office. On a form provided by the **EDBP** office, the **DBE** contractor or vendor will indicate the dollar amount of work to be subcontracted,

the specific scope or nature of the work, the percentage of the total amount of work to be performed by the **DBE** subcontractor and vendor, and the entity to whom the work will be subcontracted.

Both prime and **DBE** subcontractors are advised that the failure to comply with these requirements may result in the loss of **DBE** certification and non-compliance by the prime contractor in meeting **DBE** contractual obligations.

f. Changes in DBE Participation

The prime contractor will not be allowed to make changes in DBE participation without submittal of a written request explaining reason, a revised Participation Summary Sheet and approval by the Director of the Economically Disadvantaged Business Program. Failure to comply with these requirements may result in non-compliance by the prime contractor in meeting DBE contractual obligations.

16. POLICY TO ENHANCE THE USE OF DBE VENDORS

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

The Sewerage and Water Board has a long-standing commitment to fairness and equal opportunity in hiring and contracting. As such, the workforce of contractors/vendors is encouraged to be representative of a diverse population. Achievement of the full benefits of diversity will only come when an attitude of inclusion is adopted.

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.

17. 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.

PART V. APPENDICES

The Appendices listed below are included to provide additional information on the requirements for the GCS and on the existing SWBNO electrical and networking infrastructure. Appendices are considered to be a supplemental part of the RFP. In the event of any discrepancies for system requirements, the most stringent requirement shall take precedence where applicable. In the event of any informational discrepancies, text within the body of the main RFP (this document) shall take first priority. The Appendices are then arranged in order of precedence from Appendix A downward. For example, in the event of a discrepancy between Appendix A and Appendix B, the information in Appendix A is to be used for bidding purposes. It is the contractor's responsibility to request clarification regarding any discrepancies during the bid period.

5.1 APPENDIX LIST

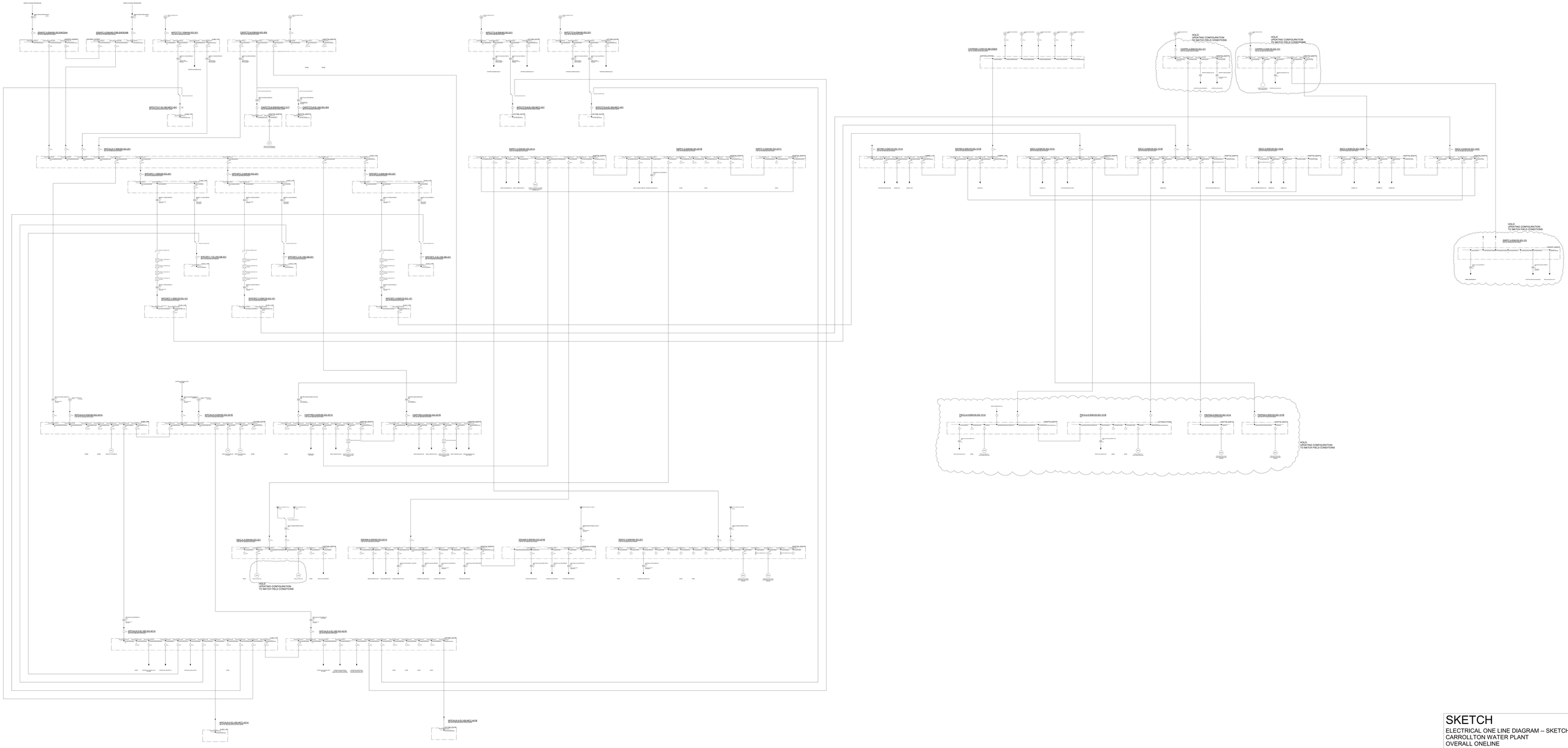
APPENDIX A – SWBNO-E-SK-20.00 SCOPING ONE LINE
APPENDIX B – GCS IMPLEMENTATION PLAN SCOPING TABLES
APPENDIX C – SPECIFICATIONS
APPENDIX D – SWBNO GRID CONTROL SYSTEM FEED STUDY
APPENDIX E – SAMPLE CONTRACT

INDEX – APPENDIX A
FOR
INSTALLATION AND IMPLEMENTATION OF A GRID CONTROL SYSTEM

FILE	DESCRIPTION
SWBNO-E-SK-30.00	**ELECTRICAL ONE LINE DIAGRAM – SKETCH CARROLLTON WATER PLANT OVERALL ONELINE**

NOTES:

1. TRANSFORMER HAS A HIGH SIDE TAP CHANGER AND A LOW SIDE TAP CHANGER. REFERENCE ENERGY DOCUMENTATION.



SKETCH

ELECTRICAL ONE LINE DIAGRAM -- SKETCH
CARROLLTON WATER PLANT
OVERALL ONELINE
9/10/2024

PROJECT NO:

SKETCH NO: SWBNO-E-SK-30.00

INDEX – APPENDIX B
FOR
INSTALLATION AND IMPLEMENTATION OF A GRID CONTROL SYSTEM

FILE	DESCRIPTION
SWBNO-OBJ-LIST	**SWBNO GRID CONTROL OBJECT LIST AND IMPLEMENTATION PLAN SCOPING TABLES**

SCOPE Part	SCOPE Group	SCOPE Description
Part 0		
	GCS Common Platform	Base GCS software deployment
		Base GCS hardware additions to PDCS
		Base GCS integration into PDCS HMI; 'common' HMI 'templates'
		Testing of all Part provided modifications
	GCS Generation Coordination and Control	Develop 'template' Generator 'app'
		Develop 'template' Generator PDCS HMI interface/graphics
	GCS Distribution Coordination and Control	Develop 'template' Distribution Coordination/Control 'app'
		Develop 'template' Distribution PDCS HMI interface/graphics
	GCS Load Management	Develop 'template' Load tables/'app'
		Develop 'template' Load PDCS HMI interface/graphics
	GCS Reporting	Develop 'template' reports
	Non-GCS Services	Review of existing PDCS configuration
Part 1		
	GCS Common Platform	Testing of all Part provided modifications
	GCS Generation Coordination and Control	Configure Part Generation/Source assets per template app
	GCS Distribution Coordination and Control	Configure Part Distribution Coordination/Control assets per template app
	GCS Load Management	Configure Part Load tables/app per template
	GCS Reporting	Configure Part reports per template
	Non-GCS Services	20EA x 30step 'predefined PDCS switching sequences'
Part 2		
	GCS Common Platform	Testing of all Part provided modifications
	GCS Generation Coordination and Control	Configure Part Generation/Source assets per template app
	GCS Distribution Coordination and Control	Configure Part Distribution Coordination/Control assets per template app
	GCS Load Management	Configure Part Load tables/app per template
	GCS Reporting	Configure Part reports per template
	Non-GCS Services	(10% of Part total elements)EA x 30step 'predefined PDCS switching sequences'
Part 3		
	GCS Common Platform	Testing of all Part provided modifications
	GCS Generation Coordination and Control	Configure Part Generation/Source assets per template app
	GCS Distribution Coordination and Control	Configure Part Distribution Coordination/Control assets per template app
	GCS Load Management	Configure Part Load tables/app per template
	GCS Reporting	Configure Part reports per template
	Non-GCS Services	(10% of Part total elements)EA x 30step 'predefined PDCS switching sequences'
Part Future	<To Be Determined>	<To Be Determined>

PART	PART ID	Part Total	Generation/Source Assets (GSA)	Distribution Control Points (DCP)	Load Control Points (LCP)	Utility Interface Control Points (UICP)	Independent Networks (INDN)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Implementation TOTAL:			23	38	32	10	33									
Part 0	0	0	0	0	0	0	0									
Part 1	1	39	3	13	10	1	12									
Part 2	2	11	1	6	3	0	1									
Part 3	3	30	3	6	11	3	7									
Future Parts	F	56	16	13	8	6	13									

APC_0	APC_1	APC_2	APC_3	APC_4	APC_5	APC_6	APC_7	APC_8
Generation/Source Asset	PDCS	GSA Part	DCP Part	LCP Part	UICP Part	INDN Part	APC_7	APC_8
CWPCTG-6-EMV60-CTG-06		1	--	--	--	--		
CWPCTG-6-EMV60-SG-300		--	1	1	--	1		
CWPEMD-0-EMV60-BB-200		--	F	--	--	--		
CWPEMD-1-EMV60-EMD-01		F	--	--	--	F		
CWPEMD-1-EMV60-SG-201		--	F	--	--	--		
CWPEMD-2-EMV60-EMD-02		F	--	--	--	F		
CWPEMD-2-EMV60-SG-201		--	F	--	--	--		
CWPEMD-3-EMV60-EMD-03		F	--	--	--	F		
CWPEMD-3-EMV60-SG-201		--	F	--	--	--		
CWPEMD-4-EMV60-EMD-04		F	--	--	--	F		
CWPEMD-4-EMV60-SG-201		--	F	--	--	--		
CWPEMD-5-EMV60-EMD-05		F	--	--	--	F		
CWPEMD-5-EMV60-SG-201		--	F	--	--	--		
CWPPH-4-EMV25-SG-101		--	3	--	--	3		
CWPPH-4-EMV25-STG-04		3	--	--	--	--		
CWPPH-5-EMV25-CTG-05		3	--	--	--	--		
CWPPH-5-EMV25-SG-101		--	3	--	--	3		
CWPYRD-0-EMV60-SG-201A		--	--	2	--	--		
CWPYRD-0-EMV60-SG-201B		--	--	2	--	--		
DPS01-0-EMV60-SG-201		--	--	F	--	--		
DPS17-0-EMV60-SG-201		--	--	--	F	--		
PWCLA-0-EMV25-SG-101A		--	--	3	--	--		
PWCLA-0-EMV25-SG-101B		--	--	3	--	--		
PWPAN-0-EMV25-SG-101		--	--	3	--	--		
RSOS-0-EMV60-SG-201		--	--	F	--	--		
RSOS-0-EMV60-SG-202		--	--	--	F	--		
SSCC-0-EMV25-SG-101A		--	1	1	--	1		
SSCC-0-EMV25-SG-101B		--	1	1	--	1		
SSCC-0-EMV25-SG-102A		--	1	1	--	1		
SSCC-0-EMV25-SG-102B		--	1	1	--	1		
SSCC-0-EMV25-SG-102C		--	1	1	--	1		
SSCFC-0-EMV25-RFC-01		F	--	--	--	--		
SSCFC-0-EMV25-RFC-02		F	--	--	--	--		
SSCFC-0-EMV25-SG-101		--	F	--	--	--		
SSCFC-0-EMV60-RFC-01		F	--	--	--	--		
SSCFC-0-EMV60-RFC-02		F	--	--	--	--		
SSCFC-0-EMV60-SG-201		--	F	--	F	--		
SSCLA-0-EMV60-SG-201		--	2	3	3	3		
SSHAM-0-EMV60-SG-201A		--	2	3	--	3		
SSHAM-0-EMV60-SG-201B		--	3	3	--	3		
SSPFC-0-EMV25-RFC-01		F	--	--	--	--		
SSPFC-0-EMV25-SG-101		--	F	--	--	--		
SSPFC-0-EMV60-RFC-01		F	--	--	--	--		
SSPFC-0-EMV60-SG-201A		--	2	3	--	--		
SSPFC-0-EMV60-SG-201B		--	Y	3	--	--		
SSPFC-0-EMV60-SG-201C		--	Y	3	--	--		
SSSYC-0-EMV60-SG-201		--	3	3	3	3		
SSYRD-0-EMV25-SG-101A		--	1	--	--	1		
SSYRD-0-EMV25-SG-101B		--	1	--	--	1		
WPCAUX-0-ELV60-SG-401A		--	--	1	--	--		
WPCAUX-0-ELV60-SG-401B		--	--	F	--	--		
WPCAUX-0-EMV60-DG-01		F	--	--	--	--		
WPCAUX-0-EMV60-DG-02		F	--	--	--	--		
WPCAUX-0-EMV60-SG-301A		--	1	--	--	1		
WPCAUX-0-EMV60-SG-301B		--	F	--	--	F		
WPCAUX-T-EMV60-SG-201		--	1	1	1	1		
WPCCTG-7-EMV60-CTG-07		1	--	--	--	--		
WPCCTG-7-EMV60-SG-201		--	1	1	--	1		
WPCCTG-8-EMV60-CTG-08		F	--	--	--	--		

WPCCTG-8-EMV60-SG-201	--	F	F	--	F
WPCCTG-9-EMV60-CTG-09	F	--	--	--	--
WPCCTG-9-EMV60-SG-201	--	F	F	--	F
WPCPDA-0-EMV60-SG-201	--	--	--	F	F
WPCPDA-0-EMV60-SG-202	--	--	--	F	F
WPCSFC-1-EMV25-SG-101	--	1	--	--	--
WPCSFC-1-EMV60-SFC-01	1	--	--	--	--
WPCSFC-1-EMV60-SG-201	--	1	1	--	--
WPCSFC-2-EMV25-SG-101	--	2	--	--	--
WPCSFC-2-EMV60-SFC-02	2	--	--	--	--
WPCSFC-2-EMV60-SG-201	--	2	2	--	--
WPCSFC-3-EMV25-SG-101	--	3	--	--	--
WPCSFC-3-EMV60-SFC-03	3	--	--	--	--
WPCSFC-3-EMV60-SG-201	--	3	3	--	--
zPart Future	F	F	--	--	--
zPhase Future	--	--	F	F	F
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	--	--	--	--	--

GSA_0	GSA_1	GSA_2	GSA_3	GSA_4	GSA_5	GSA_6	GSA_7	GSA_8
Generation/Source Asset	PDCS	GSA Part	GSA_3	GSA_4	GSA_5	GSA_6	GSA_7	GSA_8
CWPCTG-6-EMV60-CTG-06	Y	1						
CWPEMD-1-EMV60-EMD-01	Y	F						
CWPEMD-2-EMV60-EMD-02	Y	F						
CWPEMD-3-EMV60-EMD-03	Y	F						
CWPEMD-4-EMV60-EMD-04	Y	F						
CWPEMD-5-EMV60-EMD-05	Y	F						
CWPPH-4-EMV25-STG-04	Y	3						
CWPPH-5-EMV25-CTG-05	Y	3						
SSCFC-0-EMV25-RFC-01	F	F						
SSCFC-0-EMV25-RFC-02	F	F						
SSCFC-0-EMV60-RFC-01	F	F						
SSCFC-0-EMV60-RFC-02	F	F						
SSPFC-0-EMV25-RFC-01	F	F						
SSPFC-0-EMV60-RFC-01	F	F						
WPCAUX-0-EMV60-DG-01	Y	F						
WPCAUX-0-EMV60-DG-02	Y	F						
WPCCTG-7-EMV60-CTG-07	Y	1						
WPCCTG-8-EMV60-CTG-08	Y	F						
WPCCTG-9-EMV60-CTG-09	Y	F						
WPCSFC-1-EMV60-SFC-01	Y	1						
WPCSFC-2-EMV60-SFC-02	Y	2						
WPCSFC-3-EMV60-SFC-03	Y	3						
zPart Future	F	F						

DCP_0	DCP_1	DCP_2	DCP_3	DCP_4	DCP_5	DCP_6	DCP_7	DCP_8
Distribution Control Points	PDCS	DCP Part	DCP_3	DCP_4	DCP_5	DCP_6	DCP_7	DCP_8
CWPCTG-6-EMV60-SG-300	Y	1						
CWPEMD-0-EMV60-BB-200	N	F						
CWPEMD-1-EMV60-SG-201	Y	F						
CWPEMD-2-EMV60-SG-201	Y	F						
CWPEMD-3-EMV60-SG-201	Y	F						
CWPEMD-4-EMV60-SG-201	Y	F						
CWPEMD-5-EMV60-SG-201	Y	F						
CWPPH-4-EMV25-SG-101	Y	3						
CWPPH-5-EMV25-SG-101	Y	3						
CWPYRD-0-EMV60-SG-201	Y	2						
SSCC-0-EMV25-SG-101A	Y	1						
SSCC-0-EMV25-SG-101B	Y	1						
SSCC-0-EMV25-SG-102A	Y	1						
SSCC-0-EMV25-SG-102B	Y	1						
SSCC-0-EMV25-SG-102C	Y	1						
SSCFC-0-EMV25-SG-101	?	F						
SSCFC-0-EMV60-SG-201	?	F						
SSCLA-0-EMV60-SG-201	Y	2						
SSHAM-0-EMV60-SG-201A	Y	2						
SSHAM-0-EMV60-SG-201B	Y	3						
SSPFC-0-EMV25-SG-101	N	F						
SSPFC-0-EMV60-SG-201A	Y	2						
SSPFC-0-EMV60-SG-201B	N	Y						
SSPFC-0-EMV60-SG-201C	N	Y						
SSSYC-0-EMV60-SG-201	Y	3						
SSYRD-0-EMV25-SG-101A	Y	1						
SSYRD-0-EMV25-SG-101B	Y	1						
WPCAUX-0-EMV60-SG-301A	Y	1						
WPCAUX-0-EMV60-SG-301B	Y	F						
WPCAUX-T-EMV60-SG-201	Y	1						
WPCCTG-7-EMV60-SG-201	Y	1						
WPCCTG-8-EMV60-SG-201	Y	F						
WPCCTG-9-EMV60-SG-201	Y	F						
WPCSFC-1-EMV25-SG-101	Y	1						
WPCSFC-1-EMV60-SG-201	Y	1						
WPCSFC-2-EMV25-SG-101	Y	2						
WPCSFC-2-EMV60-SG-201	Y	2						
WPCSFC-3-EMV25-SG-101	Y	3						
WPCSFC-3-EMV60-SG-201	Y	3						
zPart Future	?	F						

LCP_0	LCP_1	LCP_2	LCP_3	LCP_4	LCP_5	LCP_6	LCP_7	LCP_8
Load Control Points	PDCS	LCP Part	LCP_3	LCP_4	LCP_5	LCP_6	LCP_7	LCP_8
CWPCTG-6-EMV60-SG-300	Y	1						
CWPYRD-0-EMV60-SG-201A	Y	2						
CWPYRD-0-EMV60-SG-201B	Y	2						
DPS01-0-EMV60-SG-201	F	F						
PWCLA-0-EMV25-SG-101A	Y	3						
PWCLA-0-EMV25-SG-101B	Y	3						
PWPAN-0-EMV25-SG-101	Y	3						
RSOS-0-EMV60-SG-201	F	F						
SSCC-0-EMV25-SG-101A	Y	1						
SSCC-0-EMV25-SG-101B	Y	1						
SSCC-0-EMV25-SG-102A	Y	1						
SSCC-0-EMV25-SG-102B	Y	1						
SSCC-0-EMV25-SG-102C	Y	1						
SSCLA-0-EMV60-SG-201	Y	3						
SSHAM-0-EMV60-SG-201A	Y	3						
SSHAM-0-EMV60-SG-201B	Y	3						
SSPFC-0-EMV60-SG-201A	Y	3						
SSPFC-0-EMV60-SG-201B	N	3						
SSPFC-0-EMV60-SG-201C	N	3						
SSSYC-0-EMV60-SG-201	Y	3						
WPCAUX-0-ELV60-SG-401A	Y	1						
WPCAUX-0-ELV60-SG-401B	Y	F						
WPCAUX-T-EMV60-SG-201	Y	1						
WPCCTG-7-EMV60-SG-201	Y	1						
WPCCTG-8-EMV60-SG-201	Y	F						
WPCCTG-9-EMV60-SG-201	Y	F						
WPCPDA-0-EMV60-SG201	Y	F						
WPCPDA-0-EMV60-SG202	Y	F						
WPCSFC-1-EMV60-SG-201	Y	1						
WPCSFC-2-EMV60-SG-201	Y	2						
WPCSFC-3-EMV60-SG-201	Y	3						
zPhase Future	F	F						

UICP_0	UICP_1	UICP_2	UICP_3	UICP_4	UICP_5	UICP_6	UICP_7	UICP_8
Utility Interface Control Points	PDCS	UICP Part	UICP_3	UICP_4	UICP_5	UICP_6	UICP_7	UICP_8
DPS17-0-EMV60-SG-201	F	F						
RSOS-0-EMV60-SG-202	F	F						
SSCFC-0-EMV60-SG-201	F	F						
SSCLA-0-EMV60-SG-201	Y	3						
SSHAM-0-EMV60-SG-201	Y	3						
SSSYC-0-EMV60-SG-201	Y	3						
WPCAUX-T-EMV60-SG-201	Y	1						
WPCPDA-0-EMV60-SG-201	Y	F						
WPCPDA-0-EMV60-SG-202	Y	F						
zPhase Future	F	F						

INDN_0	INDN_1	INDN_2	INDN_3	INDN_4	INDN_5	INDN_6	INDN_7	INDN_8
Independent Networks	PDCS	INDN Part	INDN_3	INDN_4	INDN_5	INDN_6	INDN_7	INDN_8
CWPCTG-6-EMV60-SG-300	Y	1						
CWPEMD-1-EMV60-EMD-01	F	F						
CWPEMD-2-EMV60-EMD-02	F	F						
CWPEMD-3-EMV60-EMD-03	F	F						
CWPEMD-4-EMV60-EMD-04	F	F						
CWPEMD-5-EMV60-EMD-05	F	F						
CWPPH-4-EMV25-SG-101	Y	3						
CWPPH-5-EMV25-SG-101	Y	3						
SSCC-0-EMV25-SG-101A	Y	1						
SSCC-0-EMV25-SG-101B	Y	1						
SSCC-0-EMV25-SG-102A	Y	1						
SSCC-0-EMV25-SG-102B	Y	1						
SSCC-0-EMV25-SG-102C	Y	1						
SSCFC-0-EMV60-SG-201A	F	F						
SSCFC-0-EMV60-SG-201B	F	F						
SSCLA-0-EMV60-SG-201	Y	3						
SSHAM-0-EMV60-SG-201A	Y	3						
SSHAM-0-EMV60-SG-201B	Y	3						
SSSYC-0-EMV60-SG-201	Y	3						
SSYRD-0-EMV25-SG-101A	Y	1						
SSYRD-0-EMV25-SG-101B	Y	1						
WPCAUX-0-EMV60-SG-301A	Y	1						
WPCAUX-0-EMV60-SG-301B	Y	F						
WPCAUX-T-EMV60-SG-201	Y	1						
WPCCTG-7-EMV60-SG-201	Y	1						
WPCCTG-8-EMV60-SG-201	Y	F						
WPCCTG-9-EMV60-SG-201	Y	F						
WPCPDA-0-EMV60-SG-201	Y	F						
WPCPDA-0-EMV60-SG-202	Y	F						
WPCSFC-1-EMV60-SG-101	Y	1						
WPCSFC-2-EMV60-SG-101	Y	2						
WPCSFC-3-EMV60-SG-101	Y	3						
zPhase Future	F	F						

INDEX – APPENDIX C
FOR
INSTALLATION AND IMPLEMENTATION OF A GRID CONTROL SYSTEM

FILE	DESCRIPTION
01.31.13	**PROJECT COORDINATION**
01.31.19	**PROJECT MEETINGS**
01.32.00	**LARGE CONSTRUCTION PROGRESS DOCUMENTATION**
01.33.00.00	**SUBMITTAL PROCEDURES** **Supplement: Project Specific Records Management Information**
01.42.13	**ABBREVIATIONS AND ACRONYMS**
01.43.33	**MANUFACTURERS FIELD SERVICE**
01.45.16.13	**CONTRACTOR QUALITY CONTROL**
01.58.53	**PROJECT EQUIPMENT IDENTIFICATION**
01.61.00	**COMMON PRODUCT REQUIREMENTS**
01.77.00	**CLOSEOUT PROCEDURES**
01.78.23	**OPERATION MAINTENANCE DATA**
01.91.14	**EQUIPMENT TESTING PROJECT STARUP**
25.05.11	**CYBERSECURITY FOR FACILITY RELATED CONTROLS SYSTEMS**
26.00.00	**ELECTRICAL GENERAL REQUIREMENT**

FILE	DESCRIPTION
26.05.19	**LOW VOLTAGE WIRE AND CABLE**
26.05.50	**ELECTRICAL EQUIPMENT INSTALLATION**
26.05.75	**BASIC ELECTRICAL MATERIALS AND METHODS** **Supplement: Hi-Pot Test Form**
26.33.55	**DC-AC UPS SYSTEMS**
27.05.26	**GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**
27.13.23	**COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING**
27.15.13	**COMMUNICATIONS COPPER HORIZONTAL CABLING**
27.15.23	**COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING**
40.90.00	**I&C GENERAL REQUIREMENTS**
40.90.13	**CONCEPT OF OPERATIONS FRAMEWORK**
40.94.23	**PDCS ELECTRICAL CONTROL SYSTEM SPECIFICATION**
40.94.24	**PDCS HUMAN MACHINE INTERFACE SPECIFICATION** **Supplements: PDCS HMI Graphics Standard** **PDCS HMI Graphics Standard Example 0** **PDCS HMI Graphics Standard Example 4**
40.94.25	**PDCS DATA EXCHANGE INTERFACE**
40.94.26	**PDCS GRID CONTROL SYSTEM**

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational:

1. Work Sequencing Plan: Submit detailed plan including all equipment, materials, labor necessary to complete installation of all new equipment and components.
2. Statement of Qualification (SOQ) for land surveyor or Professional Engineer.
3. Photographs and Video Recordings.

B. Action:

1. Contamination Mitigation Plan: Submit detailed plan including all equipment, materials, and labor necessary to protect the existing water treatment process and potable water system.
2. Outage and Shutdown Requests: Submit utility outage and shut down request 14 days ahead of required outage or shut down.

1.02 RELATED WORK AT SITE

A. General:

1. Other work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
   a. Contract 1447, Boiler House Fan Modifications.
   b. Contract 1391, Bulk Chemical Storage Project.
   c. Contract 1415, WPC Foundations and Underground Package.
   d. Contract 1418, Utility Rack.
   e. Contract 1417, SFC Procurement (includes testing and commissioning support).
   f. Contract 1420, WPC Phase 1 Installation and Commissioning.
   g. Contract 1427, Packaged Auxiliary Equipment (includes testing and commissioning support).
   h. Contract 1438, CTG Procurement (includes testing and commissioning support).
   i. Contract 1435, Electrical and Control Cable (includes testing and commissioning support).
   j. Contract 1440, GSU Transformer Procurement (includes testing and commissioning support).
   k. Contract 1443, Claiborne Water Supply Tie-in

l. Entergy Substation (in the C8 Basin by Entergy).

2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.

3. Include sequencing constraints specified herein as a part of Progress Schedule.

B. Agency and Contact Person(s): A list of contact names/numbers will be provided by the Owner as part of the preconstruction conference. Contractor will be responsible for coordination of all work with the applicable agency in accordance with the requirements to complete the work detailed within these Documents.

1.03 OWNER-FURNISHED PRODUCTS

A. As noted in Project specific Section 01 11 01, Project Summary of Work.

1.04 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.

B. Project work at the SWBNO Carrollton Water Purification Plant requires the Contractor to take abundant precaution to avoid any contamination of the water treatment process on site. Construction debris is not allowed to enter the C and L water basins at any time. Contamination of the water supply will be categorized as damages as defined in the General Conditions.

1.05 WORK SEQUENCING/CONSTRAINTS

A. Include the following work sequences and constraints in the GCS Progress Schedule:

1. The major construction sequences in the Project Schedule shall be included in the Contractor’s detailed schedule, including at a minimum:

a. NTP

b. Kickoff Meeting

c. Design Charrette

d. Activities associated with Scope Part 0 as defined in Specification 40 94 26.PDCS, PDCS Grid Control System

e. Activities associated with Scope Part 1 as defined in Specification 40 94 26.PDCS, PDCS Grid Control System

f. Activities associated with Scope Part 2 as defined in Specification 40 94 26.PDCS, PDCS Grid Control System

g. Activities associated with Scope Part 3 as defined in Specification 40 94 26.PDCS, PDCS Grid Control System

h. Activities associated with Hardware-In-The-Loop (HIL) testing as defined in Specification 40 94 26.PDCS, PDCS Grid Control System
i. Activities associated with Factory Acceptance Testing (FAT) as defined in Specification 40 94 26.PDCS, PDCS Grid Control System
j. Activities associated with Site Acceptance Testing (SAT) as defined in Specification 40 94 26.PDCS, PDCS Grid Control System
k. Commissioning, Startup. Additional scope of work items as may be referenced in Section 01 11 01, Project Summary of Work.
l. Testing, startup, and commissioning of the full system following integration of individual components.
m. Turn-over and substantial completion.
n. Final Acceptance.

2. The Progress Schedule prepared by the Contractor should include a detailed breakdown of the following activities to accommodate coordination with other contractors on site:
   a. Potential outage requests.
   b. Receipt of deliveries and associated staging and marshalling.
   c. Approximate timing for inspections.
   d. Construction activities associated with equipment and material deliveries.
   e. Construction activities associated with tie-ins to existing facilities.

B. Work Sequencing Considerations:

1. Owner supplied equipment is to be received and set as close to NTP as reasonably possible.
2. Refer to Specification Section 01 11 01, Project Summary of Work for Completion Dates.

C. The information provided herein should not be relied upon by the Contractor as fully complete, comprehensive, or fully detailed. Contractor shall make his own assessment and determination of requirements that affect or may affect the progress, sequence, or cost of the Work.

1.06 FACILITY OPERATIONS

A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified. Contractor will be responsible for any costs/labor associated with repair and restart of any facilities damaged by Contractor.

B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.

C. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.

D. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.

E. Construct Work to allow for Owner's continuous occupancy and for uninterrupted operation during construction.

1.07 MAINTENANCE OF PLANT OPERATIONS (MOPO)

A. In order to maintain the high reliability of the water plant and power plant, outages of major processes must be carefully scheduled. Where applicable, redundant equipment will be operated while the other one is out of service. Advance planning and approval by the Owner based on current plant conditions and predicted weather forecasts will be required.

1. The Contractor shall coordinate the outages based on the Contractor's detailed execution planning and in coordination with the Owner.
2. Where applicable, when a major piece of equipment is out of service then all associated work for piping, controls and instrumentation shall be scheduled simultaneously. This optimizes the outage work and avoids multiple small outages.

1.08 CONSTRUCTION SEQUENCING

A. The construction sequence information here is provided for general guidance only. It is consistent with the MOPO section and the Project Schedule. Contractor shall develop the detailed construction schedule and sequence planning and submit separately.

B. Individual components and equipment in a system shall be installed and completed in a sequence that will permit systematic checkout and operation of each component before initial operation of the system.

C. Process or Facility Shutdown/Outage:

1. Provide 14 days advance written request for approval of need to shut down or interrupt a process or facility to Owner. Submission of request does not constitute approval. Contractor shall allow 7 days decision time for Owner, and adequate time to coordinate the effort following the decision.

2. Power outages will be considered upon 48 hours written request to Owner. Describe the reason, anticipated length of time, and areas affected by the outage. In the event operating systems must be kept in service, provide temporary provisions for continuous power supply to critical facility components.

D. Install and maintain bypass facilities and/or temporary connections required to keep Owner's operations on-line. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

E. Do not proceed with Work affecting a facility's operation without obtaining Owner's advance approval of the need for and duration of such Work.

F. Relocation of Existing Facilities:

1. During construction, it is expected that relocations of Work may be necessary.
2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.09 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs and Article Audio-Video Recordings. Upon receipt, Engineer will review,

sign, and return one record copy of documentation to Contractor to be kept on file in field office.

2. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.10 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
3. Digital Images: No post-session electronic editing of images is allowed. Stored image shall be actual image as captured without cropping or other edits.

B. Preconstruction and Post-Construction:

1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take a minimum of 100 photographs of Site and property adjacent to perimeter of Site.
2. Particular emphasis shall be directed to structures both inside and outside the Site.

C. Construction Progress Photos: Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.

D. Documentation:

1. Digital Images:
   a. Electronic image shall have date taken embedded into image.
   b. Archive using a commercially available photo management system that provides listing of photographs including date, keyword description, and direction of photograph.
   c. Label each disk with Project and Owner's name, and month and year images were produced.

1.11 AUDIO-VIDEO RECORDINGS

A. Prior to beginning the Work on Site or of a particular area of the Work, and again within 10 days following date of Substantial Completion, videograph Site and property adjacent to Site.

B. In the case of preconstruction recording, no work shall begin in the area prior to Engineer's review and approval of content and quality of video for that area.

C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within areas where excavation shall be performed and areas adjacent to and within the right-of-way or easement, and on Contractor storage and staging areas.

D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.

E. Video Format and Quality:

1. Digital format, with sound.
2. Video:
   a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
   b. Electronically, and accurately display the month, day, year, and time of day of the recording.
3. Audio:
   a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
   b. Indicate date, project name, and a brief description of the location of recording, including:
      1) Facility name.
      2) Street names or easements.
      3) Addresses of private property.
      4) Direction of coverage, including engineering stationing, if applicable.

F. Documentation:

1. Digital Video File Name:
   a. Video number (numbered sequentially, beginning with 001).
   b. Project name.
   c. Date and time of coverage.
2. Project Video Log: Maintain an ongoing log that incorporates above noted label information for Videos on Project.

1.12 REFERENCE POINTS AND SURVEYS

A. Owner's Responsibilities:

1. Establish benchmarks convenient to Work.
2. Establish horizontal reference points or coordinate system with benchmarks and reference points for Contractor's use as necessary to lay out Work.

B. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
5. Retain professional land surveyor or civil engineer registered in state of Project who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
6. Maintain complete accurate log of survey work as it progresses as a Record Document.
7. On request of Engineer, submit documentation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGE OF MATERIALS

A. Owner reserves the right to remove/salvage equipment during the course of demolition.

B. Meet with Engineer and Owner prior to starting to dismantle equipment or piping designated to be salvaged. Contractor shall indicate locations where equipment is to be disconnected and submit for Engineer review and approval.

C. Provide new or repair damaged equipment or material specified or indicated to be salvaged. Clean and protect equipment from dust, dirt, natural elements, and store as directed.

3.02 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Engineer before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
2. Weather-resistant or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.
3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on the Drawings.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by Owner or Engineer.

3.03 CONSTRUCTION EXECUTION

A. Any hot work – welding, grinding, cutting, etc. – must be coordinated with the Owner prior to start of work. Proper warning signs, barricades, drop curtains and other appropriate safety measures shall be taken to protect all personnel and equipment in the work area.

B. Contractor’s detailed schedule shall show placement of orders, receipt of drawings, approval of drawings, release to fabrication and fabrication and delivery to Site in detail for each major engineered equipment item with suitable adjustment for Contractor’s execution plan.

C. Prior to any outage all materials, equipment, utilities, and construction tools shall be staged on-site and ready for installation during the outage. Outages shall not be extended due to lack of preparation by Contractor.

D. Contractor shall coordinate with the Owner for Lock-Out / Tag-Out (LOTO) of equipment. Refer to Section 01 91 14, Equipment Testing Facility Startup.

E. The Owner will furnish limited operating personnel during commissioning, startup and testing. Contractor shall request and schedule with the Owner a minimum of 14 days in advance of the need for operating personnel. The Owner will be the only party authorized to operate permanent plant equipment.

F. It is the Contractor's responsibility to protect all equipment from damage and debris during surface preparation. In areas of buildings and machinery that the Contractor and Engineer agree can be damaged by blasting operations, power tool cleaning should be used instead. If blasting occurs it is absolutely unacceptable to allow any damage to any equipment that is vital to the operations of the Sewerage and Water Board.

3.04 PROJECT SPECIFIC CONSIDERATIONS

A. General SWBNO site conditions to observe:

1. All Contractors will be subject to security protocol while on site:
   a. Personnel must be registered with security.
   b. All personnel enter through the security gates of the plant.
   c. All personnel to be compliant with COVID protocols.
2. All work to be coordinated with SWBNO plant activities to minimize plant process impact and outage.
3. Only construction vehicles with company logo/designation are allowed in the plant with the permission of the Owner.
4. Areas are limited for Contractor's temporary facilities and material/equipment laydown. Contractor shall propose areas for such use, for review and approval by the Owner.
5. Power for office and construction, internet, phone, sanitary, water services is the Contractor's responsibility.
6. It is the Contractor's responsibility to secure offsite facilities for parking and material storage. Transportation to and from parking/storage site and the plant is the Contractor's responsibility.
7. SWBNO will provide access to the SWBNO Knox Street yard for staging and storage of construction equipment and materials as space allows, this is a shared space with SWBNO materials and other contractors. If the Contractor needs larger storge space it is the Contractor's responsibility to secure offsite facilities. Transportation to and from storage site and the plant is the Contractor's responsibility. The storage and staging of materials in the SWBNO yard will be safe, neat, and orderly.
8. In the event of SWBNO process emergency the Contractor will stop work and relinquish the area in question as directed by SWBNO.
9. All cranes and point loading equipment are required to be matted within the plant to reduce ground loading.

B. Site expectations of the C7-C8 basin area:

1. Area back filled with light weight fill restricted load of 2500 pound per square foot.
2. Expected water table level at two feet below grade.
3. Access from Gate off northwest corner of plant on Claiborne Avenue.

4. Limited access requires coordination with other contractors due to shared space with other contracts, including but not limited to ongoing 1415 Contract.

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. Engineer will schedule meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. Contractor shall be prepared to discuss the following subjects, as a minimum:

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Progress payment procedures.
5. Project changes and clarification procedures.
6. Use of Site, access, office and storage areas, security and temporary facilities.
7. Major product delivery and priorities.
8. Contractor’s safety plan and representative.

B. Attendees will include:

1. Owner’s representatives.
2. Contractor’s office representative.
3. Contractor’s Resident Superintendent.
4. Contractor’s Safety Manager.
5. Contractor’s quality control representative.
6. Subcontractors’ representatives whom Contractor may desire, or Engineer may request to attend.
7. Engineer’s representatives.
8. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Large Construction Progress Documentation, if required by the Scope of Work.

1.04 PROGRESS MEETINGS

A. Engineer will schedule and facilitate regular progress meetings, conducted weekly to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.

B. Attendees will include:

1. Owner’s representative(s).
2. Contractor, Subcontractors, and Suppliers, as appropriate.
3. Engineer/Designer representative(s).
4. Others as appropriate.

C. The minimum agenda for progress meetings shall consist of the following:

1. Review and approve notes of previous meetings.
2. Review work progress since last meeting.
3. Review three-week look-ahead schedule.
4. Note field observations, problems and decisions.
5. Identify problems that currently, can, or will impede planned progress.
6. Review off site fabrication problems.
7. Review Contractor's revision(s) to the construction schedule as outlined in the Supplementary Conditions.
8. Review Contractor's corrective measures and procedures to regain plan schedule (as applicable).
9. Review submittal schedule; coordinate expediting actions as appropriate to maintain schedule.
10. Review pertinent quality and work standards.
11. Review Owner-proposed and/or Contractor-proposed changes for their effect on the construction schedule and completion date.
12. Schedule any other meetings and define attendees.
13. Complete other current business.

D. The meeting will also recognize issues and questions as addressed by attendees. Those questions not resolved will be assigned an action party for follow-up, with a defined response date.

1.05 QUALITY CONTROL MEETINGS

A. In accordance with Section 01 45 16.13, Contractor Quality Control, if required by the Scope of Work.

B. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of the Work. At a minimum these meetings shall be held prior to initiating work in a specific trade, discipline, or facet of the Work (essentially, this equates to the Work addressed by each section or group of closely related sections within the Contract Specifications).

C. As deemed necessary during the Work, the Engineer will schedule meetings to review the Contract Documents, the Contractor's quality control plan and procedures, progress reporting procedures, and measurement and payment procedures for that specific trade, discipline, or facet of the Work, and other matters relating to quality control of the Work.

D. Attendees will include:

1. Contractor's Quality Control Manager.
2. Contractor's designated quality control representative(s).
3. Subcontractors and Suppliers, as necessary.
4. Owner's Representative.
5. Owner's Quality Assurance Representatives.
6. Engineer's representatives, as appropriate.

1.06 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

A. Engineer will schedule meetings at Site, conducted monthly to review specific requirements of PICS work.

B. Attendees will include:

1. Contractor.
2. Owner.
3. PICS Subcontractor/Installer.
4. Engineer's representatives.

1.07 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) USE CASE DEVELOPMENT

A. Commissioning Agent or System Integrator shall coordinate with Engineer to schedule meetings at Site, conducted no less than monthly to review and develop Use Cases.

B. Attendees will include:

1. Owner.
2. Contractor.
3. Contractor's System Integrator.
4. Contractor's Commissioning Agent.
5. Engineer's representatives.

1.08 SHOP DRAWING/SUBMITTAL COORDINATION MEETING

A. The Engineer will schedule a Shop Drawing coordination meeting shortly after the Preconstruction Conference to review the submittal register to ensure all submittals are properly identified; discuss the submittal process in greater detail to effectively confirm everyone's understanding of the process and its purpose; identify critical submittals and what associated actions are necessary to facilitate their processing; discuss the process for identifying proposed substitutions; identify any concerns associated with the specified products; and collaborate on actions that can help overcome concerns cited. Attendees to the meeting should include the design engineer, the Contractor's Project Manager, the Contractor's Project Engineer, the Quality Control Manager, staff as deemed appropriate by the Contractor's Project Manager, key vendor representatives, key sub-contractor representatives, and appropriate Engineer's staff.

1.09 PREINSTALLATION MEETINGS

A. When required in individual Specification sections, convene at Site prior to commencing the Work of that section.

B. Require attendance of entities directly affecting, or affected by, the Work of that section.

C. Notify Engineer 14 days in advance of meeting date.

D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.10 FACILITY STARTUP MEETINGS

A. Schedule and attend facility startup meetings as defined in the Contractor-developed Facility Startup Plan, the first of which shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.

B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.

C. Attendees will include:

1. Contractor.
2. Contractor's Quality Control Manager.

3. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility startup.
4. Engineer's representatives.
5. Owner's operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.11 OTHER MEETINGS

A. In accordance with Contract Documents and as may be required by Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 32 00
LARGE CONSTRUCTION PROGRESS DOCUMENTATION

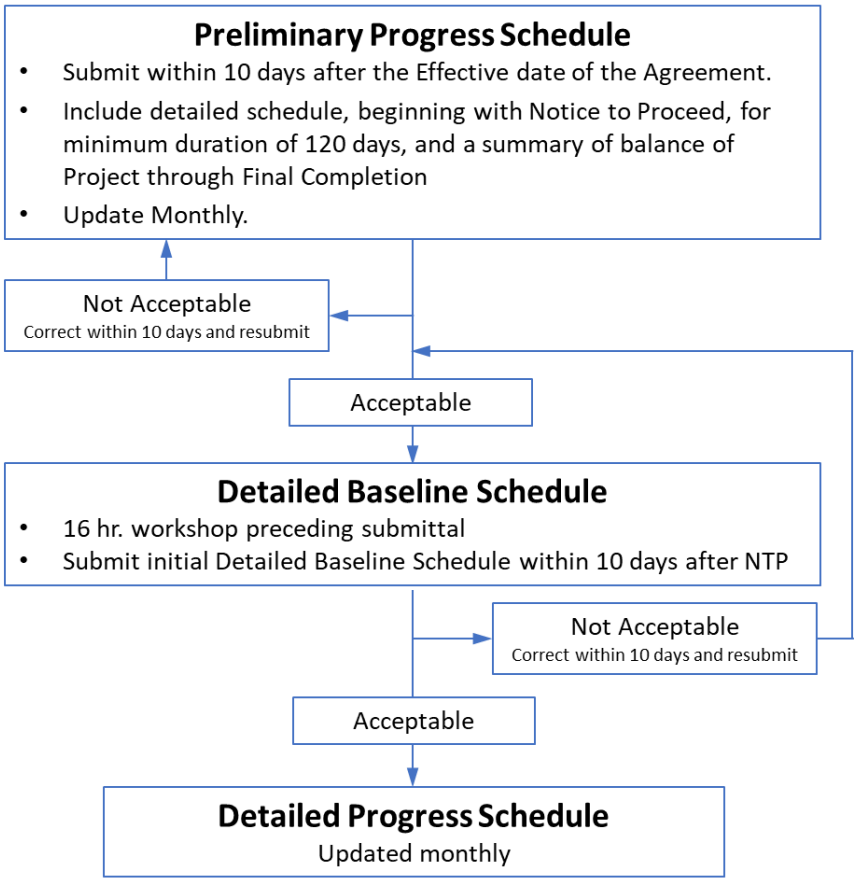
PART 1 GENERAL

1.01 SUBMITTALS

A. Submittals:

1. Scheduler Qualifications: Minimum of five years of experience scheduling construction projects similar in size and nature to this Project with scheduling software, Primavera P6 (current version), or Engineer-approved equivalent, with comprehensive knowledge of CPM scheduling principles and applications, that meets the requirements of this Specification.
2. Schedule Software: Acceptable software is Primavera P6 (current version), or Engineer approved equivalent. A proposed equivalent must be supported by detailed documentation verifying capability of the proposed software. Should the Engineer not have the proposed software for evaluation and use purposes, the Contractor shall provide appropriate copies and licenses necessary for the Engineer to effectively evaluate and implement the software. Said copies/licenses will be returned to the Contractor upon completion of the Work.
3. Preliminary Progress Schedule: Submit within 10 days after the Effective Date of the Agreement. The Preliminary Progress Schedule must include all of the required plan and program preparations, submissions and approvals (Submittals) identified in the Contract, as well as permitting activities intended to occur in the first 120 days. Site Work will not be permitted until the Preliminary Progress Schedule is approved.
4. Detailed Baseline Schedule: Submit Detailed Baseline Schedule within 10 days after Notice to Proceed.
5. Detailed Progress Schedule: Update and submit monthly, at time of Application for Payment, to reflect actual progress and occurrences to date, including delays. Prior to or concurrent with monthly payment, submit a monthly Updated Progress Schedule.
6. Prior to final payment, submit a final Updated Progress Schedule.
7. Detailed Baseline Schedule, and Detailed Progress Schedules shall be accepted in accordance with paragraph 1.07 and as shown in the following chart.

B. Schedule Review and Acceptance



1.02 PRELIMINARY PROGRESS SCHEDULE

A. In accordance with the General Conditions and paragraph 1.05, Progress Schedule—Critical Path Network.

B. Preliminary Progress Schedule shall include a detailed schedule, beginning with Notice to Proceed, for a minimum duration of 120 days, and a summary of balance of Project through Final Completion.

C. Submit within 10 days after the Effective date of the Agreement.

D. Site work will not be permitted until the Preliminary Progress Schedule is accepted.

E. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits: Division 01, General Requirements.

3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
4. Early procurement activities for long lead equipment and materials.
5. Preparatory and Initial Phase meetings.
6. Environmental controls installation.
7. Initial Site work.
8. Earthwork.
9. Specified Work sequences and constraints.
10. Contract Milestone and Completion Dates.
11. Owner-furnished products delivery dates or ranges of dates.
12. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
13. Schedule of Values Milestones – to include all SOV milestones.
14. System startup summary.
15. Project close-out summary.
16. Demobilization summary.

~~F.~~ Format: In accordance with paragraph 1.05 Progress Schedule—Critical Path Network.

1.03 DETAILED BASELINE SCHEDULE AND DETAILED PROGRESS SCHEDULE

A. In accordance with the General Conditions and paragraph 1.05, Progress Schedule—Critical Path Network.

B. Submit Detailed Baseline Progress Schedule within ten days after Notice to Proceed and monthly thereafter as the Updated Progress Schedule continuing through Final Completion.

C. When the Detailed Baseline Schedule is accepted by Engineer, it shall incorporate actual progress from the Preliminary Progress Schedule, replace the un-started activities, and become the Detailed Baseline Schedule. Subsequent revisions will be considered as Detailed or Updated Progress Schedules.

D. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.

E. Project work on Site will include multiple prime contracts with each contract awarded separately.

F. Submit updated Detailed Progress Schedule(s) at the end of the month coinciding with after approval of the Detailed Baseline Schedule. Thereafter, submit Detailed / Updated Progress Schedule(s) monthly prior to or concurrent with Pay Application(s). Update to reflect actual progress and occurrences to date, including delays. Submissions to include Contractor's certification that Detailed Progress Schedule submission is actual schedule being utilized for execution of the Work.

G. Review of Pay Applications will not commence without an Updated Progress Schedule. Failure to submit timely Updated Progress Schedule(s) may result in the Owner withholding all or part of the monthly progress payment until the Detailed Progress Schedule is updated in a manner acceptable to Engineer.

H. Prior to final payment, submit a final Updated Progress Schedule.

1.04 PROGRESS SCHEDULE—CRITICAL PATH NETWORK

A. General: Comprehensive computer-generated schedule using CPM, generally as outlined in Associated General Contractors of America (AGC) 580, "Construction Project Planning and Scheduling Guidelines." If a conflict occurs between the AGC publication and this Specification, this Specification shall govern.

B. Contents:

1. Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. Identify Work calendar basis using days as a unit of measure.
3. Show complete interdependence and sequence of Work and Project-related activities reasonably required to complete the Work.
4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
5. Reflect sequences of the Work, restraints, delivery windows, review times, Contract Times and Project Milestones set forth in the Agreement and Section 01 11 01, Project Summary of Work.
   a. Milestones are to be used for significant project events including, but not limited to, project start and end activities, payment dates, or interim completion date(s).
   b. The first Activity in the Progress Schedule must be a start milestone titled "NTP."
   c. The last Activity in the Progress Schedule must be a finish milestone titled "Project Complete."
6. Include as applicable, at a minimum:
   a. Obtaining permits. See Division 01, General Requirements.
   b. Submittals for early product procurement, and long lead time items.
   c. Mobilization and other preliminary activities.

d. Initial Site work.
e. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s) Subcontract Work.
f. Major equipment design, fabrication, factory testing, and delivery dates.
g. Delivery dates for Owner-furnished products, as specified in Section 01 11 01, Project Summary of Work.
h. Environmental controls implementation.
i. Sitework.
j. Concrete Work.
k. Structural steel Work.
l. Architectural features Work.
m. Conveying systems Work.
n. Equipment Work.
o. Mechanical Work.
p. Electrical Work.
q. Instrumentation and control Work.
r. Interfaces with Owner-furnished equipment.
s. Other important Work for each major facility.
t. Equipment and system startup and test activities.
u. Schedule of Values Milestones – to include all SOV milestones.
v. Project closeout and cleanup.
w. Demobilization.

7. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 calendar day or more than 14 calendar days, unless otherwise approved by the Engineer.

8. Activity duration for Submittal review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from Engineer.

9. Additional requirements:

a. Negative lags shall not be used.
b. Obtain written authorization prior to using lags with Finish-to Start relationships.
c. Do not use Lags in excess of 10 work days.
d. Start-to-Finish relationships are prohibited.
e. Use Retained Logic.
f. Redundant Logic is prohibited.
g. Percent Complete Types must be set to “Physical”.
h. Activity Duration Types must be set to “Fixed Duration and Units”.
i. Only the first activity will not have a predecessor and only the last activity will not have a successor.

C. Network Graphical Display:

1. Plot or print on paper not greater than 30 inches by 42 inches or smaller than 22 inches by 34 inches, unless otherwise approved.
2. Title Block: Show name of Project, Owner, date submitted, revision or update number, and the name of the scheduler. Updated schedules shall indicate Data Date.
3. Identify horizontally across top of schedule the time frame by year, month, and day.
4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
5. Indicate the critical path by setting critical path parameter to 20 days, plus/minus 5 days.
6. Show, at a minimum, the controlling relationships between activities.
7. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
8. Plot activities on an early start basis unless otherwise requested by Engineer.
9. Provide a legend to describe standard and special symbols used.

D. Reports: Four reports shall be submitted with each monthly update. These reports are as follows:

1. Standard Schedule Report:
   a. On 8-1/2-inch by 11-inch white paper, unless otherwise approved.
   b. List information for each activity in tabular format, including at a minimum:
      1) Activity Identification Number.
      2) Activity Description.
      3) Original Duration.
      4) Remaining Duration.
      5) Early Start Date (Actual start on Updated Progress Schedules).
      6) Early Finish Date (Actual finish on Updated Progress Schedules).
      7) Late Start Date.
      8) Late Finish Date.
      9) Total Float.
   c. Sort reports, in ascending order by Activity number.

2. Critical Path Report:
   a. On 8-1/2-inch by 11-inch white paper, unless otherwise approved.
   b. List information for each activity in tabular format, with the same content as for the Standard Schedule Report.
   c. Selected activities will be those activities with five or less days of total float.
   d. Sort reports by total float, in ascending order, starting with 0 days total float. Common total float activities shall be sub-organized by early start date.

1.05 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

1. Progress of Work to within 5 working days prior to submission.
2. Approved changes in Work scope and activities modified since submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.
7. Report of changed logic.

B. Produce detailed sub-schedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

C. Weekly Progress Meetings include an agenda item for a detailed 3-week look-ahead schedule of the work that will address the upcoming 3 weeks and the past week of history. This schedule shall be included with the meeting agenda, and shall be extracted from, and consistent with, the Detailed Progress Schedule and shall provide expanded details as sub-activities of the work forecasted over the period. This update shall feature a sub-set of the latest Detailed Progress Schedule to highlight the status of those activities that are either currently active as of the update, that will start within the upcoming 3 weeks, or that were completed in the past week, including submittal delivery to the Construction Manager, all meetings scheduled or planned, special inspections, special tests (routine testing will be assumed to occur within the corresponding activity), major equipment deliveries, any operational shutdowns/outages, interconnections to existing utilities. The weekly progress update shall be made available to the Construction Manager at least 24 hours prior to the weekly progress meeting. At each meeting, the Contractor shall demonstrate to the satisfaction of the Construction Manager that they have the resources required to perform the portion of the Works included in the construction package as specified; and that the Contractor’s

health, safety and environment, and quality control plans are adequate for the phases of work to be commenced or in progress. All expanded activities within the forecast shall be subsets of current schedule activities. In summary, the forecast shall include:

1. All submittals to be made during the period.
2. Special inspection events.
3. Engineer's observation as required by Special Inspection protocols.
4. All scheduled meetings.
5. All meetings planned or anticipated to be scheduled.
6. Utility interconnections.
7. Owner operations that are scheduled to be interrupted by construction activity.
8. Tie-ins to existing Owner facilities or building services.
9. Greater detail for large scale schedule activities.
10. Critical or major equipment deliveries.
11. Specialty subcontractor activities.
12. Specialty supplier/fabricator activities.
13. Detailed progress report and estimate to complete for any ongoing authorized extra work initiated through the procedures outlined in Section 01 26 00, Contract Modification Procedures.
14. Other details as requested by the Engineer or Construction Manager.

D. If Contractor or Packager fails to complete activity by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones) or if requested by Owner or Engineer, Contractor or Packager shall, within 7 days of such failure, submit a written statement as to how Contractor or Packager intends to correct nonperformance and return to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

E. Owner may order Contractor to increase plant, equipment, labor force or working hours, at Contractor's cost, if Contractor fails to:

1. Complete a Milestone activity by its completion date.

2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

F. Adverse Weather Days:

1. Anticipated Adverse Weather Days shall be shown on the critical path by incorporating them into the work calendar. The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) for temperature, precipitation, and wet ground conditions or similar data for the Project location. Anticipated adverse weather days should be incorporated into weather dependent activities only.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
13	8	8	5	5	7	7	6	6	2	4	11

2. The number of actual Adverse Weather Days shall include days impacted by actual adverse weather such that a significant majority of the planned Work at the Site is prevented from being safely executed, and which therefore requires Contractor to evacuate or stand down 50 percent (or more) of Contractor's direct craft workforce.
3. The Contractor and the Engineer shall discuss and agree upon the number of actual adverse weather days experienced at the Project Site on a monthly basis. The results of this meeting will be used to update the weather activity by either increasing or decreasing the duration of this activity by modifying the work calendar for the specific where more adverse weather occurred than was anticipated.
4. Unused Adverse Weather Days for each month shall be removed from the work calendar after the month has passed. Unused weather allowance days should not be used directly by any party to mitigate a delay not caused by weather. Instead, unused weather days should be returned to the schedule as float to the Project. Unused Adverse Weather Days shall be returned to the schedule as float by creating a weather allowance activity to be inserted prior to Substantial Completion. This is done by increasing the number of days an appropriate reduction in the weather allowance planned for the time period under analysis. For example: There are 13 weather days allowed for January, but there were only weather events on 3 days. The work calendar should be updated and the remaining 10 weather days should be added to the duration of the weather allowance activity to add float back to the Project.

G. Dealing with Alternatives:

1. All versions of the Detailed Progress Schedule up to, and including, the Detailed Baseline Schedule, shall be based solely on the specific work sequences or procedures of construction indicated in or required by the Contract Documents for the Work as awarded, and shall exclude any "alternate" proposals.
2. The Engineer's final determination on any Contractor or Packager-proposed alternates will not be made until after the Detailed Baseline Schedule is developed as provided in this section and consideration is given to the possible impact upon other Prime Contractors working on the Project.

1.06 NARRATIVE PROGRESS REPORT

A. Format:

1. Organize same as Progress Schedule.
2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.

B. Contents:

1. Number of days worked over the period; lowest, average and peak work force onsite; construction equipment staged onsite (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks). All figures shall be inclusive of subcontracted work and shall be so identified.
2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved. By activity, report in a table:
   a. Actual Start to Early Start comparison, displaying the dates and calculating percentage of activities where Actual Start was scheduled Early Start;
   b. Actual Duration to Original Duration comparison, for each activity;
   c. Actual Finish to Early Finish comparison, displaying the dates and calculating percentage of activities where Actual Finish was scheduled Early Finish.
3. Contractor's plan for management of Site (e.g., lay down and staging areas, construction traffic), utilization of construction equipment, buildup of trade labor, and identification of potential Contract changes.

4. Identification of new activities and sequences as a result of executed Contract changes.
5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
7. Changes to activity logic.
8. Changes to the critical path.
9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
10. Steps taken to recover the schedule from Contractor or Packager-caused delays.

1.07 SCHEDULE ACCEPTANCE

A. Engineer's acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:
   a. Contract Times, including Final Completion and all intermediate Milestones are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected.
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
   g. Startup testing duration is as specified and timing is acceptable.
2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that, in Engineer's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer, continue review and revision process, during which time Contractor or Packager shall update schedule on a monthly basis to reflect actual progress and occurrences to date.

C. Unacceptable Baseline or Detailed Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Detailed Baseline Schedule or Detailed Progress Schedule, continue review and revision process.

D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.08 ADJUSTMENT OF CONTRACT TIMES

A. Reference General Conditions and Section 01 26 00, Contract Modification Procedures.

B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.

C. Float:

1. Total float is the number of days by which a part of the work in the CPM Construction Schedule may be delayed from its early start and finish dates without extending the Contract Times. The difference in time between the Project's scheduled early completion date, as submitted, and the required contract completion date, shall be considered as float. Float within the schedule, and total float within the overall schedule, is not for the exclusive use of either the Owner or the Contractor but is jointly owned by both parties and is a resource available to be shared by both as needed to meet contract milestones and the contract completion dates.
2. The Contractor shall not sequester shared float through such strategies as extending activity duration estimates to consume available float, using preferential logic, using extensive crew/resource sequencing, etc. Since float time within the schedule is jointly owned, no time extensions will be granted or delay damages paid until the critical path of the CPM schedule is affected which extends the Work beyond a Milestone or Contract Completion Date.

3. Early completion schedules are generally not acceptable to the Owner but may be accepted as a convenience to the Contractor under the following conditions:
   a. The Contractor must submit a written request outlining the specific reasons for using an early completion schedule.
   b. The Contractor acknowledges and agrees in writing that the proposed reduction in time represents project time already paid for by the Owner as part of the Bid Price, and available to both the Contractor and the Owner for mitigation of impacts to the Project from any source. The Contractor shall not be entitled to any increase in Contract Price for failure to achieve the early completion and waives all claim to same.
   c. The Contractor shall not be entitled to any extension in Contract Time, nor to recover any delay, disruption, interference, hindrance, extension or acceleration costs, however caused, incurred because of extension of an early completion date established on the As-Planned CPS, until all Contract Float, if any, is used or consumed with the concurrence of the Engineer and performance or completion of the Work, or specified part, necessarily extends beyond the corresponding Contract Time or Milestone.
   d. Early completion schedules shall not be based on expedited approvals, inspections, or the relaxing of construction constraints by the Owner, Construction Manager or the Engineer.
   e. Early completion schedules must meet all other contract requirements.
   f. The Contractor acknowledges and agrees in writing that the Owner has the right to hold the final payment due the Contractor until the contractual end date.
   g. Early completion schedule updates which have activities behind schedule shall be revised when requested by the Construction Manager.

D. Claims Based on Contract Times: See General Conditions and Supplemental Conditions. Contractor shall not adjust Contract Time for proposed substitutions, delays, authorized additional work, or claims in anticipation of a Change Order, but rather will provide a proposed schedule revision with the Change Order, if requested by the Engineer, which will become affective with approval of the change.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Pursuant to paragraph 1.01.A.2 of this Specification, the Contractor shall develop, submit, and finalize a Detailed Baseline Schedule which will serve as the baseline schedule for executing the Work under this Contract. To provide a forum for development of the schedule, the Engineer and Contractor will conduct a 16-hour workshop during which:

1. The Engineer will be available to discuss with the Contractor the designer's perspective to constructing the Work and the constraints recognized in developing the approach. This will include information gained during the design phase that may assist the Contractor with understanding the process functions and integration of the facilities and structures involved in the Work.
2. The Contractor and Engineer will collaborate on development of the schedule, with the Engineer being available to assist with milestone discussions, sequence of construction details, explanation of scheduling requirements, design clarification, and the like. Recognizing that the schedule is a critical tool in the successful delivery of the Work, the Engineer's express interest is to assist in development of the schedule, as requested by the Contractor, and to obtain better knowledge of the Contractor's plan by participating in/observing development of the overall schedule.
3. A draft baseline schedule will be formulated for development into the computerized schedule, which will be submitted after the workshop, pursuant to paragraph 1.01.A.3 of this Specification.

B. This collaborative effort does not in any way relieve the Contractor of their responsibility for the preparation, management, and maintenance of the project schedule.

C. To be prepared for the Scheduling Workshop, the Contractor shall develop and be ready to discuss an overall outline of the project schedule and general sequence of work, which includes, but is not limited to:

1. Designation of responsible superintendent(s) for the various aspects/locations of the Work.
2. List of technical and administrative submittals.
3. List of subcontractors expected to be assigned activity responsibility.
4. Major product procurement.

D. The Engineer shall be prepared to discuss:

1. Submittals requirements.
2. Design details and special requirements.
3. Schedule management and progress update requirements.
4. Schedule format and presentation.
5. Major equipment and process requirements.
6. Instrumentation and Control requirements.
7. Testing and Startup requirements.
8. Owner training requirements.

E. The meeting will also recognize additional issues and questions as addressed by attendees.

F. The Contractor shall advise the Engineer no less than 14 days prior to the desired date as to when the Contractor is scheduling the Schedule Workshop. The Schedule Workshop shall be scheduled to occur prior to submission of the Detailed Progress Schedule.

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. Specific details must be included identifying and describing any 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.

C. [Add No. 5] 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.

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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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	Installation and Implementation of a Grid Control System (GCS)
Records Management Software	Procore
Managing Company	Jacobs Engineering and Power Engineers
Contact Name	Marcy Deville
Contact Email	Marcy.Deville@jacobs.com

RECORDS MANAGEMENT SOFTWARE BY DOCUMENT TYPE

Document Type	**Records Management Software**
Design Documents	Procore
Contractor Submittals	Procore
Contractor RFIs	Procore
Progress Schedules	Procore
Meeting Minutes	Procore
Contractor Pay Applications	Procore
Work Change Directives	Procore
Project Photos	Procore
Daily Reports	Procore

DOCUMENT UPLOAD PROCEDURES

General: Contractors and Suppliers will transmit submittals by uploading them electronically into the Cloud Based Contract Management Platform.

Submittal Requirements: To be accepted for review, all Submittals 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 Property	Input
Name	Refer to Uploading Best Practices for the file naming convention
Document Title	The Document Title should match the title in the drawing title block or datasheet.
Document Type	Submittal or RFI
Project/Package	GCS
Originated By	This attribute is intended to indicate the entity that uploaded the document to SharePoint
Author	This attribute is intended to indicate the entity that 'authored' the document, such as a subconsultant, original equipment manufacturer, supplier
RFI/Submittal Number	Refer to Uploading Best Practices for the RFI and Submittal naming convention
Date Originated	Date the file is uploaded
Submittal Type	Action Submittal, Informational Submittal, Data Sheets, Drawings, Schedules, or Specifications
Specification Section	Specification section associated with the submittal
Revision	Revision number of the specific file being uploaded (usually included in the document title block) ▪ For a submittal Cover Page: Type 0 for initial submittal; sequential numbering for re-submittals ▪ For Individual Documents within a submittal: Type the revision number of the specific document (drawing, specification, datasheet, etc) Please note that if a submittal revision is required, only the specific revised files should be uploaded
Revision Date	The date associated with the individual document revision (usually included in the document title block
RFI Category	Question or Clarification
Submittal Category	Preliminary, Issued for Review, Issued for Approval, Issued for Construction, Issued for Permit, Record/As-Built, Final, Issued for Bid
Document Remarks	(OPTIONAL) Free-form attribute to provide any brief information about the subject document not captured by another attribute

Uploading Best Practices:

- Requirement: Individual Submittal documents will be reviewed and dispositioned independently, which requires individual documents be uploaded separately so that reviews, comments, responses, and revisions can be tracked separately. For example, a submittal that includes a drawing package with 15 sheets, must be uploaded as 15 individual files. Deviation from this practice will result in a rejection of the submittal.
- Name guidance for select submittal types:
  General criteria is that file name is materially equivalent to base document number allowing ability to search, and filter submittal data by actual document number.
  - **Coversheet**: [Submittal number].[Submittal revision].pdf

    Example: SN-005. r0.pdf
  - **Drawings**: [Drawing Number].[Sheet number (typ 3 digits)].[drawing revision number].pdf

Example: A5E51274298A.013.rAA.pdf

- **Datasheets or Product Data**: [DS].[Unique Datasheet or Product Data Number].[datasheet revision number].pdf

  Example: DS.HindlePowerAT10.1.r0.pdf

- **Calculations**: [CALC].[Calculation Number].[Calculation revision number].pdf
  [Calculation Number] = [single letter discipline]-[###]

  Example: CALC.E-001.r0.pdf

- Document Title ideally is the exact title of the subject document, providing another way to search and filter by information directly correlated to a document.
- Document Remarks attribute is a free-form attribute intended for brief additional information not captured by another attribute; best practice is to include the date of when the remarks were added. Examples could include explanation of VOID status.
- Each RFI must include a specific focused topic. RFIs with multiple focus/topics will be rejected.
- For numbering RFI files, please use the format of RFI-XXX, and number sequentially based on the previous RFI number.
- For numbering Submittals, please use the format SN-XXX, and organize sequentially based on the previous Submittals.

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.

APPROVED _____ ☐
APPROVED AS NOTED _____ ☐
REVISE AND RESUBMIT _____ ☐
REJECTED _____ ☐
NOT SUBJECT TO REVIEW _____ ☐

Engineer's review and approval of this submittal are expressly limited as provided in the Contract Documents and are only to determine conformance with information given in the Contract documents and compatibility with the design concept for the completed project as a functioning whole as indicated in the Contract Documents. Contractor is, and Engineer is NOT, responsible for all matters relating to fabrication, shipping, handling, storage, assembly, installation, construction (including all safety aspects of performing the Work), and for coordinating the Work.

ENGINEER _____ Date _____

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SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual Specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor's personnel, Subcontractors, Owner, and Engineer.

1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association
34.	BHMA	Builders Hardware Manufacturers' Association
35.	CBM	Certified Ballast Manufacturer

36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	DOT	Department of Transportation
47.	EIA	Electronic Industries Alliance
48.	EJCDC	Engineers Joint Contract Documents' Committee
49.	EPA	Environmental Protection Agency
50.	ETL	Electrical Test Laboratories
51.	FAA	Federal Aviation Administration
52.	FCC	Federal Communications Commission
53.	FDA	Food and Drug Administration
54.	FEMA	Federal Emergency Management Agency
55.	FIPS	Federal Information Processing Standards
56.	FM	FM Global
57.	Fed. Spec.	Federal Specifications (FAA Specifications)
58.	FS	Federal Specifications and Standards (Technical Specifications)
59.	GA	Gypsum Association
60.	GANA	Glass Association of North America
61.	HI	Hydraulic Institute
62.	HMI	Hoist Manufacturers' Institute
63.	IBC	International Building Code
64.	ICBO	International Conference of Building Officials
65.	ICC	International Code Council
66.	ICEA	Insulated Cable Engineers' Association
67.	IEC	International Electrotechnical Commission
68.	IFC	International Fire Code
69.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
70.	IESNA	Illuminating Engineering Society of North America
71.	IFI	Industrial Fasteners Institute
72.	IGMA	Insulating Glass Manufacturer's Alliance
73.	IMC	International Mechanical Code
74.	INDA	Association of the Nonwoven Fabrics Industry
75.	IPC	International Plumbing Code
76.	IRI	Industrial Risk Insurers
77.	ISA	International Society of Automation

78.	ISO	International Organization for Standardization
79.	ITL	Independent Testing Laboratory
80.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
81.	LDEQ	Louisiana Department of Environmental Quality
82.	MIA	Marble Institute of America
83.	MIL	Military Specifications
84.	MMA	Monorail Manufacturers' Association
85.	MSS	Manufacturer's Standardization Society
86.	NAAMM	National Association of Architectural Metal Manufacturers
87.	NACE	NACE International
88.	NBGQA	National Building Granite Quarries Association
89.	NEBB	National Environmental Balancing Bureau
90.	NEC	National Electrical Code
91.	NECA	National Electrical Contractor's Association
92.	NEMA	National Electrical Manufacturers' Association
93.	NESC	National Electrical Safety Code
94.	NETA	InterNational Electrical Testing Association
95.	NFPA	National Fire Protection Association
96.	NHLA	National Hardwood Lumber Association
97.	NICET	National Institute for Certification in Engineering Technologies
98.	NIST	National Institute of Standards and Technology
99.	NRCA	National Roofing Contractors Association
100.	NRTL	Nationally Recognized Testing Laboratories
101.	NSF	NSF International
102.	NSPE	National Society of Professional Engineers
103.	NTMA	National Terrazzo and Mosaic Association
104.	NWWDA	National Wood Window and Door Association
105.	OSHA	Occupational Safety and Health Act (both Federal and State)
106.	PCI	Precast/Prestressed Concrete Institute
107.	PEI	Porcelain Enamel Institute
108.	PPI	Plastic Pipe Institute
109.	PS	Product Standards Section-U.S. Department of Commerce
110.	RMA	Rubber Manufacturers' Association
111.	RUS	Rural Utilities Service
112.	SAE	SAE International
113.	SAMA	Scientific Apparatus Makers Association
114.	SDI	Steel Deck Institute
115.	SDI	Steel Door Institute
116.	SJI	Steel Joist Institute
117.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association

118.	SPI	Society of the Plastics Industry
119.	SSPC	The Society for Protective Coatings
120.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
121.	SWI	Steel Window Institute
122.	TEMA	Tubular Exchanger Manufacturers' Association
123.	TCA	Tile Council of North America
124.	TIA	Telecommunications Industry Association
125.	UBC	Uniform Building Code
126.	UFC	Uniform Fire Code
127.	UL	(Formerly known as Underwriters Laboratories Inc.)
128.	UMC	Uniform Mechanical Code
129.	USBR	U.S. Bureau of Reclamation
130.	WCLIB	West Coast Lumber Inspection Bureau
131.	WI	Wood Institute
132.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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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. Recorded training of Owner's personnel in the operation and maintenance of respective product as required. Contractor is required to coordinate with the Owner to confirm appropriate personnel are available during the scheduled training time.

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 45 16.13
CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 QUALITY CONTROL

A. Quality control is the responsibility of the Contractor, and the Contractor shall maintain control over construction and installation processes to assure compliance with specified requirements of Contract Documents.

B. Means and methods of construction and installation processes are the responsibility of the Contractor, and at no time is it the intent of the Engineer to supersede or void that responsibility. In the event there is a degree of uncertainty that the process observed or planned will accomplish the required quality, the Engineer will refer to the Contractor's Quality Control Plan and initiate discussion with the person primarily responsible for the process or installation in question. Should this interface not reconcile the issue or concern, the concern will be elevated to the appropriate level in the respective organizations until reconciliation has been reached. The Engineer intends to implement Quality Assurance practices in observing the Work in such a manner that assures the Contractor is taking the necessary actions to prevent and avoid rework or the need for corrective action. In the event observations reveal a failure of the Contractor's Quality Control System, the Engineer will initiate actions to restore the quality system through quality oriented discussions and collaboration with the Contractor. This does not imply or state that the Engineer will direct the Contractor's activities. It does mean that the Engineer will be onsite monitoring the Quality Control activity of the Contractor with the intent of assuring quality results are consistently and routinely achieved within the requirements of the Contract Documents and the objectives of the Owner.

1.03 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

B. Quality Control System (QCS):

1. The system developed and implemented by the Contractor that establishes and maintains a comprehensive and effective approach to ensure that the Works comply with the Contract.
2. The QCS shall consist of plans, procedures, resources, and the organization necessary to ensure adequate quality planning, assurance, and control occur to achieve the requirements of the Contract Documents and the objectives of the Owner, as well as ensure the quality of materials, equipment, workmanship, construction, fabrication, and operations covering both onsite and off-site work by the Contractor, inclusive of subcontracted elements of the Work.
3. The Owner is purchasing a newly constructed Work, and as such has every right to expect the Contractor to provide a product that is new – not repaired, restored, reworked, or otherwise made to look like new. The effectiveness of this system will be gauged by the level of success achieved in preventing non-compliant work and deficiencies that require corrective actions and/or repairs.

C. Definable Feature of Work (DFOW): DFOW is a task that is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment.

1.04 SUBMITTALS

A. Informational Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. CQC Report: Submit, monthly.
3. CQC Daily Report.
4. Contractor Site Specific Safety Plan: Submit not later than 5 days prior to the Pre-Construction Conference.

1.05 OWNER’S QUALITY ASSURANCE

A. All Work is subject to Owner’s quality assurance program and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner's quality assurance program and tests are for the sole benefit of Owner and do not:

1. Relieve Contractor of responsibility for providing adequate quality control measures;
2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance; or
4. Affect the continuing rights of Owner after acceptance of the completed Work.

C. The presence or absence of a quality assurance representative does not relieve Contractor from any Contract requirement.

D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient monitoring and tests as may be required by Engineer.

E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests shall be properly coordinated by the Contractor to allow said quality assurance procedures to be performed in a manner that will not delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall develop and maintain an inspection system and perform such inspections and tests as will ensure that the Work conforms to the Contract Documents.

B. Maintain complete CQC records and make them available at all times to Owner and Engineer. One copy of all CQC documents and reports (exclusive of CQC Daily Reports, which are submitted daily and addressed elsewhere within this Specification) shall be transmitted to the Owner's Representative on a weekly basis, at an agreed to time. "Weekly" shall be construed as each transmittal containing 7 calendar days of reporting – including reports of no activity. The documents are subject to review and acceptance by the Owner's Representative, and each copy shall be legible and intelligible.

C. The Quality Control System as defined in paragraph 1.03.B, above, shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

A. After the Preconstruction Conference, but before start of construction, and following submission of but prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the Quality Control System.

B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. Quality Control System Manager:

1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
2. The Owner retains the right to approve the appointment of the Quality Control System Manager, and to direct replacement of same during the course of the Work should their performance be deemed lacking in the express opinion of the Owner.
3. The Quality Control System (QCS) Manager shall be located onsite and shall not have or be assigned any additional responsibilities within the company, project, or other formal construction organization within the Contractor's business operation. The QCS Manager's sole responsibility shall be to oversee and implement the Quality Control Plan, which will include oversight of the QC staff.
4. QCS Manager shall be an experienced construction person, with a minimum of 4 years' experience in supervising construction of similar type Work.
5. The QCS Manager shall report directly to an officer or principle within the company who is outside the project-specific organization and is responsible for quality assurance. The QCS Manager is not to be subordinate to or report to the Contractor's project manager or any supervisor within the Contractor's production organization.

6. QCS Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
7. Identify an alternate for QCS Manager to serve with full authority during the QCS Manager's absence. The requirements for the alternate will be the same as for designated QCS Manager.

B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. This staff shall include those personnel involved with quality control of all products generated by the Contractor, be they administrative in nature (e.g., schedules, submittals, reports, etc.) or construction. CQC staff members shall be subject to acceptance by Engineer. The overall quality control organization shall be comprised of multiple personnel (commensurate with the amount of work being performed) knowledgeable of the construction industry and trade practices, and technically competent. Those involved with inspection and monitoring of construction activities will be referred to as "Quality Control Representatives." Actual staffing for and implementation of the plan will be the responsibility of the Contractor, but all staff assigned shall be reviewed and approved by Owner and Engineer on an on-going basis.
2. CQC staff shall take direction from QCS Manager in matters pertaining to QC.
3. A sufficient number of CQC staff with proper corresponding skills must be appropriately assigned to ensure effective quality control of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities, and they must be allowed sufficient time to carry out these responsibilities. The Contractor shall assign QC Representatives in accordance with the following requirements:
   a. Representatives shall be knowledgeable of the trade responsibility assigned.
   b. Representatives shall become thoroughly familiar with the construction requirements of the trade and areas assigned.
   c. An individual Representative shall be responsible for overseeing no more than $1,000,000 of construction-in-place per month (this includes the cost of equipment and equipment installation).
   d. The QC Representative position requires a minimum of 8 years' experience in construction of process/industrial facilities.
4. The actual number and related skills of members assigned to the CQC staff may vary during any specific Work period to cover the needs of the Project. Contractor shall assign additional staff when necessary for a proper CQC organization.

C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

A. CQC shall include at least three phases of control to be conducted by QCS Manager for all definable features of Work (DFOW), as follows:

1. Preparatory Phase:
   a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
   b. This phase shall include a meeting conducted by the QCS Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The QCS Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements. The agenda for the meeting shall include confirmation of the items cited in subparagraph "d," below. The meeting shall be conducted no sooner than 3 weeks prior to the commencement of the respective work, and no later than 3 work days prior to commencement, unless as specifically authorized by the Owner's Representative.
   c. Document the results of the preparatory phase meeting by separate minutes prepared by the QCS Manager. Minutes are to be published no more than 2 business days following the meeting.
   d. Perform prior to beginning Work on each definable feature of Work:
      1) Review applicable Contract Specifications.
      2) Review applicable Contract Drawings.
      3) Verify that all materials and/or equipment have been tested, submitted, and approved.
      4) Verify that provisions have been made to provide required control inspection and testing.
      5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
      6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
      7) Review the appropriate activity hazard analysis to verify safety requirements are met.
      8) Review procedures for constructing the Work, including repetitive deficiencies.

9) Document construction tolerances and workmanship standards for that phase of the Work.
10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.

2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.
      2) Perform prior to beginning Work on each definable feature of Work:
         a) Review minutes of the preparatory meeting.
         b) Check preliminary Work to verify compliance with Contract requirements.
         c) Verify required control inspection and testing.
         d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
         e) Resolve all differences.
         f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
      3) Separate minutes of this phase shall be prepared by the QCS Manager and published within 2 business days of the session. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
      4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
3. Follow-up Phase:
   a. Implement the Construction Installation and Quality Plan (CIQP) for each corresponding DFOW. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
   b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
   c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.

4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. Construction will be permitted to begin only after acceptance of the CQC Plan.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
   a. Definable Features of Work (DFOW): A list of the DFOW is included herein as an attachment to this Specification. The list may be altered to meet the Contractor's objectives, but only upon approval of the Engineer. The list is established to identify those areas that have been identified through the design phase of this project, and are cited for the Contractor's incorporation into their Quality Control Plan, and while deviation from this list may be acceptable, the Engineer must be ensured that adequate quality control procedures will be instituted to embrace the quality management principles invoked under these Contract Documents.
   b. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
      1) The organization chart shall be kept current. As members or positions change within the organization, the chart is to be updated within 2 workdays.
      2) Accompanying the organization chart will be a staffing schedule showing the staff and when the respective individuals are to be expected onsite. Should implementation of the construction plan and/or schedule change, the staffing schedule is to be revised to reflect both actual events and the revised forecast. These changes shall be documented in an updated staffing schedule to be submitted to the Engineer within 1 week of the acknowledged schedule change.

c. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.

d. Letters of Authority: A copy of a letter to the QCS Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the QCS Manager, including authority to stop Work which is not in compliance with the Contract. The QCS Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.

e. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.

f. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, Specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.

g. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.

h. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

i. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

j. Checklists: Checklists are to be developed and incorporated into the quality control process. These checklists serve as one of the bases for hold point/witness point (Item n, below) reviews. Sample checklists are included herein as an attachment to this Specification.

k. As-built drawing management, including data and survey gathering procedures, QC checking, drawing format and conventions, and work and personnel scheduling.

l. Audit system, including schedule, structure, process, personnel, resources, and documentation.

m. Construction and Installation Quality Plans (CIQPs): CIQPs for Definable Features of Work (DFOW), as defined within the Contract Specifications and in collaboration with the Engineer, shall, as a minimum, include the following:

1) Construction quality management, inspection, and QC organization and responsibility, as well as identification of the Contractor's staff directly responsible for management, supervision, and compliance verification of the Works.

2) The specific methods of construction and/or installation that shall be followed together with an identification of the Contractor's method statements and risk-assessment requirements.
3) Surveying: Construction staking QC, including construction layout/alignment/staking proof of compliance and tolerances for field survey verification and a coordination and interface procedure between surveyors for the Contractor and Employer.
4) Quality hold points and/or witness points (paragraph n, below) in which each activity, component, or construction phase is subject to confirmation by the Owner's Quality Assurance Representative that the quality control aspects for that element of work have been properly executed.
5) Environmental compliance and monitoring, including a monitoring schedule and environmental management documentation and records.
6) Identification of critical design/construction details and procedures for reconciliation of any issues with the Engineer.
7) Requirements and controls for any special processes.
8) Processes for verification of as-built information and incorporation of changes identified during construction.

n. Hold Points/Witness Points: Hold points and witness points are those events over the construction of the Work when the Owner's Quality Assurance Representative is invited to observe, witness, or inspect the status of a particular element or aspect of a DFOW (e.g., pressure test, leak test, cast-in-place concrete wall form closure, etc.). Witness points and hold points will be identified within the respective CIQP. A provision will be made in each CIQP for the Owner's Quality Assurance Representative to indicate requirements to monitor or witness any of the activities which make up the Work. Notwithstanding any other witness points that may be required by the CQC Plan or Engineer, a hold point will be established in accordance with the Special Inspection requirements of the contract whenever the Work is ready and before it is covered up or put out of sight. Notification to the Engineer of an upcoming hold point or witness point is required no less than 48 hours in advance of the event.

C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction (refer to paragraph 1.03.B.3). Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORTS

A. Prepare a CQC report daily. Account for all calendar days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff. The report shall be submitted no later than noon of the workday following the workday being reported. Days of no activity are to be reported on the next workday, and sequential days of no activity may be reported on one report (e.g., a weekend or holiday period wherein two or more consecutive days have no work activity). The report shall be submitted to the Engineer. Failure to be current with the Daily Quality Control Reports shall be cause for rejection of payment request(s).

1. The report shall be prepared in electronic format consistent with the document management procedures for the Project, and a .pdf file of the entire report, including attachments, will be transmitted electronically to the Engineer. A printed version of the report will be delivered to the Owner's Representative onsite.
2. Comments on disposition of the report shall be provided to the Contractor no later than 3:00 p.m. of the same day. Final reconciliation of the report shall be completed no later than 9:00 a.m. of the day following initial submission of the report.
3. The report content may be a summary statement by the QCS Manager with individual reports from QC Representatives attached thereto, along with other attachments, as necessary. The QCS Manager must review and endorse each attachment submitted, be it a Daily Report by a QC Representative or a test report received from a testing agency.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.

C. Reports shall be on a form approved by the Owner's Representative and shall be a complete description of inspections, the findings and any resultant actions of inspections, daily work/production activities, tests, and other items, including but not limited to the following:

1. Contractor/subcontractor and their areas of responsibility.
2. All operating plant/equipment onsite with hours worked, idle, or down for repair and designation as to whether the equipment is owned or rented/leased.

3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.
6. Identify submittals reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. Address any quality issues identified and agreed to be reconciled by the Contractor without Engineer involvement.
10. Address any quality issues identified for response action by the Contractor that will require some lead-time in resolving. Describe the plan of action and the target implementation date.
11. Address any quality issues identified and agreed to be reconciled by the Contractor which require Engineer involvement or endorsement of the proposed resolution.
12. Address any quality issues formally identified by the QC Representative with which the production supervisor is not in agreement with, and the corresponding proposed disposition by the CQC System Manager.
13. List any discussions that led to the conclusion that there is a conflict in Drawings and/or Specifications, and detail the corresponding conflict.
14. Indicate a description of trades working on the Project; the number of personnel working; if outside work is occurring, record weather conditions encountered (temperature, precipitation, humidity, wind) at 8:00 a.m., Noon, and 4:00 p.m., and any consequential changes thereto during the course of the day; and any delays encountered.
15. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

D. Non-Conformance Reports: Non-Conformance Reports will be issued by the Engineer in the event there is a disagreement between the Contractor and Engineer regarding the quality of the constructed product and/or the conformance of a product or equipment item with regard to the Specification. Issuance of this report will be construed as direction to the Contractor to remedy the situation pursuant to the recommendation of the Engineer. The Contractor must respond to the report within the specified period, as noted in the report, with their plan to remedy the situation.

E. Monthly Quality Control Summary that addresses the following:

1. Certification by both the QCS Manager and Contractor Project Manager that all work not specifically cited by a Non-Conformance Report satisfies the requirements of the Contract Documents.
2. Summary table identifying all assigned CQC Representatives and their corresponding area of responsibility.
3. Summary table identifying all non-conformance notices and their respective current status.

3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
   a. Verify testing procedures comply with contract requirements.
   b. Verify facilities and testing equipment are available and comply with testing standards.
   c. Check test instrument calibration data against certified standards.
   d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
   e. Documentation:
      1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
      2) Include Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
      3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
      4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
      5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.

B. Punchlist:

1. QCS Manager shall develop a punchlist of items which do not conform to the Contract requirements.
2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
3. QCS Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

3.10 CQC STAFF COMPLIANCE

A. In the event a position within the quality control organization is unfilled, or if in the sole and express opinion of the Owner the effectiveness of the Quality Control organization is inadequate, the Owner may choose to fill the functional position through alternative means and reduce the Contract amount accordingly for the Contractor’s failure to satisfy the Contract requirements. The rates at which the Contract value will be reduced are as follows:

1. Quality Control System Manager – $1,500/day.
2. Quality Control Representative – $1,200/day.

END OF SECTION

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) or POWER Engineers (POWER).

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:

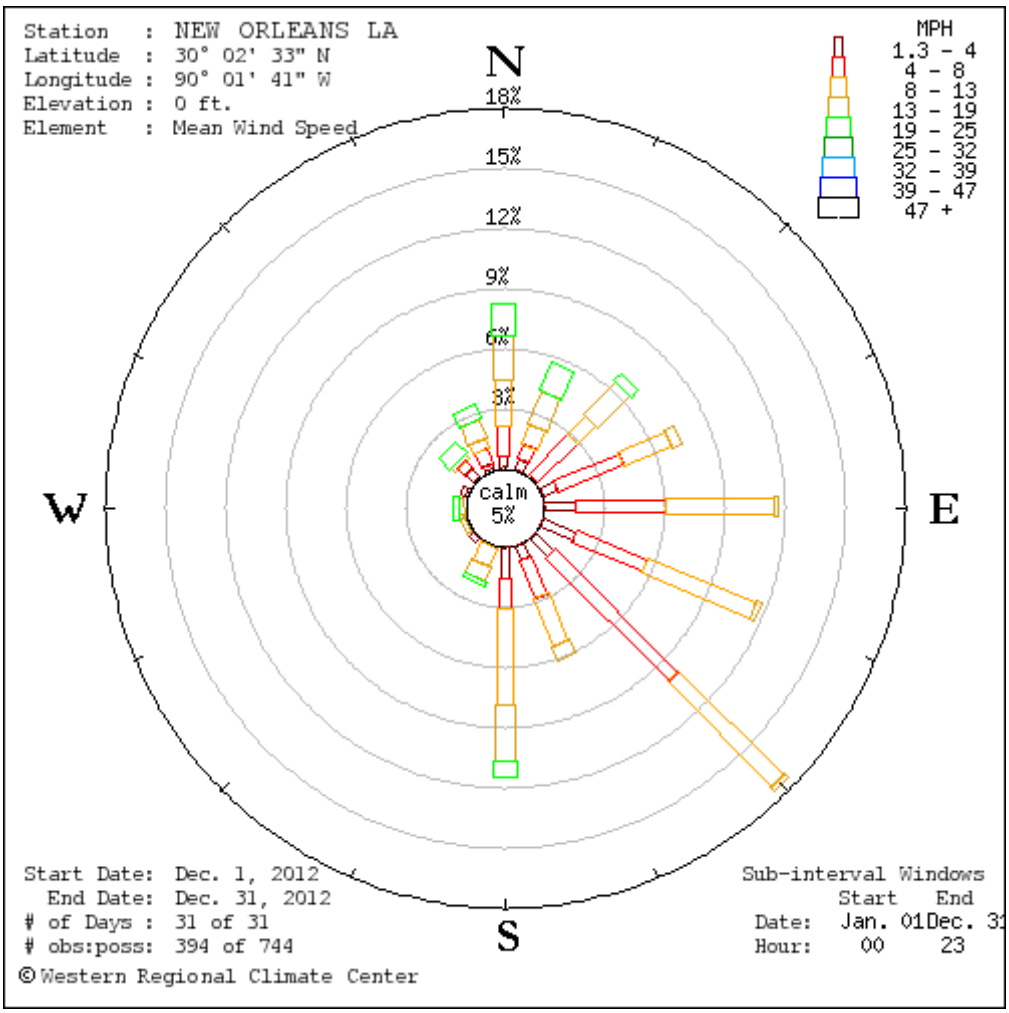
1. Temperature and Precipitation:

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

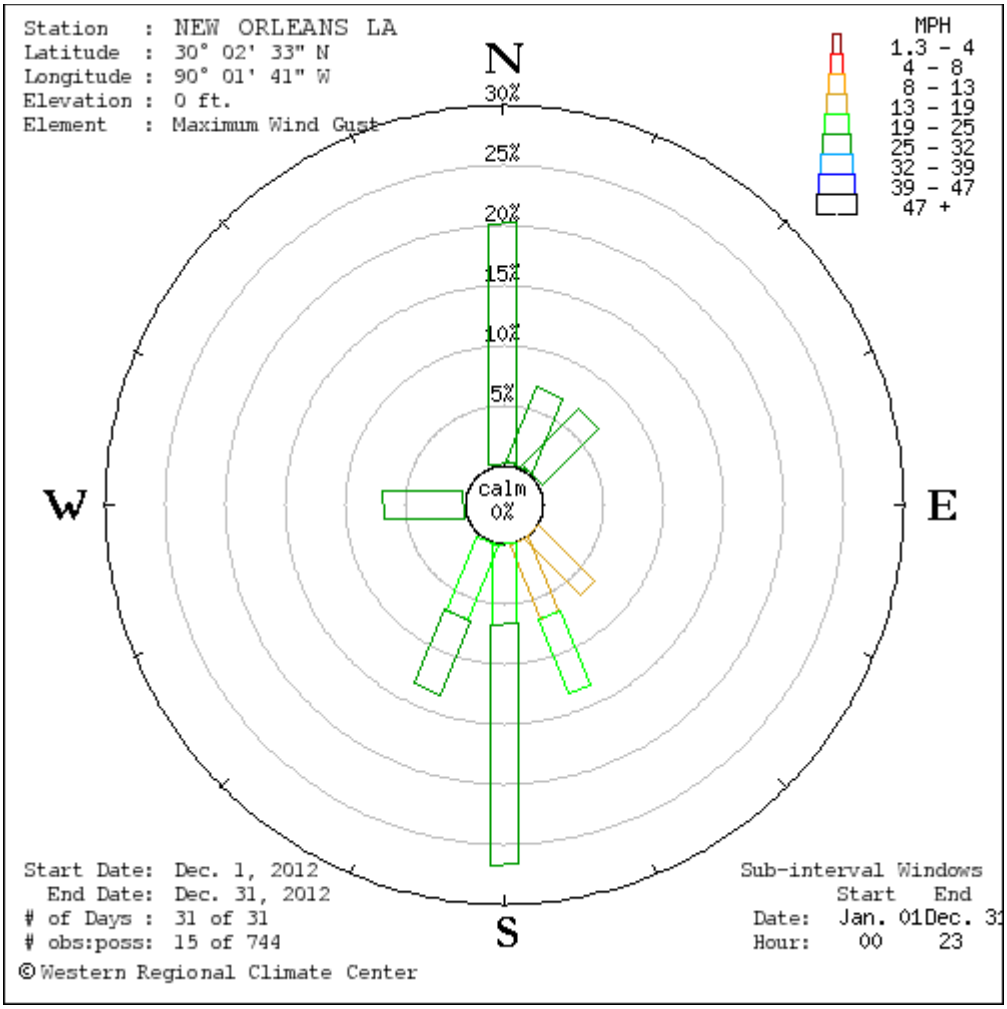
2. Wind Speeds:
   a. Structures shall be designed for wind loads in accordance with ASCE 7-16 for Orleans Parish and the following parameters:

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	D
Importance Factor (IE)	1.5
Risk Category	IV Essential Facility per Table 1604.5
SS	0.086g
S1	0.053g
S_{DS}	0.137g
S_{D1}	0.149g

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/protection when scope is completed and accepted by Owner/Engineer.

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 the 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, COMMISSIONING AND PROJECT STARTUP

PART 1 GENERAL

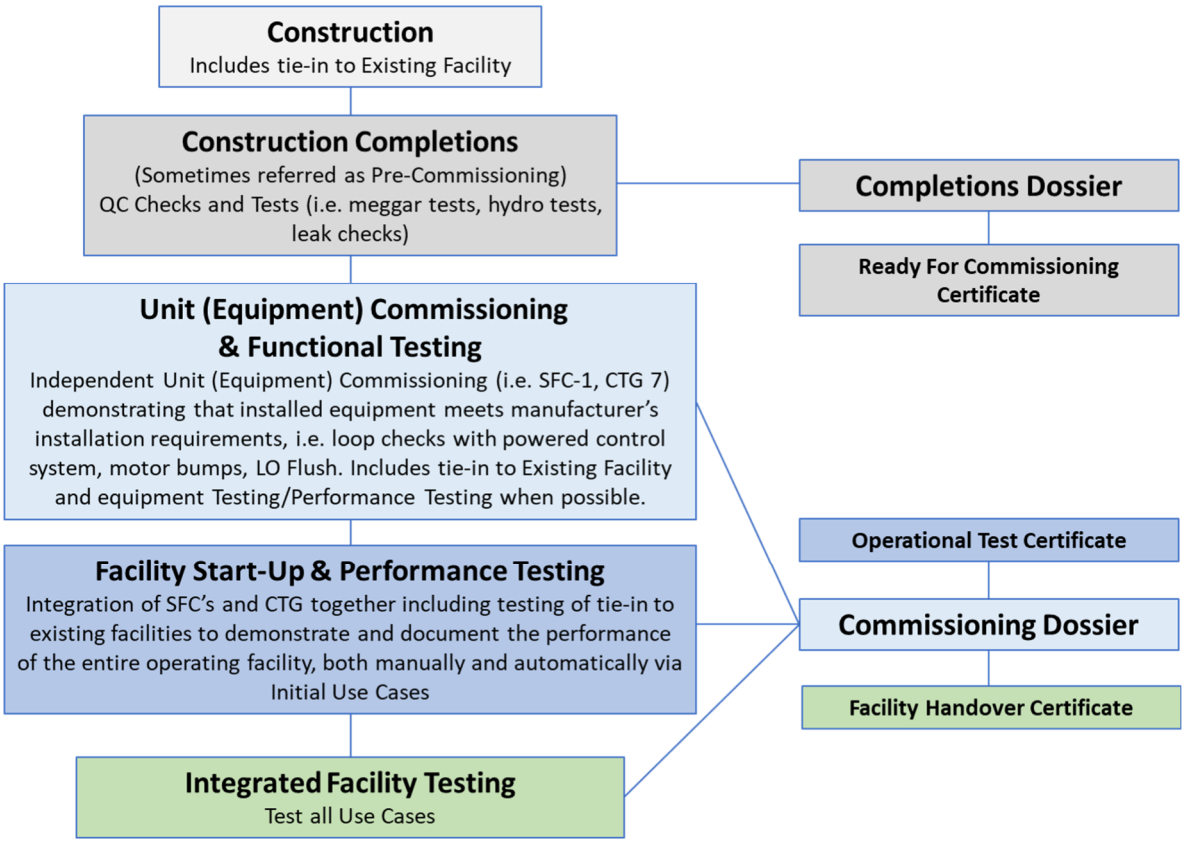
1.01 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Contractor is responsible for commissioning all equipment and systems included in the specifications including coordinating OEM support and coordination with Owner's Operations.

C. Operations of the Owner's Project must not be impacted at any time. Submit outage and shut down requests and Commissioning/Startup needs at least 14 days in advance.

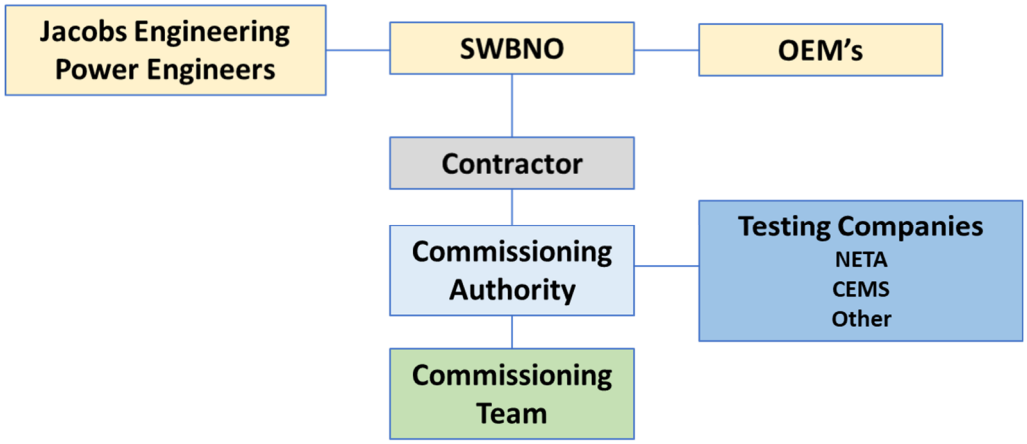
D. The following Commissioning/Startup sequence is referred to throughout these Specifications:



1. **Construction Completions** - Verify that the applicable equipment and systems are installed in accordance with the Contract Documents and according to the manufacturer's recommendations.
2. **Unit (Equipment) Commissioning and Functional Testing** - Verify and document proper performance of equipment supplied by Contractor and equipment provided by Owner as defined elsewhere in the Specification and/or Contract Documents.
3. **Project Start-Up and Performance Testing** – Verify the performance of the equipment and systems noted above as an integrated system including interface with and operation of existing Project.
4. **Integrated Project Testing** - Verify the Project Use Case scenarios integrating new equipment with the Owner's existing Project.
5. Additionally:
   a. Unless otherwise provided in Owner's Equipment Supply Contracts and where applicable, provide first-fills, flushing oil replacement fill, and lubrication as required. If additional 'first-fill' chemicals are required due to fault of Contractor, Contractor shall supply.
   b. Verify that Operations and Maintenance documentation is complete, where provided by Contractor.
   c. For Contractor supplied equipment and/or systems, verify that sufficient training is provided to Owner's operating personnel to enable them to operate, monitor, adjust, maintain, and repair equipment and systems in an effective manner.
   d. Coordinate and manage Owner supplied equipment manufacturers.
   e. Document the successful achievement of the commissioning objectives listed above.
   f. Verify that operations and maintenance tools and spare components are supplied as required by the Contract Documents.

1.02 THE COMMISSIONING ORGANIZATION

A. The Contractor shall retain a Commissioning Authority, or as also alternately stated Commissioning Agent, and qualified Testing Companies as defined throughout these specifications experienced with Contractor supplied equipment and/or systems commissioning and testing as detailed below.



B. Qualifications:

1. Qualifications of Commissioning Authority, or as also alternately stated Commissioning Agent:
   a. Membership and certification as a Certified Commissioning Firm (CCF) with the Building Commissioning Association or similar organization is required.
   b. Commissioning Firm must have experience with at least ten other projects of similar managerial and technical complexity and a high level of experience in hands-on field experience with energy systems performance, interaction, start-up, balancing, testing, troubleshooting, operation, and maintenance procedures for a minimum of ten full years in this type of work.
   c. Contractor shall submit the Commissioning Authority's company qualifications and the resumes of the personnel proposed to be assigned to this Project for the Owner's approval within 30 days of Notice to Proceed (NTP).
2. Qualifications of Commissioning Personnel:
   a. A bachelor's degree in Engineering is required, and a Professional Engineer (PE) license is desired.
   b. Active Membership and valid certification as a Certified Commissioning Professional (CCP, CxA, etc.) with the Building Commissioning Association or similar organization is required.
3. Qualifications of NETA Testing Company:
   a. The NETA testing company shall meet OSHA 29 CFR 1907 criteria for accreditation of testing laboratories. A testing company with full membership in NETA constitutes proof of meeting such criteria. Contractors with employees that are full members of NETA, yet the Contractor is not, are not acceptable.
   b. Contractor shall submit the NETA testing company's qualifications and the resumes of the personnel proposed to be assigned to this Project for Owner approval before commencement of the Work.

4. Qualifications of Other Testing Companies: As defined by other Specifications in this package, Contractor shall submit other testing company's qualifications and the resumes of the personnel proposed to be assigned to this Project for Owner approval before commencement of the Work.

1.03 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01, General Requirements Specification sections, apply to this section.

1.04 DEFINITIONS

A. Project: Entire Project, or an agreed-upon separable portion, including all of its unit processes.

B. Commissioning Dossier: Documentation per this Specification shall be provided to the Owner upon completion of the commissioning process. The Commissioning Dossier documentation serves to document the commissioning process and the ultimate configuration of the commissioned Project.

C. Construction Completions Dossier: Documentation shall be provided to the Owner upon completion of the construction process. The Construction Completions Dossier documentation serves to document the construction process and the ultimate configuration of the Project.

D. Functional Test: Test or tests in presence of Owner to demonstrate that installed equipment and/or system meets manufacturer’s installation, calibration, and adjustment requirements and other requirements as specified.

E. Performance Test: Test or tests performed after any required functional test in presence of Owner to demonstrate and confirm individual equipment and/or system meets performance requirements specified in individual sections.

F. Unit Process: As used in this section, a unit process is a separable portion of the Project that performs a specific process function.

G. Project Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating Project, both manually and automatically (if required), based on criteria developed in conjunction with Owner.

2. Such demonstration is for the purposes of (i) verifying to Owner entire Project performs as a whole, and (ii) documenting performance characteristics of completed Project for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire Project the responsibility of Contractor unless such performance is otherwise specified.
3. Should any testing or demonstration be interrupted or require retest due to a failure attributable to Contractor, Contractor shall bear the full cost of that retest including additional vendor support and/or engineering support.

1.05 SUBMITTALS

A. Submittals:

1. Commissioning Authority, or as also alternately stated Commissioning Agent, Qualifications.
2. Commissioning Personnel Qualifications.
3. Testing Company(s) Qualifications.
4. Commissioning Schedule.
5. Project Startup and Performance Demonstration Plan.
6. Training Plans / Syllabus / Trainer Qualifications.
7. Contractors Permit-To-Work/Lock-Out-Tag-Out Process.
8. Functional and performance test results.
9. Construction Completions Dossier.
10. Commissioning Dossier.
11. Completed Ready for Commissioning Certificate.
12. Completed Operational Test Certificate and Performance Test Certificate for each separable portion.
13. Completed Handover Certificate.

1.06 PROJECT 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 Project.
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 6 months prior to the first scheduled testing/startup activity.

3. System Startup ITP to minimally include the following for each Unit, Separable Portion or Project:
    a. Description of the system, including equipment numbers/nomenclature of each item of equipment and all included devices as well as system limits and isolations.
    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. Existing Project restrictions, prerequisites and if applicable, coordination.
    f. Personal protective equipment for those participating in the process.
    g. Space for evaluation comments.
4. Project Performance ITP to minimally include the following:
    a. Description of systems included in the Project startup.
    b. Sequence of system(s) startup to achieve Project startup.
    c. Description of computerized operations, if any, included in the Project.
    d. Contractor certification Project is capable of performing its intended function(s), including fully automatic operation, if applicable.
    e. Signature spaces for Contractor and Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Care Custody and Control: Contractor will have responsibility for care, custody and control of Owner supplied equipment and material from delivery until handover to the Owner in accordance with this Specification.

B. Separable Portions: The Project shall be organized into mutually agreed to Separable Portions which may be handed over independently to the Owner that generally meet the following criteria.

1. Logical subset of the Project that provides a useable portion and meaningful advancement of completion of the Project.

2. Separable portion boundaries will be further developed by Contractor for Owner approval based on the start-up methodology of the Project such that no Unit (Equipment) is covered by more than one separable portion.

C. Project Startup Meetings: To discuss test schedule, test methods, materials, special requirements, operations interface, and Owner involvement, including provision of external products, services, and/or utilities.

D. Concept of Operations Use Case Meetings:

1. A Use Case is a defined set of circumstances the Project must be able to respond to. Examples include A) hurricane loads, all Project equipment and utility grid operational; B) same as (A) but no utility grid; (C) same as (A) but limited Project equipment.
2. Owner has provided example Use Cases with Specification 40.19.13.
3. Contractor is to work with Owner to collectively develop a minimum of 200 Use Cases through periodic meetings run by the Commissioning Authority or other authorized and approved party. Meetings to begin immediately after NTP and be held nominally monthly, or more often as deemed necessary by Owner or Commissioning Authority.

E. Completions Management System (CMS): Contractor shall implement a fully computerized and integrated Completions Management System that is to track all Construction Completions and Commissioning activities. The CMS is to include the Project Punchlist and be usable, accessible, and intuitive. Contractor shall provide documentation and training. Owner shall be provided access to the CMS with all records turned over to Owner at Project Completion.

F. PTW/LOTO System Requirements and Expectations:

1. A Project Permit to Work (PTW) / Lock-Out Tag-Out (LOTO) system shall be implemented for specific construction activities and all commissioning activities taking place on equipment or systems where energy is applied including to upstream and downstream systems. The Permit to Work system shall be based on Contractors PTW / LOTO system and shall be submitted for Owner review and approval prior to use.
2. Upon connection to Owner's permanent plant Project, Owner's PTW/LOTO system will be implemented for work connecting to those systems.
3. Contractor will have a designated PTW/LOTO Manager assigned to the Project whose primary responsibility will be to administer the PTW/LOTO Procedure throughout the Startup and Commissioning

phase of the Project, through substantial completion and acceptance by the Owner. The PTW/LOTO Manager will also be responsible to approve Permit Holders and to educate and train personnel as required by the procedure, to ensure adherence and compliance with the procedure.

4. All Contractor Startup personnel will be qualified in administering and issuing of PTW's and LOTO's . This will also ensure 24/7 coverage during major activity and Operational phase(s) of Commissioning. ALL personnel at the Project will be required to adhere to the Contractor's Policy including all subcontractors and Owner's personnel. Owner's policy is ZERO Tolerance for PTW/LOTO violations and disciplinary action will result.

G. Provide all temporary measures, test equipment and other materials and equipment required for testing and startup NOT provided by Owner. All such equipment is to be provided with current calibrations.

H. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Manufacturers staff provided by Owner is described elsewhere in these Specifications. Schedule ongoing work so as not to interfere with or delay testing and startup.

I. In the event of any delays or unexpected issues, including delays due to unforeseen circumstances, the responsible Contractor should communicate these issues promptly during regular coordination meetings or sooner. Additionally, a recovery plan should be discussed and implemented as needed to mitigate the impact of these delays and ensure the Project stays on track.

3.02 CONSTRUCTION COMPLETIONS

A. Construction Completions is the last major activity and milestone achieved by construction and includes all necessary installation and fabrication checks to prove equipment has been constructed and installed correctly and in accordance with Drawings, Specifications, applicable statutory codes and practices. Construction Completions includes all necessary documentation, certification, verification and checks prior to declaring the system Ready for Commissioning.

B. Construction Completions checks are single discipline and non-energized / non-pressurized, except for strength testing and insulation testing.

C. Electrical, Mechanical and Instrumentation Construction Completions checks are performed during the Construction Phase and witnessed by the Commissioning Agent and Owner as required to ensure a high degree of confidence in the process and facilitate simple and seamless handover.

D. Owner provided equipment will be supplied with instrumentation and controls calibrated from the factory and good for one year. It is anticipated that most, or all, equipment calibrations will be out-of-date by the time Contractor is ready to begin commissioning. Contractor is required to re-test/calibrate all instrumentation and controls and to provide Owner Calibration record.

E. Construction Completion Dossiers:

1. Construction Completions documentation including Inspection Test Plans (ITP's) and Inspection Test Records (ITR's) are to be compiled by Separable Portion and Functional System into Construction Completions Dossiers. The content of Construction Completions Dossiers shall be developed by the Commissioning Agent (with support from Construction) and be in general accordance with the following guideline:
2. System Boundary Definition and Description,
3. P&ID / Single Line Markup,
4. Equipment List / Valve List / Instrumentation List,
5. Electrical Cable Schedule,
6. Electrical Control System Input/Output List,
7. Other/TBD Lists,
8. System Instrumentation and Control Setpoint List,
9. Electrical Cable Pull Ticket(s),
10. Construction QC Records - Construction QC Records such as, but not limited to, Special Inspections for rebar, concrete placement, structural steel, and weld inspection records are to be performed and documented in accordance with the applicable Specifications.
11. ITP's - Inspection and Test Plans for activities such as leak-testing, hydro-testing, meggar-testing, point-to-point wire checking, calibrations and similar. Als to include validation of installation against OEM requirements.
12. ITR's - Inspection and Test Records documenting the results of ITP's.
13. As-Built Red-Lines – Drawing mark-ups detailing any and all deviations from plans and Specifications. These may be provided electronically. The Contractor is responsible for obtaining approval and communicating deviations and reporting during regular coordination meetings. In addition, the Contractor is responsible for incorporating any redlines into the Final As-Built Drawings.
14. Punchlist.

3.03 UNIT (EQUIPMENT) COMMISSIONING AND FUNCTIONAL TESTING

A. When all Equipment in a Separable Portion or Functional System is fitted, installed and checked as per the allocated Construction Completions Inspection Test Plans and Inspection and Test Records are complete, the

Equipment/Functional System is ready to be handed over from the Construction Phase to the Commissioning Agent.

B. To ensure safety and consistent communications, the Contractor shall prepare a Ready for Commissioning Certificate, complete with a punchlist report of outstanding punchlist items in the Functional System (no Safety Related Punchlist Items may remain open), as well as the full Construction Complete Dossier, for Commissioning Agent and Owner approval. The Owner shall review the entire Construction Complete Dossier before granting approval for the Ready for Commissioning Certification. All safety-related punchlist items, must be resolved and approved by SWBNO prior to certification.

C. Acceptance of the Ready for Commissioning Certificate indicates that Care, Custody and Control of all equipment in the Functional System has passed from Construction to Commissioning, and any further works performed by Construction on the equipment, including punchlist clearance shall be performed under the control of the Commissioning Agent, and Contractors Permit to Work system.

D. Upon acceptance of a Functional System from Construction, Equipment Commissioning can begin. The commissioning testing is the first time at which equipment becomes energized or pressurized and is to be in accordance with OEM requirements. Inspection and Test Record sheets are developed and assigned to individual pieces of equipment by the Commissioning Agent.

E. The Commissioning Agent shall be responsible to coordinate OEM support through the Owner including ensuring contracted OEM services are not exceeded. Refer to individual Specifications and Commissioning Register for OEM services provided by Owner.

F. Inspection and Test Plans (ITP's) define the exact scope of work that shall be performed on every pre-defined item of equipment (i.e. Unit) including packages (i.e. Fuel Gas Compressor, SFC). Inspection and Test Records (ITR's) shall be completed in the field during the time of testing, with all test values, results and readings recorded on the original Commissioning Test Record Form. Where practical the ITR's shall contain expected values and acceptance criteria prior to performing the commissioning test.

G. Testing shall be conducted as specified in individual Specification sections.

H. Preparation:

1. Complete installation before testing.
2. Contractor shall furnish qualified manufacturers' representatives, when required by individual Specification sections for Contractor purchased

equipment and shall coordinate OEM support for Owner provided equipment.

3. Contractor shall 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. Inspection and 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 (Reference Test Standards).
    f. Test conditions.
    g. Test results (Explicit Pass/Fail Conditions).
    h. Calibrated testing tools used.
    i. Signature spaces for Contractor and Owner 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. Perform torque checks (where applicable).
    i. Test piping for leaks.
6. Ready-to-test determination will be by Commissioning Agent 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. While the delivery of spare parts can occur after testing, consumables, and special tools essential for testing must be readily available to ensure a smooth and efficient testing process.

I. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner in writing at least 10 days prior to scheduled date of testing.
3. Prepare Inspection and Test Report summarizing test method and results.
4. When, in Commissioning Agent'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 Owner's signature as witness on Inspection and Test Report.

J. Commissioning and Testing Dossier:

1. Unit (Equipment) Commissioning and Functional Test Records and Operational Test Records will be compiled with all other commissioning records by Equipment/Functional System into Commissioning Dossiers. The content of Commissioning dossiers shall be developed by the Commissioning Agent and, in general, shall include:
   a. System Boundary Definition and Description,
   b. P&ID / Single Line Markup,
   c. Equipment List / Valve List / Instrumentation List,
   d. Electrical Cable Schedule,
   e. Electrical Control System Input/Output List,
   f. System Instrumentation and Control Setpoint List,
   g. Inspection and Test Plans (ITP's) and Records (ITR's),
   h. As-Built Red-Lines – Drawing mark-ups detailing any and all deviations from plans and Specifications. These may be provided electronically.
   i. Punchlist.

3.04 PROJECT STARTUP AND PERFORMANCE TESTING

A. Prior to operating unit/system startup, equipment within unit/system shall be accepted by Owner as having met functional and performance testing requirements specified.

B. Startup sequencing of operating unit/system shall be as identified by Commissioning Agent and coordinated with the Owner within the Project Startup Plan in order to meet schedule requirements and comply with Contract milestones and completion dates.

C. Project Startup and Performance Testing (Operational Testing):

1. Once Commissioning testing is completed, Project Startup and Performance Testing (Operational Testing) may commence. Operational testing proves the functionality of utilities and systems to the full requirements as detailed in this specification package including Manufacturer guarantees for separable portions. Final performance testing of equipment is to be performed during this phase of start-up when operational loads and fluctuations are present. Where operational loads must be simulated, the simulation shall be part of the Operational Test Procedure.
2. Demonstrate proper operation of required interfaces within and between individual unit processes.
3. After Project is operating, complete performance testing of equipment and systems not previously tested.
4. Document, as defined in Project Startup and Performance Demonstration Plan, the complete and overall performance of the Project and all related systems, subsystems, components, ancillary elements, and anything associated with operation of said.
5. Operational Test Procedures (OTP's)
   a. The Contractor shall develop Operational Test Procedures which are a detailed description of each operational test by Functional System and the Project. As well as providing the test methodology, the operational Test Procedures shall list the observations and readings to be recorded, the acceptance criteria for the equipment under test and the expected result of each test.
   b. Operational Test Procedures shall be developed such that the required results and acceptance criteria are documented, with operating instructions coming from the OEM and Use Cases. The only exceptions to this will be for special operation methodology required to test a particular function. This allows test procedures to be consistent with operating manuals while allowing the field practicality of the operating manuals to be reviewed.
   c. Operational Test Procedures shall be approved by Owner prior to use and all testing performed under the Operational Test Procedures shall be witnessed by Owner personnel.
   d. Operational Test Procedures shall be completed in the field during the time of testing, with all test values results and readings recorded on the original document. Results shall be recorded for all testing performed.

e. Operational Test Certificate: Upon completion of the Operational Test Procedure, a certificate is issued by Commissioning Agent signifying that the Functional System is complete and operates as per design intent and Acceptance Criteria.

6. Operational Performance Testing:
   a. Conduct as specified in individual Specification sections.
   b. Notify Owner in writing at least 10 days prior to scheduled date of test.
   c. Performance testing shall not commence until equipment has been accepted by Owner as having satisfied functional test requirements specified.
   d. Type of fluid, gas, or solid for testing shall be as specified.
   e. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test(s) and taking samples and performance measurements.
   f. Prepare Inspection and Test Report summarizing test method and results.
   g. When, in Owner's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Owner's signature on Contractor's Operational Test Certificate.

3.05 INTEGRATED PROJECT TESTING

A. Once all equipment has been commissioned, started-up and OEM guarantees tested, The Commissioning Agent is to establish a test program to validate Project Operations to all Use Cases as defined in Specification 40.90.13, Concept of Operations Framework including those Use Cases developed during the Project as specified herein. In addition, the Commissioning Agent shall submit the test program to the Owner for their review as an integral part of this process. As with the previous Commissioning iteration. Integrated Project Test Procedures and Integrated Project Test Records are to be prepared and provided to Owner as part of the Commissioning Dossier.

B. When, in the opinion of Owner, startup of all operating units/systems has been achieved and each operating unit/system to the point that Project is operational. such equipment will be accepted as to conforming to Contract requirements and handed over to Owner's Operations Team. Such acceptance will be evidenced by Owner's signature on Contractor's Handover Certificate.

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:
   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. 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. Disable Microsoft Office macros or similar embedded code.
    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 workstations.
    j. The HMI software must be connected to the centralized domain account repository.
    k. The HMI software shall log all user actions - logs/records must be kept for no less than 90 days.
    l. Security logs shall be protected from tampering and unauthorized access.
    m. The workstation must automatically lock after more than 30 minutes of in-activity.
    n. Biometric access may be used to simplify operator login to the workstation and HMI.
    o. Removable USB Drives are strictly prohibited and shall not be connected to any operator workstation.
    p. USB port restrictions must be applied via domain/group policies to prevent removable media mounting to the operating system.
    q. Workstation shall have the system clock synchronized with a GPS and/or NTP time source.
    r. Policies shall be applied to whitelist authorized applications only and prevent the installation of unauthorized and/or malicious software and applications.
    s. Workstation policies must be created to prevent the execution of (but not limited to) PowerShell or batch file scripts.
    t. Workstation policies must prevent access to the CLI and internal hard drives/file system.

u. Workstation policies must restrict the use of (but not limited to) SMB, RDP and Telnet protocols.
v. 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. Logs shall be protected from tampering and unauthorized access.
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.

B. Electrical equipment Suppliers and Contractors shall comply with installation requirements in Section 01 88 15, Anchorage and Bracing and Section 01 45 36, Equipment Seismic Certification.

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, if applicable, and not limited to the following:

1. Section 01 33 00, Submittal Procedures.
2. Section 01 45 36, Equipment Seismic Certification.
3. Section 01 58 53, Project Equipment Identification.
4. Section 01 61 00, Common Product Requirements.
5. Section 01 88 15, Anchorage and Bracing.
6. Section 26 00 10, Electrical Summary of Work.
7. Section 26 05 50, Electrical Equipment Installation.
8. 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
24kV ac	60Hz	3PH, 3W
13.8kV ac	60Hz	3PH, 3W
6.6kV ac	25Hz	3PH, 3W
4.16kV ac	60Hz	3PH, 3W
3.3kV ac	25Hz	3PH, 3W
480V ac	25Hz and 60Hz	3PH, 3W and 3PH, 4W
208V ac	25Hz and 60Hz	3PH, 4W
120V ac	25Hz and 60Hz	1PH, 2W
125V dc	--	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, 25-Hz or 60-Hz 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, 25-Hz or 60-Hz 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, if required by the Scope of Work, 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 60-Hz 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 60-Hz and/or 25-Hz 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 60-Hz 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, Medium Voltage Cable and 26 05 19, Low Voltage Wire and Cable 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 Electrical Control System (ECS).
2. 40 94 24, PDCS Human Machine Interface (HMI).
3. 40 94 25, PDCS Data Exchange Interface (DEI).

END OF SECTION

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. American National Standards Institute (ANSI): TIA 568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
2. 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.
3. 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.

4. 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.
5. 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.
6. National Fire Protection Association (NFPA): 70, National Electrical Code.
7. 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.

B. Related sections, as applicable to this specific Project:

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), UL listed as Type TC 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 600 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. Category 5E High Speed Network Cable:
   a. For copper network cables, reference the following Specifications 27 15 13, Communications Copper Horizontal Cabling.
3. Category 6A High Speed Network Cable:
   a. For copper network cables, reference the following Specifications 27 15 13, Communications Copper Horizontal Cabling.
4. Fiber Optic Cable:
   a. For fiber optic cables, reference the following Specifications:
      1) 27 13 23, Communications Optical Fiber Backbone Cabling and 27 15 23, Communications Optical Fiber Horizontal Cabling.
5. RS232:
   a. For printer cables and fire panel communication to Alertus devices: RS232/423 Low Cap, #24-4c, FPO, O/A Foil+Braid, PVC Jkt, CM.
6. 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. 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. Supplier shall indicate if cable reel return is required.
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

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SECTION 26 05 50
ELECTRICAL EQUIPMENT INSTALLATION

PART 1 GENERAL

1.01 SUMMARY

A. General electrical equipment installation requirements are specified herein. A general order of precedence applies to electrical equipment installation criteria as noted below. Where conflicting requirements exist, Contractor shall recommend suggested resolution to Engineer for disposition.

1. Codes and Standards.
2. Electrical OEM's instructions.
3. Project Drawings.
4. Project Specifications.

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. Work in compliance with this section is the responsibility of Contractor.
2. Provide manufacturer’s standard products unless otherwise specified or approved.

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. American Institute of Steel Construction (AISC).
3. American Iron and Steel Institute (AISI).
4. Electronic Industries Association (EIA).
5. Factory Mutual (FM).
6. Illuminating Engineering Society (IES).
7. International Society of Automation (ISA).
8. National Fire Protection Association (NFPA).
9. Occupational Safety and Health Administration (OSHA).
10. UL.

11. American Society for Testing and Materials (ASTM).
12. National Electrical Manufacturers Association (NEMA).
13. Institute of Electrical and Electronic Engineers (IEEE).
14. American National Standards Institute (ANSI).

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.
6. Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.
7. Section 26 05 75, Basic Electrical Materials and Methods.
8. Section 26 12 13, Liquid Filled Medium Voltage Transformers.
9. Section 26 13 00, Medium Voltage Metal-Clad Switchgear.
10. Section 26 23 00, Low Voltage Metal Enclosed Switchgear.
11. Section 26 24 16, Panelboards.
12. Section 26 24 19, Low Voltage Motor Control Centers.
13. Section 26 33 55, DC/AC UPS Systems.

1.03 DEFINITIONS

A. Drawings: Drawings includes all Technical Drawings and Documents used to define the system(s) and equipment specified herein.

B. Electrical Equipment List: The Electrical Equipment List is a listing of tagged electrical equipment. The Electrical Equipment List includes several attributes for tagged electrical equipment, including, but not limited to the following;

1. Item Tag Number: Tagged component tag number.
2. Item Name: The brief ‘name’ for component.
3. Item Description: Brief description of component.
4. Supplied By: Project item Supplier.
5. Constructed By: Project item constructor or installer.
6. Voltage and Power rating.
7. Manufacturer.
8. Manufacturer’s Order Number.

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.
2. Maintenance Records of maintenance performed during construction.
3. Calibration and Testing records.

B. Electrical Equipment List; maintain the Electrical Equipment List during construction for all electrical equipment installed by the Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 STORAGE AND HANDLING

A. Store materials in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

B. For any large items that cannot or should not be stored inside, equipment equipped with space heaters should have their anti-condensation space heaters connected and energized as soon as reasonably practicable.

3.02 COORDINATION OF WORK

A. Special attention shall be given to the coordination of Work.

B. Where practical, equipment shall be directly installed upon receipt. Review of equipment installation instructions shall be performed in advance of equipment installation such that all necessary manufacturers' requirements are followed during equipment installation.

C. Where manufacturer's representatives are required for field oversight during equipment installation sufficient schedule coordination shall be performed to ensure timely presence of manufacturer's representative.

3.03 EXAMINATION OF SITE

A. Project Site conditions shall be investigated by Contractor to ensure that equipment furnished and installed is capable of withstanding most severe Site condition that will be encountered.

3.04 PROTECTION OF WORK

A. Protect installed Work and provide temporary and removable protection for installed Work. Control activity in immediate Work area to prevent damage.

B. Damage occurring to Work during installation shall be repaired or replaced to conditions existing prior to damage at Contractor's cost.

3.05 RECEIPT OF EQUIPMENT

A. Equipment description and quantities shall be inspected prior to taking receipt of all equipment and so documented. Defects, non-conformances, damage, or quality issues shall immediately be brought to the attention of the Engineer.

B. After receipt, and prior to installation, all equipment shall be safely and securely stored in accordance with the manufacturer's instructions.

3.06 LIQUID FILLED MEDIUM VOLTAGE TRANSFORMERS

A. Liquid Filled Medium Voltage Transformers include components shipped loose that require field installation by the Contractor, including, but not limited to, the insulating oil. The Contractor is responsible for completing the assembly, oil filling, and testing. All Work associated with the installation of the Liquid Filled Medium Voltage Transformer shall be performed in strict accordance with the manufacturer's installation manual.

B. Work Included:

1. Contractor shall receive, uncrate, inspect, offload or set, inventory and store all of the Power Transformer manufacturer supplied material.
2. Assemble all shipped loose components together into completed assemblies as required by the manufacturer's drawings, including connection to adjacent electrical equipment.
3. Safely store all installation and maintenance tools and accessories for conveyance to Owner at completion of installation.
4. Insulating Oil Fill:
   a. The Contractor shall prepare and oil fill the power transformers in accordance with the manufacturer's instructions.
   b. The Contractor shall supply all labor and services to validate the integrity of the oil fill.
   c. Oil filling of the power transformers shall be conducted on a 24 hour, 7 day week basis. The Contractor shall provide qualified supervision and sufficient manpower at all times during and until final acceptance of the oil fill as requested by the Startup Engineer.
   d. The power transformer oil fill shall continue until the oil meets the acceptance requirements.

C. Examination and Construction Testing:

1. The Contractor shall furnish all necessary labor required to assist the OEM’s Vendor during initial startup and operation of all power transformers.
2. The Contractor's human resources requirements shall include all standby and overtime labor. The Contractor shall follow in detail, but not be limited to, the OEM's initial startup procedure in determining the human resources requirements that shall be submitted to the Engineer in detailed form for review and approval.
3. Test records shall be kept and turned over to Owner upon completion.

D. OEM’s Vendor: The services of the Power Transformer OEM's advisor for erection, startup and test are included in the requirements of the equipment procurement specification. The advisor's services will be available at the Job Site during erection, startup and testing of the power transformers as authorized by the Engineer.

E. Materials: All materials required for the installation of the Power Transformers shall be provided by the Contractor, including all test equipment and consumables typically required to perform the above described Scope of Work.

3.07 DRY-TYPE TRANSFORMERS

A. Dry-Type Transformers include components shipped loose that require field installation by the Contractor. The Contractor is responsible for completing the assembly and construction testing. All Work associated with the installation of the transformers shall be performed in strict accordance with the OEM’s installation manual.

B. Work Included:

1. Receive, uncrate, inspect, offload or set, inventory and store all of the OEM supplied material.
2. Safely store all installation and maintenance tools and accessories for conveyance to Owner at completion of installation.
3. Assemble all shipped loose components together into completed assemblies as required by the OEM’s drawings, including connection to adjacent electrical equipment.

C. Examination and Construction Testing:

1. The Contractor shall furnish all necessary labor required to assist during installation sufficiency examination and construction testing of the Transformer.
2. Test records shall be kept and turned over to Owner upon completion.

D. OEM’s Technical Advisor: The services of the Dry-Type Transformer equipment OEM's advisor for erection, startup, and test may be included at the discretion of the Engineer. If an advisor is present, the advisor's services will be available at the Job Site during erection, startup, and testing of the Transformer.

E. Materials: All materials required for the installation of the Power Transformers shall be provided by the Contractor, including all test equipment and consumables typically required to perform the above described Scope of Work.

3.08 MOTORS

A. Work Included:

1. Receive, uncrate, inspect, offload or set, inventory and store all of the OEM supplied material.
2. Assemble all components together into completed assemblies as required by the OEM’s drawings, including connection to adjacent electrical equipment.

B. Examination and Construction Testing: The Contractor shall furnish all necessary labor required to assist during installation sufficiency examination and construction testing of Motors and equipment.

C. Materials: All materials required for the installation of the Motor shall be provided by the Contractor, including all consumables typically required to perform the above described Scope of Work.

D. Phase Testing:

1. Prior to Equipment turnover, end to end phase testing shall be verified in accordance with the design drawings and OEM drawings.
2. Test records shall be kept and turned over to Owner upon completion.

3.09 LOW AND MEDIUM VOLTAGE SWITCHGEAR

A. Switchgear will be shipped as designed by the OEM and will be placed on the foundation by the Contractor. Complete re-connection of the shipping splits will be the responsibility of the Contractor. Switchgear includes several electrical sub-components requiring minor shipping restoration-to-service work and miscellaneous installation tasks. All work associated with the installation of Switchgear and its sub-components shall be performed in strict accordance with the OEM’s installation manual.

B. Work Included:

1. Prepare pad for placement, including all leveling channels as required by OEM instructions. Ensure proper cure time for both concrete and grout prior to placement.

2. Receive, uncrate, inspect, offload or set, inventory and store all of the OEM supplied material.
3. Safely store all installation and maintenance tools and accessories for conveyance to Owner at completion of installation.
4. Assemble all components together into completed assemblies as required by the OEM’s drawings, including connection to adjacent electrical equipment.

C. Examination and Construction Testing:

1. The Contractor shall furnish all necessary labor required to assist the OEM's Technical Advisor to perform installation sufficiency examination and construction testing of all sub-components. This includes torque-checking of all accessible bolted conductor connections.
2. Test Records shall be kept and turned over to Owner upon completion.

D. OEM’s Technical Advisor: The services of the Switchgear OEM's advisor for erection, startup, and testing may be included at the discretion of the Engineer. The advisor's services will be available at the Job Site during erection, startup and testing of the Switchgear as authorized by the Engineer.

E. Materials: All material required for installation of the Switchgear and its sub-components shall be provided by the Contractor, including all consumables typically required to perform the above described Scope of Work.

3.10 MISCELLANEOUS ELECTRICAL

A. All remaining miscellaneous Electrical components, assemblies, and systems, as noted herein and as supplied by the Owner or the Contractor, shall be erected and/or installed by the Contractor, where not identified as erected and/or installed by Others. Complete functional system installations of above scopes will the responsibility of the Contractor. All work associated with these Scopes of Work, where applicable, shall be performed in strict accordance with the OEMs installation manual(s).

B. Work Included:

1. Receive, uncrate, inspect, offload or set, inventory and store all of the Miscellaneous Electrical supplied material.
2. Assemble all components together into completed assemblies as required by the OEM’s drawings, including connection to adjacent electrical equipment.
3. All work is to be performed by Contractor.

C. Examination and Construction Testing:

1. The Contractor shall furnish all necessary labor required to assist during installation sufficiency examination and construction testing of all Miscellaneous Electrical components.
2. Test Records shall be kept and turned over to Owner upon completion.

D. Materials: All material required for installation of Miscellaneous Electrical components shall be provided by the Contractor, including all test equipment and consumables typically required to perform the above described Scope of Work.

3.11 MISCELLANEOUS ELECTRICAL ENCLOSURES

A. Miscellaneous Electrical Enclosures shall be mounted in accordance with the OEM's instructions and at the proper mounting height.

B. All electrical enclosures shall be mounted in such a way to accommodate the space about, and working space per the National Electric Code.

C. Miscellaneous Electrical Enclosures include but are not limited to:

1. Outlet boxes.
2. Welding receptacles.
3. Pull and junction boxes.
4. Separately mounted motor starters.
5. Separately mounted circuit breakers.
6. Separately mounted disconnect switches.
7. Panelboards.

3.12 BATTERY SYSTEMS

A. Prior to installation, emergency eyewash station shall be prepared, filled, and readied for use in case of emergency.

B. Install in accordance with OEM's instructions and the design drawings. Close attention shall be paid to proper storage and handling of batteries. Battery mounting system, including containment and personnel protection infrastructure, shall be in place prior to commencement of battery installation.

C. Follow all OEM recommendations on the charging, topping off and other pre-installation activities for the batteries prior to placing them on service. Note that most battery OEMs require a prerequisite soak time for the batteries prior to service that could impact the start of subsequent activities.

3.13 GENERAL REQUIREMENTS

A. Shipping Splits:

1. Ensure that mechanical and electrical connections between shipping splits are installed per the OEM's instructions.
2. Touchup any damaged finish with matching OEM's touchup paint per OEM's instructions.

B. Installation on Slab:

1. Review slab installation to confirm slab is installed per design drawings. Special attention should be given to slab embedments and their relative position in the slab as coordinated with the equipment interfaces.
2. Certain electrical equipment requires a concrete slab that is very flat to ensure that all equipment doors can be properly opened. Special attention should be given to the flatness of the installing surface.
3. Locate equipment on slab per design drawings. Install equipment anchorage per manufactures instructions and/or design drawings.

C. Welding:

1. If special welding requirements are required for any piece of equipment during installation, requirements shall be stated on OEM's Shop Drawing of affected part.
2. Follow detailed welding requirements furnished with equipment shipment or Drawings.
3. All flammable and combustible material shall be removed from areas subject to falling sparks or slag prior to Commencement of Work.

3.14 PROJECT SITE CABLE MANAGEMENT

A. Contractor is required to perform Project Site Cable Management that emphasizes high quality cable management through the Project Site cable life cycle from receipt through installation, as loosely outlined below. These processes shall be developed into individual procedures by the Contractor and submitted for review and approval by Owner. These processes are subject to audit by the Owner.

1. Project Site Cable Receipt.
2. Project Site Cable Storage.
3. Project Site Cable Inventory Control.
4. Contractor Cable Pull Ticket.
5. Contractor Cable Termination Ticket.
6. Project Site Cable Utilization Monitoring.

B. Project Site Cable Receipt:

1. Project Site Cable Receipt shall, at a minimum, follow all material handling requirements as defined elsewhere in this Specification as well as all cable manufacturer required material handling requirements.
2. Project Site Cable Receipt also begins/triggers the Project Site Cable Inventory Control process as defined below.
3. Project Site Cable Receipt shall also, when a third party cable supply arrangement exists as specified in Section 26 05 10, Cable Management Specification be closely coordinated with the Section 26 05 10, Cable Management Specification.

C. Project Site Cable Storage:

1. Project Site Cable Storage shall, at a minimum, follow all material storage requirements as defined elsewhere in this Specification as well as all cable manufacturer required material storage requirements.
2. Project Site Cable Storage shall also be in a clean secure area subject to pre-approval by the Owner.

D. Project Site Cable Inventory Control:

1. Project Site Cable Inventory Control along with the Project Site Cable Utilization Monitoring is intended to aid in the cable planning process in coordination with the Project Schedule.
2. Project Site Cable Inventory Control is intended to specify a pragmatic approach to managing Project Site Cable Inventory; setting expectations for all involved parties. Principle minimum tenants of the Project Site Cable Inventory Control include, but are not limited to:
   a. Clearly communicating the Project Site Cable Inventory within the Contractor's care and custody.
   b. Documenting the Project Site harvesting of cable from Project Site Cable Inventory.
   c. Documenting the chain-of-custody for Contractor managed Project Site Cable Inventory.
   d. Just-in-time cable requisitioning when cable supplied by Owner via Section 26 05 10, Cable Management Specification; cable shall be requisitioned no more than 30 days in advance of planned installation as shown by Contractor's detailed Project Schedule.
3. Key Project Site Cable Inventory Control terms are:
   a. Contractor Cable Cut Record (CCCR); Contractor record of Contractor managed Project Site cable incorporating and documenting all elements of Project Site Cable Inventory Control. The CCCR shall include date, time, and responsible party performing the task being recorded. The Contractor Cable Cut Record shall be included with Contractor's daily report.

b. Engineers Designed Cable Length (EDCL); Engineers cable schedule ‘designed length’.
c. Engineers Pull Cable Length (EPCL); EDCL + tails (tails are purposeful lengths of cable at each end of pull to allow for training cable into final termination; typically 8 feet on each end).
d. Contractors Cut Cable Label; all cable removed from Contractor managed Project Site Cable Inventory requires a label correlating the cut cable to the Contractor Cable Cut Record and include a unique identifier if different than Engineer’s Cable Number.
e. Contractors Cut Cable Length (CCCL); this is the actual cable cut length for harvested cable, as determined by the difference of cable footage markings on cable. Cable footage markings shall be recorded on the Contractor Cable Cut Record.

E. Contractor Cable Pull Ticket (CCPT):

1. The Contractor Cable Pull Ticket (CCPT) is a means for documenting the Contractor cable installation basis and process. CCPT’s shall be developed on a per-cable basis and completed CCPT’s shall be included in the Contractors weekly report.
2. The CCPT shall include the following groups of information:
   a. Cable definition; cable data from Engineer’s Cable Schedule
   b. CCCR unique identifier, if different than Engineer’s Cable Number.
   c. Cable routing and length basis; cable routing path listed by individual raceway segments and Contractors Field Verified Cable Path Length (FVL).
   d. Cable installation method; Contractors planned method of installation in simple terms, such as: Hand, Mechanically Assisted, etcetera.
   e. Cable installation quality control record, at a minimum:
      1) Date pulled.
      2) Individual responsible for pulling activity.
      3) Individual responsible for quality control of pulling activity.
      4) Weather during pulling activity.
      5) Post pulling activity cable integrity verification.
      6) Mechanical Assistance maximum tension value during pulling activity, if mechanical assistance used for pulling activity.

F. Contractor Cable Termination Ticket (CCTT):

1. The Contractor Cable Termination Ticket (CCTT) by cable end is a means for documenting the Contractor cable termination process. Completed CCTT’s shall be included in the Contractor’s weekly report.

2. The CCTT shall include the following groups of information:
   a. Cable definition; cable data from Engineer's Cable Schedule
   b. Cable termination basis; reference drawing from which cable termination is determined.
   c. Cable end treatment in simple terms, by cable end, such as: stress cone, shielded-grounded, shielded-tapped, etcetera.
   d. Cable Final Installed Length (CFIL); final cable length once dressed into termination as determined cable footage marking.
   e. Cable termination quality control record, at a minimum:
      1) Date terminated.
      2) Individual responsible for termination activity.
      3) Individual responsible for quality control of termination activity.
      4) Post termination activity cable integrity verification.
      5) Post termination activity cable termination correctness check against cable termination basis verification.

G. Project Site Cable Utilization Monitoring:

1. The Contractor shall develop a rigorous Project Site Cable Utilization Monitoring program to aid in the projection of actual cable utilization versus planned cable utilization. Additionally, Project Site Cable Utilization Monitoring supports demonstration of efficient utilization of Owner supplied cable. Cable utilization efficiency monitoring documentation on a per-cable basis shall be included with the Contractor's weekly report.
2. The Contractor's Project Site Cable Utilization Monitoring program shall include, but not limited to, the following functions and duties:
   a. Basic cable efficiency formula: Cable Waste = CCCL - EPCL.
   b. Cable waste in excess of 5 percent of EPCL is considered excessive and will be subject to replacement by the Contractor at the Contractor's expense.

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.

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: 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

A. The Contractor shall make all splices, unless noted otherwise on the Drawings.

B. Splices shall follow cable manufacturer’s recommended procedure or where none is specified by the cable manufacturer, splices shall follow these minimum requirements.

C. 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.

D. Temperature rating of splices shall be rated no less than 75 degrees C or the temperature rating of the cable, whichever is greater.

E. 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.

F. Insulating tapes and compounds for splices shall be UL-listed for intended use, location, and voltage by manufacturer. High voltage rubber tape shall be Scotch 130C ‘linerless’ tape. Irregular surfaces of high voltage bolts, connectors, etcetera shall be filled with Scotch “Scotchfil” insulating putty prior to taping. Scotch 33+ plastic tape shall be the final external tape layer applied overall.

G. Where splices utilize crimped components, crimping tool shall be purpose-specific, sized and calibrated for the crimp; this requirement is to avoid utilizing the wrong tool for the job.

H. Medium voltage cable splices shall use heat shrink splice kits, Raychem Type HVS, 3M, or approved equal or as recommended by the cable manufacturer. Cable manufacturer recommended cable splice kit will require approval as though being considered an approved equal.

I. Personnel performing splices, especially medium voltage splicing, shall be qualified and trained specifically for the splicing being performed. For medium voltage splicing personnel training shall be documented to have been received within the past 18 months and subject to review by the Engineer.

J. Medium voltage cable splices shall be completed once begun. It is unacceptable to pause a splicing activity at the end of a work shift and resume the following day; such splices will be rejected and redone at the Contractor's expense.

2.04 TERMINATIONS

A. Temperature rating of terminations shall be rated no less than 75 degrees C or the temperature rating of the cable, whichever is greater.

B. Termination of conductors to equipment with bolted connections:

1. Use compression type lugs.
2. Compression lugs for cables 4/0 AWG 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.

C. Terminals: Conductors larger than No. 4/0 AWG: Terminate to tinned copper bus bar drilled and tapped with standard NEMA sized and spaced holes.

D. Medium voltage connections to bus bar shall be accomplished by crimping two hole NEMA lugs to cables. Lugs shall be bolted to bus bar and torqued to the manufacturer's recommendation. Insulate medium voltage connection with Raychem or 3M bus termination shrinkable kits, insulating sheets, or manual hand taping to the full insulation level of the installed system.

E. Insulating tapes and compounds for terminations shall be UL-listed for intended use, location, and voltage by manufacturer. High voltage rubber tape shall be Scotch 130C 'linerless' tape. Irregular surfaces of high voltage bolts, connectors, etcetera shall be filled with Scotch "Scotchfil" insulating putty prior to taping. Scotch 33+ plastic tape shall be the final external tape layer applied overall.

F. Coordinate sizes and types of conductor terminals for 600V power cable terminations in equipment with furnished conductor and terminal connector data.

G. 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.

H. Terminal blocks for external connections shall leave from centrally mounted location, not from individual devices in enclosure, unless shown otherwise on the Drawings.

I. 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.

J. 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.

K. 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.

L. Terminate each conductor in multiconductor control cable or as shown on the Drawings. Provide 10 percent spare terminals for circuit modifications.

M. 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.

N. 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.

O. Cable designations shall be visible after installation without requiring physical movement of cable.

2.05 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 240V ac minimum, and shall be sized for operation on applied voltage of 120V 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.

2.06 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.

2.07 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.

2.08 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.

2.09 PIN AND SOCKET CONNECTORS

A. Not allowed unless shown on the Drawings or is part of Manufacturer's standard equipment package.

2.10 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.

2.11 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 5A current transformer secondary and 120V voltage transformer secondary.

E. Electrical meters shall be provided with communications capability.

2.12 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.

2.13 CONTROL SWITCHES

A. Multistage, rotary-type rated 120V ac or 125V 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.

2.14 PUSHBUTTONS

A. Standard pushbuttons shall be heavy duty, industrial-type rated 120V ac or 125V dc, 3A minimum, as required.

B. Provide with colored LED lamps and nameplates as required.

2.15 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.

2.16 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 125V dc and shall be rated 5A make or break, minimum.

2.17 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 100VA for Size 1 starters and 150VA 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 120V 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.

2.18 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.

2.19 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.

2.20 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.

2.21 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.

2.22 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.

2.23 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.

2.24 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 2 feet in any dimension. For those enclosures that are less than 2 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.

2.25 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.

2.26 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.

2.27 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.

2.28 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.

2.29 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.

2.30 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.

2.31 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.

2.32 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.

2.33 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.

2.34 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, Low Voltage Wire and Cable and 26 05 13, Medium Voltage Cable.

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.

2.35 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”.

2.36 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 by O.D. of largest conductor in group or adjacent group where noted on the Drawings or where space allows.

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 CLEANING OF EXISTING AND NEW CONDUITS WITHIN DUCTBANK

A. Before new cable is installed in ductbank conduit, flush the ductbank conduit using water until thoroughly cleaned.

B. Contractor shall pull full size flexible segmented mandrel through each ductbank conduit in the presence of an Owner’s Inspector, as further described below.

C. Contractor shall swab out all ductbank conduits to remove any residual dirt or debris, as further described below.

D. The below sequence by Conduit Size shall be performed utilizing the noted Greenlee products or approved equal:

Conduit Size	**Sequence**	**Manufacturer**	**Cat. No.**
4”	First – Wire Brush	Greenlee	<TBD>
4”	Second – Segmented Mandrel	Greenlee	<TBD>
4”	Third – Lube Spreader Swab	Greenlee	<TBD>
5”	First – Wire Brush	Greenlee	39284
5”	Second – Segmented Mandrel	Greenlee	39255
5”	Third – Lube Spreader Swab	Greenlee	17370

Conduit Size	Sequence	Manufacturer	Cat. No.
6”	First – Wire Brush	Greenlee	39286
6”	Second – Segmented Mandrel	Greenlee	39288
6”	Third – Lube Spreader Swab	Greenlee	17371

E. Contractor shall install a 40 pound, minimum, pull string following the completion of the above steps.

F. Cap or plug cleaned conduits to prevent entry of foreign matter, water, dirt, debris, etcetera, after cleaning. Temporary other means will not be accepted.

3.07 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.

3.08 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.

3.09 ACCEPTANCE TESTS OF MEDIUM VOLTAGE CABLE

A. The Contractor shall supply all labor and equipment required for High Potential (Hi-Pot) testing of all medium voltage cable installed under the Work. The Hi-Pot testing shall be done in strict accordance with the Cable Manufacturer's field testing recommendations for step voltage proof testing of installed cables, including the following:

1. Each conductor shall be individually tested with all other conductors and shields grounded. Ambient temperature and humidity during test shall be recorded.
2. Voltage shall be applied to each cable in equal steps until the final test voltage is reached. Leakage current shall be read and recorded at each voltage level. The final cable test voltage shall be per the Cable Manufacturer's recommendations.
3. After reaching the final level of test voltage, the voltage shall be held for a minimum of 15 minutes and the leakage current read and recorded every minute.
4. The Owner's Inspector shall witness the Hi-Pot testing and shall be notified at least 24 hours prior to the scheduled start of such tests. Testing shall not be performed on wet, damp, or rainy days.
5. The Hi-Pot test reports shall be submitted to the Engineer for review and acceptance.
6. Sample Hi-Pot test form – Medium Voltage Cable Test Sheet – is attached to this Specification.

3.10 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.

1. Hi-Pot Test Form – Medium Voltage Cable Test Sheet.
2. Automatic Transfer Switches Data Sheets.
3. Three Phase Pad Mounted Transformers Data Sheets.

END OF SECTION

MEDIUM VOLTAGE CABLE TEST SHEET

CUSTOMER		DATE		JOB #	
ADDRESS		AIR TEMP	°F	HUMIDITY	%
OWNER/USER		LAST INSPECT.			
ADDRESS		LAST PROJ#			
EQUIP. LOC.		OWNER IDENT.			

DATA

MANUF.		SIZE	
INSUL. TYPE		LENGTH	
AGE		# CONDUCTRS	
INSTALLED IN		RATED KV	
OTHER		MAX TEST KV	

LEAKAGE CURRENT (Microamps)

TIME	TEST VOLTG (KV)	PHASE 1	PHASE 2	PHASE 3
.25 Min.				
.50 Min.				
.75 Min.				
1.0 Min.				
2.0 Min.				
3.0 Min.				
4.0 Min.				
5.0 Min.				
6.0 Min.				
7.0 Min.				
8.0 Min.				
9.0 Min.				
10.0 Min.				
11.0 Min.				
12.0 Min.				
13.0 Min.				
14.0 Min.				
15.0 Min.				
	SHIELD CONTINUITY	OK – BAD – N/A	OK – BAD – N/A	OK – BAD – N/A

INSULATION RESISTANCE (1 min. @ KV)	**PH1 to GRD**	**PH2 to GRD**	**PH3 to GRD**	**PH1 to PH2**	**PH2 to PH3**	**PH3 to PH1**
	Gigohms or Megohms			Gigohms or Megohms		

REMARKS					
TESTED BY		EQUIP. USED	Megger, D.C. Hipot	SHT #	

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.
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 supplement listed below, following "End of Section," is a part of this Specification:

1. Data Sheets.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.
3. Selection of signal reference grids.
4. Installation of grounding and bonding for towers and antennas.

1.02 DEFINITIONS

A. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.

B. PBB: Primary bonding busbar, located in main distribution frame room, ideally near electrical service entrance.

C. RBB: Rack bonding busbar, located in equipment cabinets and racks.

D. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.

E. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.

F. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.

G. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.

H. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

I. IBT: Intersystem Bonding Termination – An intersystem bonding termination for connecting intersystem bonding conductors required for other systems shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures.

1.03 ACTION SUBMITTALS

A. Shop Drawings:

1. For communications equipment room signal reference grid.
2. Include plans, elevations, sections, details, and attachments to other work.

B. Field Quality-Control Submittals: Field quality-control reports.

1.04 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installing wire connector on conductor.
2. Recommended torque values.

1.05 CLOSEOUT SUBMITTALS

A. Record Documentation: Project record documents in accordance with Section 01 78 39, Project Record Documents must include locations of PBB and SBBs, and routing of TBC, TBBs, and BBCs.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of TBC connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

3.02 SELECTION OF COMMUNICATIONS BUSBARS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

B. PBB:

1. Dimensions: 1/4 inch thick by 4 inches high by 20 inches long.
2. Stand-Off Distance: 1.5-inch insulators with a 1-inch offset stainless steel mounting bracket.

C. SBB:

1. Dimensions: 1/4 inch thick by 2 inches high by 20 inches long
2. Stand-Off Distance: 1.5-inch insulators with a 1-inch offset stainless steel mounting bracket.

3.03 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

B. Communications Busbar Connections:

1. TBC: Not smaller than 3/0 AWG and no smaller than largest TBB.
2. TBB: Not smaller than 250 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
3. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
4. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
5. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
6. Bonding Conductors to Structural Steel: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.

C. Cable Tray Connections:

1. Cable Tray Equipment Grounding Conductor: 6 AWG.
2. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than 6 AWG and not longer than 12 inch. If jumper is wire, it must be terminated with lug having two holes. If jumper is flexible braid, it must be terminated with one- or two-hole ferrule. Attach with bonding screw or connector provided by cable tray manufacturer.

D. Underground Connections: Not smaller than 2 AWG. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on the Drawings.

3.04 SELECTION OF SIGNAL REFERENCE GRIDS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

B. Access Floor Signal Reference Grid:

1. Provide low-impedance path between telecommunications cabinets, equipment racks, and reference grid, by installing 6 AWG bonding conductors in a grid pattern under floor.
   a. Install grid bonding conductors on 4-foot centers, to permit bonding of one structural pedestal for each access floor tile. Connect grid conductors together where they cross each other.
   b. Bond SBBs in room to two or more bonding conductors of reference grid with TEBCs.
   c. Bond equipment to nearest SBB and to reference grid with TEBCs.
   d. Bond conduits and piping entering equipment room with TEBCs to nearest SBB and to grid conductor nearest entry into room.

3.05 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Busbars:
   a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 90 inch above finished floor unless otherwise indicated.
   b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

2. Conductors:
   a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
   b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:
      1) Use crimping tool and die specific to connector.
      2) Pretwist conductor.
      3) Apply antioxidant compound to bolted and compression connections.
   c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
   d. Install without splices.
   e. Support conductors at not more than 36-inch intervals.
   f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.
      1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing that complies with Division 27, Communications, and bond both ends of raceway to SBB.
3. Provide TBC and terminate ends to PBB and intersystem bonding termination device or busbar at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
4. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together BBCs where required by TIA-607-D.1.
5. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.
6. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
7. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide vertically mounted RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70; equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this section.
8. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1-E and TIA-568.2-D when grounding shielded balanced twisted-pair cables.
9. Primary Protector: Bond to PBB with insulated bonding conductor.

10. Electrical Power Panelboards: Where electrical panelboards for communications equipment are in same room or space, bond each ground bar of panelboard to SBB.
11. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
12. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
13. Access Floors: Bond metal parts of access floors to SBB.
14. Server cabinets for Control House and other server applications.

3.06 INSTALLATION OF GROUNDING AND BONDING FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Special Requirements for Waveguides and Coaxial Cable:
   a. Bond cable shields at point of entry into building to nearest SBB and to cable entrance plate, using 2 AWG bonding conductors.
   b. Bond coaxial cable surge arrester to ring electrode or roof ring using bonding conductor size recommended by surge-arrester manufacturer.

3.07 IDENTIFICATION

A. Comply with Section 01 58 53, Project Equipment Identification.

B. Labels must be preprinted or computer-printed type.

1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.
2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!".

3.08 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation: All new grounding and bonding systems must be tested by fall of potential.

B. Field tests and inspections must be witnessed by Architect, Tenant, authorities having jurisdiction and telecommunications designer RCDD.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.
   a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.
      1) If measured resistance from electrical service equipment to ground exceeds 5 Ω, notify Architect and include recommendations to reduce resistance to ground.
   b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.
3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.
   a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB and to SBBs. Maximum acceptable AC current level is 1 A.

D. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

3.09 PROTECTION

A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

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SECTION 27 13 23
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Type OFNR optical fiber cable.
2. Optical fiber cable hardware.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ANSI/Institute of Electrical and Electronics Engineers (IEEE)/NEMA/NECA/UL.
2. BICSI TDMM 14th Edition.
3. TIA/EIA-455 (2014C) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.
4. TIA-455-21 (1988a; R 2012) FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices.
5. TIA-455-78-B (2002) FOTP-78 Optical Fibers – Part 1-40: Measurement Methods and Test Procedures – Attenuation.
6. TIA-455-107 (1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Se.
7. TIA/EIA-455-204 (2000) Standard for Measurement of Bandwidth on Multimode Fiber.
8. TIA-472D000 (2007b) Fiber Optic Communications Cable for Outside Plant Use.
9. TIA-492CAAA (1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
10. TIA-526-7 (2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
11. TIA-526-14 (2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
12. ANSI/TIA 569-E Commercial Building Standard for Telecommunications Pathways and Spaces.
13. ANSI/TIA-604-10B Fiber Optic Connector Intermateability Standard (FOCIS), Type LC.
14. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure.
15. ANSI/TIA-758-C Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

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16. ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises.
17. ANSI/TIA 568.1-E Commercial Building Telecommunications Infrastructure Standard.
18. ANSI/TIA 568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
19. ANSI/TIA 568.3-D Optical Fiber Cabling Components Standard
20. ANSI/TIA 942-B Telecommunications Infrastructure Standard for Data Centers.
21. ANSI/TIA 606-C Administration Standard for Telecommunications Infrastructure.
22. ANSI/TIA 607-D.1 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

1.03 DEFINITIONS

A. Conductive Cable: Cable containing non-current carrying electrically conductive members such as metallic strength members and metallic vapor barriers.

B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

C. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.

1.04 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.05 ACTION SUBMITTALS

A. Product Data:

1. Type OFNR optical fiber cable.
2. Optical fiber cable hardware.

B. Shop Drawings:

1. System Labeling Schedules:
   a. Electronic copy of labeling schedules, in software and format selected by Owner.
   b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

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2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:
   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Cross-connects.
   f. Patch panels.
   g. Patch cords.
4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

1.06 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Contracts: Software service agreement.

B. Maintenance Data: For optical fiber cable, splices, and connectors.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project Site:

1. Test optical fiber cable to determine continuity of strand end to end. Use optical fiber flashlight and optical loss test.

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2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 PRODUCTS

2.01 TYPE OFNR OPTICAL FIBER CABLE

A. Type OFNR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:
   a. Performance: TIA-568.3-D.
   b. Inside Plant Mechanical Properties: ICEA S-83-596.
   c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
   d. Jacket:
      1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
      2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

C. Type OFNR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer:
   a. AFL 48 Strand AFL DNA 28262 ADSS.
   b. Corning 48 Strand 048E8F-61131-29.
   c. Corning 24 Strand 024E8F-31131-29.
   d. Corning 12 Strand 012E8F-31131-29.
   e. Corning 6 Strand 006E8F-31131-29.
2. Additional Characteristics:
   a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 1310 nm wavelength; 500 MHz-km at 1550 nm wavelength.

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D. Type OFNR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable (OWNER PREFERRED FOR BUILDING TO BUILDING AND WITHIN):

1. Source Limitations: Obtain products from single manufacturer:
   a. Corning 48 Strand 048EUF-T4101D20.
   b. Corning 24 Strand 024ESF-T4101D20.
   c. Corning 12 Strand 012ESF-T4101D20.
   d. Corning 6 Strand 006ESF-T4101D20.
2. Additional Characteristics:
   a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
   b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 1310 nm wavelength; 500 MHz-km at 1550 nm wavelength.
3. Options:
   a. Configuration: As depicted on the Drawings: Jetted, single mode, tight buffer, optical fiber cable.
   b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
   c. Jacket Color: Yellow.

2.02 OPTICAL FIBER CABLE HARDWARE

A. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3-D.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Patch Panels:
   a. Corning 4RU Enclosure-CCH-04U.
   b. Corning 24 Strand Cassettes-CCH-CS24A9-P00RE.
   c. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables based on distance from electronic hardware.

D. Connector Type: Type LC complying with TIA-604-10.

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E. Plugs and Plug Assemblies:

1. Male: color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.03 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: Engage qualified testing agency to evaluate cables.

C. Factory Tests and Inspections: Test and inspect singlemode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-7-A and TIA-568.3-D before delivering to Site. Affix label with name and date of manufacturer's certification of system compliance.

D. Nonconforming Work: Cables that do not pass tests and inspections will be considered defective. A partial pass is considered a failed test.

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.02 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:
   a. Type OFNR or in listed plenum communications raceway.
   b. Type OFNR in metallic conduit.

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2. Conductive:
   a. Type OFCR or Type OFCP in listed plenum communications raceway.
   b. Type OFCP in metallic conduit.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:
   a. Type OFNP in listed plenum communications raceway.
   b. Type OFNR or Type OFNP in metallic conduit.
2. Conductive:
   a. Type OFCP in listed plenum communications raceway.
   b. Type OFCP in metallic conduit.

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: Type OFNR in metallic conduit.
2. Conductive: Type OFCR in metallic conduit.

3.03 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:

1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

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2. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
    a. Install plenum cable in environmental airspaces, including plenum ceilings.
    b. Comply with requirements for pathways specified in Section 27 05 28, Pathways for Communications Systems.
3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide 10-foot long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

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H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Installation of Cable Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inch in diameter below each feed point.

J. Group connecting hardware for cables into separate logical fields.

3.04 FIRESTOPPING

A. Comply with TIA-569, Annex A, "Firestopping."

B. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.05 GROUNDING

A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607 and NECA/BICSI-607.

C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Sections 01 58 53, Project Equipment Identification and 26 05 53, Identification for Electrical Systems.

1. Administration Class: Class 3 or based on current labeling scheme of Client.

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B. Paint and label colors for equipment identification must comply with TIA-606 for Class 3 level of administration including optional identification requirements of this standard and the Client.

C. Comply with requirements in Section 27 15 23, Communications Optical Fiber Horizontal Cabling for cable and asset management software.

D. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

G. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-C, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

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3.07 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Certification equipment must be calibrated within 12 months of the completed certification.
2. Provide an end-to-end loss budget for each cable to be performance tested and certified.
3. Provide optical fiber cleaning procedure used before inserting test cables into optical fiber connectors and bulkheads. All connectors, bulkheads and patch cables must be cleaned before each insertion. Assume all connectors, bulkheads patch cables are contaminated and must be cleaned before each insertion.
4. Backbone cabling must remain undisturbed from the beginning, during and after performance testing and certification. Any cabling connectors or bulkheads relocated or re-inserted after testing and certification must be re-tested and re-certified.

B. Field tests and inspections must be performed by a BICSI certified Installer 2 and witnessed by an RCDD.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
   a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:
      1) Tier 2 bi-directional testing is required for all interbuilding backbone cabling. Tier 2 testing includes PDF results from an Optical Loss Test Set (OLTS) and an Optical Time Domain Reflectometer (OTDR).
      2) Reference ANSI/TIA-526-7-A – Test procedure for installed single mode fiber cable plant – Released in July 2015 – Reaffirmed: May 11, 2022. Adoption of IEC 61280-4-2 Ed 2.0.
      3) Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

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D. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

E. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented. Provide Tier 2 PDF test results within 2 weeks of completion of performance test and certification.
2. Data for field quality-control report submittals must be printed in summary report that is formatted like Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

F. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

3.08 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for 2 years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.
   a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION

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SECTION 27 15 13
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Related Requirements: Section 26 05 19, Low Voltage Wire and Cable for cables not addressed within Division 27, Communications.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ANSI/Institute of Electrical and Electronics Engineers (IEEE)/NEMA/NECA/UL.
2. BICSI TDMM 14th Edition.
3. TIA/EIA-455 (2014C) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.
4. TIA-455-21 (1988a; R 2012) FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices.
5. TIA-455-78-B (2002) FOTP-78 Optical Fibers – Part 1-40: Measurement Methods and Test Procedures – Attenuation.
6. TIA-455-107 (1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Se.
7. TIA/EIA-455-204 (2000) Standard for Measurement of Bandwidth on Multimode Fiber.
8. TIA-472D000 (2007b) Fiber Optic Communications Cable for Outside Plant Use.
9. TIA-492CAAA (1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
10. TIA-526-7 (2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
11. TIA-526-14 (2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
12. ANSI/TIA 569-E Commercial Building Standard for Telecommunications Pathways and Spaces.

13. ANSI/TIA-604-10B Fiber Optic Connector Intermateability Standard (FOCIS), Type LC.
14. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure.
15. ANSI/TIA-758-C Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
16. ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises.
17. ANSI/TIA 568.1-E Commercial Building Telecommunications Infrastructure Standard.
18. ANSI/TIA 568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
19. ANSI/TIA 568.3-D Optical Fiber Cabling Components Standard.
20. ANSI/TIA 942-B Telecommunications Infrastructure Standard for Data Centers.
21. ANSI/TIA 606-C Administration Standard for Telecommunications Infrastructure.
22. ANSI/TIA 607-D.1 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

1.03 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.04 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568.1-E requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 square feet. and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.05 ACTION SUBMITTALS

A. Product Data:

1. Category 6a twisted pair cable.
2. Category 5e twisted pair cable.
3. Twisted pair cable hardware.
4. Cable management system.
5. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:
   a. Electronic copy of labeling schedules, in software and format selected by Owner.
   b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.
2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Telecommunications conductor drop locations.
   f. Typical telecommunications details.
   g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and cover plates for color selection and evaluation of technical features.

E. Field Quality-Control Submittals: Field quality-control reports.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.

3. Device address list.
4. Printout of software application and graphic screens.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Technician or Level 2 Installer, who shall be present at all times when Work of this section is performed at Project Site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project Site.

1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568.1-E, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-E.

C. Grounding: Comply with TIA-607-D.

2.02 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:
   a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.
   b. Type CMP in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
2. Communications, Non-Plenum Rated:
   a. Type CMR complying with UL 1666 and ICEA S-103-701.
   b. Type Type CMR in listed plenum or riser communications raceway.
   c. Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. RoHS compliant.

2.03 CATEGORY 6A TWISTED PAIR CABLE

A. Category 6a Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

1. Siemon CAT 6A Cable F/UTP- 9A6P4-A5-07-R1A.

B. Standard: Comply with TIA-568.2-D for Category 6a cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP) and/or Shielded twisted pairs (FTP).

E. Cable Rating: Riser.

F. Jacket: Blue thermoplastic.

2.04 CATEGORY 5E TWISTED PAIR CABLE

A. Category 5e Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

1. Siemon CAT 5e Cable 9C5P4-E1-06-RXA.

B. Standard: Comply with TIA-568.2-D for Category 5e cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP) and/or Shielded twisted pairs (FTP).

E. Cable Rating: Riser.

F. Jacket: Blue thermoplastic.

2.05 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6a and 5e.

2. Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer or manufacturer partner as twisted pair cable, from single source.

D. Connecting Blocks:

1. 110-style IDC for Category 6a and 5e.
2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Siemon DIN-PNL-RIC-01:
   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 ports.
2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated, conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Patch Cords: Factory-made, four-pair cables in 36-inch, 48-inch, and 72-inch lengths as necessary based on termination field and switch location. Additional lengths may be required; terminated with an eight-position modular plug at each end.

1. Siemon MC5-07-0202.
2. Siemon SP6A-S03-07.

3. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
4. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568.2-D.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Siemon Z-MaxShield 6A Jacks.
2. Siemon MX5-K06 5e Jacks.
3. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
4. Designed to snap-in to a patch panel or cover plate.
5. Standard: Comply with TIA-568.2-D.
6. Marked to indicate transmission performance.

J. Cover Plate:

1. Siemon 2 Port Faceplate-10GMX-FPS02-02.
2. Siemon 4 Port Faceplate-10GMX-FPS04-02.
3. Cover Plates: Reference Section 26 05 75, Basic Electrical Materials and Methods
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.06 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view, schematic plans, or technical drawings.

1. AutoCAD or Revit drawing software shall be used as Drawing and schematic plans software.

D. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.07 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.08 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568.1-E.

C. Factory test twisted pair cables according to TIA-568.2-D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
   a. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways specified in Section 26 05 33, Conduit Installation and 26 05 36, Cable Tray.
   a. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures using hook and loop fasteners. No plastic zip ties are allowed for bundling or dressing network cables. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 40 95 33, Process Control Networks.

B. Comply with Sections 26 05 33, Conduit Installation, 26 05 36, Cable Tray, and 26 05 29, Hangers and Supports for Electrical Systems.

C. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568.0-E, TIA-568.1-E, and TIA-568.2-D.
2. Comply with the most current version of BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:
   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for twisted pair cables at least 49 feet from communications equipment room.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
14. Pulling Cable: Comply with the most current version of BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Open-cable installation is only to be used in locations where cable tray or conduit is not feasible. The maximum distance for the cable tray using open-cable supports is 50 feet.
2. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
3. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
4. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable in a figure 8 configuration 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 FIRESTOPPING

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.05 GROUNDING

A. Comply with requirements in Section 27 05 26, Grounding and Bonding for Communications Systems for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-D and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Sections 01 58 53, Project Equipment Identification and 26 05 53, Identification for Electrical Systems.

1. Administration Class: Class 3.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 3 level of administration, including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
   b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-C requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation: Horizontal cabling must remain undisturbed before, during and after testing and certification. Certification equipment must be calibrated within 12 months of the complete certification.

B. Field tests and inspections must be witnessed by authorities having jurisdiction or be performed by a third party RCDD or Technician.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568.1-E.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    a. Test instruments shall meet or exceed applicable requirements in TIA-568.2-D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

3.08 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for 2 years.
2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.
    a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION

SECTION 27 15 23
COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, General Requirements Specification sections, apply to this section.

1.02 SUMMARY

A. Section Includes:

1. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
3. Grounding.
4. Cabling identification products.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ANSI/Institute of Electrical and Electronics Engineers (IEEE)/NEMA/NECA/UL.
2. BICSI TDMM 14th Edition.
3. TIA/EIA-455 (2014C) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.
4. TIA-455-21 (1988a; R 2012) FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices.
5. TIA-455-78-B (2002) FOTP-78 Optical Fibers – Part 1-40: Measurement Methods and Test Procedures – Attenuation.
6. TIA-455-107 (1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Se.
7. TIA/EIA-455-204 (2000) Standard for Measurement of Bandwidth on Multimode Fiber.
8. TIA-472D000 (2007b) Fiber Optic Communications Cable for Outside Plant Use.
9. TIA-492CAAA (1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.

10. TIA-526-7 (2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
11. TIA-526-14 (2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
12. ANSI/TIA 569-E Commercial Building Standard for Telecommunications Pathways and Spaces.
13. ANSI/TIA-604-10B Fiber Optic Connector Intermateability Standard (FOCIS), Type LC.
14. ANSI/TIA-606-C Administration Standard for Telecommunications Infrastructure.
15. ANSI/TIA-758-C Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
16. ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises.
17. ANSI/TIA 568.1-E Commercial Building Telecommunications Infrastructure Standard.
18. ANSI/TIA 568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
19. ANSI/TIA 568.3-D Optical Fiber Cabling Components Standard.
20. ANSI/TIA 942-B Telecommunications Infrastructure Standard for Data Centers.
21. ANSI/TIA 606-C Administration Standard for Telecommunications Infrastructure.
22. ANSI/TIA 607-D.1 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

1.04 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.05 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568.1-E requires that a minimum of two equipment outlets be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 square feet and includes the components that extend from the equipment outlets to the equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration Drawings and printouts.
4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Telecommunications conductor drop locations.
   f. Typical telecommunications details.
   g. Mechanical, electrical, and plumbing systems.

C. Fiber optic cable testing plan.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.08 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

B. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.09 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field-testing program development by an RCDD or Technician.
2. Installation Supervision: Installation shall be under the direct supervision of Technician or Level 2 Installer, who shall be always present when Work of this section is performed at Project Site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD or Technician.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project Site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.13 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

1.14 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for 2 years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568.1-E, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-E.

C. Grounding: Comply with TIA-607-D.

2.02 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

A. Description: Multimode, 50/125-micrometer (strand count as described on the Drawings) nonconductive, tight buffer, optical fiber cable.

1. Corning 12 Strand 012T8F-31190-29.
2. Corning 6 Strand 006T8F-31190-29.
3. Corning 2 Strand 002T8F-31190-29.

B. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-D.3 for performance specifications.
3. Comply with TIA-492AAAD for detailed specifications.

C. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

D. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

E. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

F. Jacket:

1. Jacket Color: Aqua.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Non Plenum Rated, Nonconductive: Type OFNR, complying with NFPA 262.
2. Non Plenum Rated, Nonconductive: Type OFNR in listed plenum communications raceway.
3. Non Plenum Rated, Conductive: Type OFCR, complying with NFPA 262.
4. Non Plenum Rated, Conductive: Type OFCR or Type OFNR in listed plenum communications raceway.
5. Non Plenum Rated, Conductive: Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.03 OPTICAL FIBER CABLE HARDWARE

A. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568.3-D.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths.

D. Connector Type: Type LC complying with TIA-604-10-B, connectors.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

G. Faceplate:

1. Four -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Twelve -port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Cover Plates: Reference Section 26 05 75, Basic Electrical Materials and Methods.
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.04 GROUNDING

A. Comply with requirements in Section 27 05 26, Grounding and Bonding for Communications Systems for grounding conductors and connectors.

B. Comply with TIA-607-D.

2.05 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.06 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-D.3.

C. Factory test preterminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-D.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways specified in Sections 26 05 33, Conduit Installation and 26 05 36, Cable Tray.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568.1-E and TIA-568.3-D.
2. Comply with the most current version of the BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in the most current version of the BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.
10. Pulling Cable: Comply with the most current version of the BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.03 FIRESTOPPING

A. Comply with TIA-569-E, Annex A, "Firestopping."

B. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.04 GROUNDING

A. Install grounding according to the most current version of the BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-D and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.05 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-C. Comply with requirements for identification specified in Sections 01 58 53, Project Equipment Identification and 26 05 53, Identification for Electrical Systems.

1. Administration Class: Class 3.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-C for Class 3 level of administration including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, horizontal pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-C, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-E.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in TIA-568-D.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:
      1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
      2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568.1-E.

F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted like Table 10.1 in the most current version of the BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

G. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

H. End-to-end cabling will be considered defective if it does not pass tests and inspections.

I. Prepare test and inspection reports.

END OF SECTION

SECTION 40 90 00
I&C GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 PURPOSE OF DOCUMENT

A. This section 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, Diesel Engine Driven Generator Sets, Balance of Plant Equipment such as Air Compressors and Water Treatment.
   b. Refer to Control Panel referenced in 409423PSS 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, Division 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.

F. 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.

G. 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.

H. Local control valves shall be pneumatic unless process conditions dictate otherwise.

I. Filter regulators with output pressure gauge shall be provided for all pneumatically operated control equipment.

J. 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.

K. Control valve, pressure relief valve, and flow measuring device calculations shall be prepared using customary imperial U.S. Units.

L. All elastomers (liners, gasketing, packing, etc.) and wetted materials are to be compatible with the process service.

M. All electronic instrumentation shall be immune to Radio Frequency Interference (RFI).

N. 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.

O. 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.

P. 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.

Q. 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.

R. Alarm or shutdown actuating transmitters or switches must be separate from any devices used for normal process control.

S. 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.

T. 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.

U. 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.

V. Instruments shall not be located in areas where the ambient temperature exceeds 130 degrees F or areas exceeding manufacturers requirements.

W. Instruments shall not be supported on handrails or equipment subject to vibration.

X. Instruments subject to vibration shall be mounted to minimize the effect of vibration. An anti-vibration mount may be used.

Y. Fiber optic cable shall be installed and terminated by a licensed Supplier certified in fiber optic installation.

Z. 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.

AA. 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.

BB. Local instruments shall be mounted no more than 30 feet from the point of measurement without Owner/Engineer’s approval.

CC. 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.

DD. Mount instruments so centerline of device is 4 feet 6 inches above the platform or grade.

EE. The connection or welding of instrument supports or brackets to structural steel shall be approved by the Engineer prior to performing the actual work.

FF. Welding on process equipment or process piping shall be approved by the Engineer prior to performing the actual work.

GG. 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.

HH. Materials that are to be attached or clamped to process piping or equipment shall be selected to avoid electrolysis.

II. 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 Performance Acceptance Test Sheet, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements. For Loop Status Report requirements, see paragraph 2.02 D1. And Article Supplements for an example.

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.
      3) Section 26 32 13, Diesel Engine Driven Generator Sets.
      4) Section 22 15 19, Air Compressor Package.
   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.
1. 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, Section 26 05 04, Electrical Requirements for Packaged Mechanical Equipment.

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. Instrument Calibration Sheet.
2. Instrument Calibration Sheet Example.
3. I&C Valve Adjustment Sheet.
4. I&C Valve Adjustment Sheet Example.
5. Performance Acceptance Test Sheet.
6. Performance Acceptance Text Sheet Example.
7. Loop Status Report Example.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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JACOBS **INSTRUMENT CALIBRATION SHEET** Rev.06.05.92

COMPONENT	MANUFACTURER	PROJECT
Code:	Name:	Number:
Name:	Model:	Name:
	Serial #:	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N
Indicate? Y / N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
Record? Y / N	Scale:				SWITCH? Y / N Unit Range:
Transmit/	Input:				Differential: fixed/adjustable
Convert? Y / N	Output:				Reset? automatic / manual

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
			Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	Note No.
Input	Indicated	Output	Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
							1.					
							2.					
							3.					
							4.					
							5.					
							6.					
CONTROL MODE SETTINGS:			P:	I:	D:		7.					

#	NOTES:	Component Calibrated and Ready for Startup
		By:
		Date:
		Tag No.:

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JACOBS **INSTRUMENT CALIBRATION SHEET** Rev.06.05.92

EXAMPLE - ANALYZER/TRANSMITTER

COMPONENT	**MANUFACTURER**	**PROJECT**
Code: *A7*	Name: *Leeds & Northrup*	Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Name: *UOSA AWT PHASE 3*
	Serial #: *11553322*	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							**DISCRETE CALIBRATIONS**					
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
			Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	**Note No.**
Input	Indicated	Output	Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*	1.	*N.A.*		*N.A.*		
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*	2.					*1.*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*	3.					
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*	4.					
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*	5.					
							6.					
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:		7.					

#	**NOTES:**	**Component Calibrated and Ready for Startup**
	1. Need to recheck low pH calibration solutions.	By: *J.D. Sewell*
		Date: *Jun-6-92*
		Tag No.: AIT-12-6[pH]

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JACOBS **I&C VALVE ADJUSTMENT SHEET**

Rev.06.05.92

PARTS	Project Name:	Project Number:
Body	Type:	Mfr:
	Size:	Model:
	Line Connection:	Serial #:
Operator	Type:	Mfr:
	Action:	Model:
	Travel:	Serial #:
Positioner	Input Signal:	Mfr:
	Action:	Model:
	Cam:	Serial #:
Pilot Solenoid	Action:	Mfr:
	Rating:	Model:
		Serial #:
I/P Converter	Input:	Mfr:
	Output:	Model:
	Action:	Serial #:
Position Switch	Settings:	Mfr:
	Contacts:	Model:
		Serial #:
Power Supply	Type:	Air Set Mfr:
	Potential:	Model:
		Serial #:

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set			Valve Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					

REMARKS:	**Valve Ready for Startup**
	By:
	Date:
	Tag No.:

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JACOBS **I&C VALVE ADJUSTMENT SHEET** Rev.06.05.92

EXAMPLE

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear - Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot Solenoid	Action:	Mfr:
	Rating: *None*	Model:
		Serial #:
I/P Converter	Input: *4-20 mA dc*	Mfr: *Taylor*
	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position Switch	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power Supply	Type: *Pneumatic*	Air Set Mfr: *Air Products*
	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*JuN-001-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*JuN-001-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*JuN-001-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*JuN-001-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Startup**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

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JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** Rev.06.05.92

Project Name:	Project No.:

Demonstration Test(s): For each functional requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

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JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** Rev.06.05.92
EXAMPLE

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

Demonstration Test(s): For each functional requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. Jun-20-92 BDG

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. Jun-6-92 BDG

2.b Reading is transmitted to FI on LP-521-1. Jun-6-92 BDG

2.c Reading is transmitted and displayed to CCS. Jun-6-92 BDG

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Acceptance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B.deGlanville*	*Jun-6-92*	Loop No.: *30-12*

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JACOBS **LOOP STATUS REPORT – EXAMPLE FORMAT** Rev.06.05.92

Project Name: *Newport News WTP*	Project No. *WDC23456.C1*

FUNCTIONAL REQUIREMENTS:

1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
3. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

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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 Sequence 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

A. Related Sections:

1. 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

A. General:

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:
   a. Control Systems often have User Account controlled varying levels of access to different functions, providing intentional 'role' based User functionality.
   b. Standard User access rights are identified as:
      1) Monitor and Reporting Only: Users will be able to view the status and generate reports.
      2) Monitor and Control: Users will be able to view status of the systems, activate pre-programmed sequences, and manipulate devices.
      3) System Configuration: Users will be able to configure or adjust settings.
      4) 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 SYSTEM DESCRIPTION

A. A verbal description and overview of the design of the system. Key sections to be included in a system description are listed below:

1. General – describes the scope boundaries of the system and briefly describes the function.
2. System Summary – describes the major components and redundancy.
3. Process Design Basis – describes major sizing criteria such as design flows, design pressures, design temperatures and items such as storage capacity.

4. Safety Features – describes the safety features included in the design such as safety valves, rupture disks, eye wash, showers, and equipment isolation parameters.
5. Control Functions – describes verbally all major control loops.
6. Operation – describes the operational considerations for startup, normal operation and shutdown.
7. Alarm Summary – describes all system alarms.
8. Starting Permissive Summary – describes all the operational system parameters that must be met to start the system.
9. Interlock Summary – describes system interlocks.

3.05 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.

3.06 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.

3.07 CONTROL SYSTEM INPUT/OUTPUT LIST

A. The Control System Input/Output List provides a detailed list of the points in the particular Control System.

3.08 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.

3.09 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.

3.10 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).

END OF SECTION

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 software defined 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, logical controllers, remote terminal units, serial port expanders, protocol converters, smart relays, etcetera, or generally categorized as intelligent electronic devices (IEDs), 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 Drawing 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.

7. Control narratives, control logics, HMI graphics, associated documentation, and all associated configuration for a fully functional PDCS ECS.
8. System reports including, but not limited to, as developed by the Supplier and subject to review during the Design Workshops:
    a. Shift ECS report.
    b. Shift Alarm report.
    c. Shift Operator Log report.
    d. Shift Maintenance report.
    e. ECS event report, by selected IED in COMTRADE format triggered by system faults, overloads, or other abnormal operating conditions that include at a minimum:
        1) Measured current waveform.
        2) Measured voltage waveform.
        3) Calculated power.
        4) Power factor.
        5) Frequency.
        6) Relevant digital data used in the protection and control scheme.
    f. ECS asset report, by selected asset.
    g. LOTO report.
    h. Other reporting deemed necessary by Owner/Engineer, a minimum of three fully developed reports.

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 specified and/or shown 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 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. 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 40 90 10, Instrumentation and Control Summary of Work.
7. Section 40 90 13, Concept of Operations Framework
8. Section 40 94 24.PDCS, PDCS Human Machine Interface.

9. Section 40 94 25.PDCS, PDCS Data Exchange Interface.
10. Section 40 94 26.PDCS, Grid Control System.

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. GCS – Grid Control System

F. HMI – human-machine interface; a computer-based operator interface for a control system.

G. PAC – Programmable Automation Controller.

H. PCS – Plant Control System.

I. PDCS – Power Distribution Control System.

J. PLC – Programmable Logic Controller.

K. 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. Supplier shall provide Controller logic and associated control narrative in advance of Design Review Workshops, defined elsewhere in the Specification, for Owner/Engineer review and comment.

D. Supplier shall provide one final hard copy and one electronic copy of all configuration files and associated control narratives after the Factory Acceptance Test (FAT) and also after the Site Acceptance Test (SAT).

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 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 <u>are</u> required to be redundant. Controller redundancy is defined as controller's ability to operate completely independent of another redundant controller with uninterrupted overall system operation upon failure of a redundant controller. Restoration of redundant controller shall not interrupt operation of the active system.
2. Power supplies <u>are</u> required to be redundant.
3. I/O modules, local and remote I/O module communications, and datalink communications to other control packages are <u>not</u> required to be redundant.
4. 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 or as required for a fully functional system.

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 PDCS Systems Integrator services from demonstrated established experienced specialty PDCS Systems Integrator with electrical protection control system design experience including a minimum 100,000 points and ten 50MW each, or greater, electrical network projects experience utilizing the hardware, software, and configuration specified for the Work. Selected Systems Integrator to provide field support during Construction, Startup, and Commissioning. Selection of the PDCS Systems Integrator is subject to approval by the Engineer based on substantiating proven experience meeting the Specified requirements. Additionally, resumes of key PDCS Systems Integrator personnel performing no less than 60 percent of the Work shall also be the basis of PDCS Systems Integrator selection approval. Non-approval of underqualified PDCS Systems Integrator requiring an alternate qualified PDCS Systems Integrator is not basis for a contract change.

M. All data files and software tools used for setup and configuration 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 equipment manufacturer’s 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 an alternate 120V ac power supply.

C. The Supplier shall provide one redundant pair of 24V 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) or approved equal. The system design is based on SEL 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.

2.06 COMMUNICATIONS

A. All ECS 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 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 1,000 Mbits per second.
2. Local and remote I/O interfaces shall be via non-redundant Ethernet/IP connection operating at 1,000 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 1,000 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, a minimum of 1 second, 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 equipment with Original Equipment Manufacturer (OEM) recommended software. Any other software specifically required for programming of equipment 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. Alarms shall remain active until condition initiating alarm returns to normal operating condition.
5. 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.
6. All analog input points shall have the capability of being assigned an alarm dead band and time delay for control of nuisance alarms.
7. It shall be possible to automatically shelve 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 shelved, 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.
8. All shelved alarms shall be automatically logged. A summary of inhibited alarms shall be provided as part of the Shift Alarm Report.
9. Provisions shall be made to avoid erroneous alarms on temperature differences and rate of change alarms when scanning of a point first resumes.
10. High and low alarm set points shall be capable of configuration using a "process curve algorithm" as well as fixed point alarms.
11. 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. 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:

1. Passwords to change once per year.
2. Passwords are a minimum of eight characters, cannot form a name, date, acronym, or a word and contain at least one character from <u>each</u> 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 three 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.

2.11 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 field testing as required to ensure all equipment and systems are installed per manufacturer's requirements and per the Drawings.
2. 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.

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 software configuration 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, 50 percent, and 75 percent completion of control narrative, 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. 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.

C. FAT test shall not be scheduled before approval of the FAT test procedure.

D. Factory acceptance test simulation shall include discrete items subject to PDCS control. 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, process condition feedback 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 Drawings. 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. 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 the Drawings.

5. Branch circuit fuses shall be inspected for compliance with the 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. All system deficiencies will be corrected by the Supplier prior to shipping unless otherwise agreed to by the Owner.

M. The actual system database will be used for all testing.

N. The Supplier will demonstrate, test, and prove all interconnections and communication between the various interconnected components of the control system.

O. 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.

P. 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.

Q. 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.

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 control system.

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 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 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.

3.01 SUPPLEMENTS

A. The supplement listed below, included following “END OF SECTION,” are part of this Specification.

1. PDCS ECS node Data Sheet.

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.
e. ISA 101, Human-Machine Interfaces.

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 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 40 90 10, Instrumentation and Control Summary of Work.
7. Section 40 90 13, Concept of Operations Framework.
8. Section 40 94 23, PDCS Electrical Control System.
9. Section 40 94 25, PDCS Data Exchange Interface.
10. Section 40 94 26, PDCS, Grid Control System.

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. GCS: Grid Control System

F. HMI: human-machine interface; a computer-based operator interface for a control system.

G. PAC: Programmable Automation Controller.

H. PCS: Plant Control System.

I. PDCS: Power Distribution Control System.

J. PLC: Programmable Logic Controller.

K. 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 USB flash media.
7. Bill of materials, which shall use actual manufacturer names and part numbers, not Supplier tracking codes.

8. Manufacturer's product data sheets annotated for specific application for each component.
9. Operation and maintenance manuals for all hardware and software.
10. Logic and HMI graphics programming documentation (see below).

C. Supplier shall provide HMI graphic screens in advance of Design Review Workshops, defined elsewhere in the Specification, for Owner/Engineer review and comment.

D. Supplier shall provide one final hard copy and one electronic copy of all configuration files, upon successful completion of the Factory Acceptance Test (FAT) and also the Site Acceptance Test (SAT).

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. Main Control Room nodes are required to have redundant network switches.
3. 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 120V ac, 60-Hz, single-phase power or approved alternate.

F. Supplier shall obtain PDCS Systems Integrator services from demonstrated established experienced specialty PDCS Systems Integrator with electrical protection control system design experience including a minimum 100,000 points and ten 50MW each, or greater, electrical network projects experience utilizing the hardware, software, and configuration specified for the Work. Selected Systems Integrator to provide field support during Construction, Startup, and Commissioning. Selection of the PDCS Systems Integrator is subject to approval by the Engineer based on substantiating proven experience meeting the Specified requirements. Additionally, resumes of key PDCS Systems Integrator personnel performing no less than 60 percent of the Work shall also be the basis of PDCS Systems Integrator selection approval. Non-approval of underqualified PDCS Systems Integrator requiring an alternate qualified PDCS Systems Integrator is not basis for a contract change.

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: 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 REPORTS

A. PDCS Reports shall be a function of the PDCS HMI system(s). In general, PDCS Reports will access historized data from the HMI Historian.

B. The PDCS Reports generator shall be authored by the same entity as the HMI Historian, unless otherwise approved by the Engineer.

C. PDCS Reports shall generally be categorized as follows:

1. Shift Reports.
2. Specific Reports.
3. Ad-hoc Reports.

D. Shift Reports shall include, but not be limited to, the following:

1. Shift Production Report.
2. Shift Operator Log Report.
3. Shift Events Report.
4. Shift Alarm Report.

2.12 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 eight characters, cannot form a name, date, acronym, or a word and contain at least one character from <u>each</u> 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 three 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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 field testing as required to ensure all equipment and systems are installed per manufacturer’s requirements and per the Specification and Drawings.
2. 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.

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, 50 percent, and 75 percent completion of operator graphic and report 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. The FAT procedure 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.

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. 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.

M. Supplier shall submit a test procedure 30 days in advance of the FAT for review and approval.

N. All system deficiencies will be corrected by the Supplier prior to shipping unless otherwise agreed to by the Owner/Engineer.

O. The actual system database will be used for all testing.

P. The Supplier will demonstrate, test, and prove all interconnections and communication between the various interconnected components of the control system.

Q. 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.

R. 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.

S. 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.

T. 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 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. HMI Data Sheets.
2. HMI Data Sheet WPCAUX-PDCS-RAK-01.
3. HMI Graphics Standard.
4. HMI Graphics Standard Example 0.
5. HMI Graphics Standard 4.

END OF SECTION

SUPPLEMENT 40 94 24PDCS
PDCS HMI GRAPHICS STANDARD

1 GENERAL

1.01 SUMMARY

A. This Supplement, together with applicable Data Sheets and/or Supplements, augments the requirements for the design, configuration/programming, testing services, and construction services required to provide totally functional Power Distribution Control System (PDCS) Human Machine Interface (HMI) graphics fully integrated into the PDCS HMI system(s) for a fully functional user interface.

B. The overarching premise of PDCS HMI graphics is the consistent legible graphical presentation of PDCS information for efficient user interaction and execution. A measure of success for achieving this premise is the ability to access desired information and/or control function in, at most, three steps.

C. PDCS HMI graphics are generally developed for two form-factors; (i) main control room and (ii) equipment node. The (i) main control room form-factor is a multi-screen workstation interface, with keyboard and mouse, versus the (ii) equipment node form-factor of a single touch-screen interface. The (i) main control room is where operators are stationed 24/7/365 observing and operating system control elements remotely from the system control elements. The (ii) equipment node is where personnel are local, or at least close proximity, to operated equipment and executing system control in relative close proximity to operated equipment.

D. The nature of the PDCS system being dominantly ‘electrical’, a key system graphic diagram is a one line diagram, comparable to a P&ID in a process oriented control system. The PDCS HMI graphic screen content heavily refer to one line diagrams in varying levels of detail.

E. The PDCS HMI graphics are organized hierarchically in Graphic Groups, from general overview graphics content to progressively more specific graphics content, with additional specialty graphics content groups.

F. The PDCS is capable of various modes of operation to ensure reliable and efficient electrical distribution network operation.

G. This supplement outlines the guiding HMI graphics functionalities, modes of operation, and presentation for the PDCS. The graphics concepts are a combination of existing graphics styles, general industrial control system graphics principles, and common industry standards. Where practical the principles of High Performance Graphics shall be utilized in the graphics development.

H. The PDCS HMI graphics standard is organized into the following main topics:

1. Topology
2. Structure
3. Format
4. Functionality

I. An important design and implementation principle is that HMI graphics do NOT include control logic. Control logic is deliberately organized and outside of the HMI system, stated otherwise, is further down in the RMF. HMI graphics are intelligent and can utilize control system telemetry for dynamic presentation and impacted content, ie smart alarm management, dynamic control activation, etcetera.

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 Society of Automation (ISA):
   a. ISA 100 – Human Machine Interface
   b. ISA 62443-2-1, Security for Industrial Automation and Control Systems.

C. Related Sections:

1. Section 40 94 24PDCS, PDCS Human Machine 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. Development Environment: Development Environment is isolated from the active PDCS, or more generically described Industrial Control System, as contrasted to the Production Environment which is the active PDCS. The intent is to allow development of control system content separately from the active control system, as is common in industrial control systems.

D. ECS – Electrical Control System.

E. FAT - Factory Acceptance Test.

F. GCS – Grid Control System

G. HMI - human-machine interface; a computer-based operator interface for a control system.

H. Industrial Control System: Generic common name for a control system applied in industrial applications.

I. PAC – Programmable Automation Controller.

J. PCS - Plant Control System.

K. PDCS – Power Distribution Control System.

L. Production Environment: Production Environment is the active PDCS, or more generically described Industrial Control System, as contrasted to the Development Environment which is isolated from the active PDCS. The intent is to allow development of control system content separately from the active control system, as is common in industrial control systems.

M. PLC - Programmable Logic Controller.

N. PSS – Process SCADA System.

O. RMF – Risk Management Framework.

P. RTAC – Real Time Automation Controller.

Q. SAT - Site Acceptance Test.

1.04 SUBMITTALS

A. See Section 40.94.24PDCS for Submittal requirements.

1.05 QUALITY ASSURANCE

A. See Section 40.94.24PDCS for Quality Assurance requirements.

1.06 WARRANTY AND GUARANTEES

A. See Section 40.94.24PDCS for Warranty and Guarantee requirements.

2 PDCS HMI GRAPHIC STANDARDS

2.01 TOPOLOGY

A. The PDCS HMI graphics infrastructure is part of a PDCS superset of purpose-specific subsystems including:

1. PDCS electrical control subsystem (ECS); networked electrical control and protection
2. PDCS human machine interface subsystem (HMI); user interface and associated data management
3. PDCS external device interface subsystem(s) (EDI); interface(s) with external non-PDCS system(s)
4. PDCS grid control subsystem (GCS); SWBNO managed electrical distribution system power delivery to load balancing

B. Additionally, the PDCS, from a networking structure perspective, is one of four (4) primary physically independent network families:

1. IT network; information technology (IT)
2. Security network; security
3. PSS network; process SCADA system (PSS)
4. PDCS network; Power Distribution Control System (PDCS)

C. The PDCS HMI main-control-room form-factor infrastructure, as defined in Specification Section 40.94.24PDCS, is an AVEVA Operations Control, formerly Wonderware, solution and is implemented at RMF level 4. The AVEVA Operations Control solution ‘ecosystem’ is comprised of serval modules providing purpose-specific functionality. The AVEVA Operations Control HMI graphics module is able to utilize ‘templates’ organized into logical groups for efficient content development, leveraged quality control, and user interface consistency – all important aspects and goals of the PDCS HMI graphics.

D. The PDCS HMI equipment-node form-factor infrastructure, as defined in Specification Section 40.94.24PDCS, is an Schweitzer Engineering Laboratories (SEL) native RTAC HMI solution. The SEL RTAC HMI

solution is optimized to the RTAC. The SEL RTAC HMI graphics solution is highly resilient for RMF level 2 resiliency and functionality. The approach and execution of ‘template’ based HMI graphics methodology is also expected in this form-factor for efficient content development, leveraged quality control, and user interface consistency – all important aspects and goals of the PDCS HMI graphics.

E. The PDCS HMI infrastructure, as defined in Specification Section 40.94.24PDCS, is resilient via redundant independent instances. The intent of these redundant independent instances is to allow uninterrupted system operation upon any single instance failure. The PDCS HMI graphics implementation is also intended to be physically independent yet administratively harmonized, requiring special attention to pragmatic deployment of HMI graphics from the Development Environment to the Production Environment. The independent PDCS HMI instances point to associated independent PDCS data concentration RTAC(s) versus a common or shared data source. This approach is philosophically consistent with both main-control-room and equipment-node HMI graphics, yet implemented via different HMI graphics solutions.

2.02 STRUCTURE

A. The PDCS HMI graphics are organized hierarchically in Graphic Groups, from general overview graphics content to progressively more specific graphics content, with additional specialty graphics content groups. The PDCS HMI Graphic Groups are organized as follows:

1. Graphic Group 0: overview - whole system
2. Graphic Group 1: overview - geographic location
3. Graphic Group 2: overview - functional group, may be a `logical node'
4. Graphic Group 3: detailed view - logical node / switchgear
5. Graphic Group 4: detailed view - individual circuit / circuit breaker 'faceplate'
6. Graphic Group 5: historical view - preconfigured trend, ad-hoc trends
7. Graphic Group 6: reporting / logging - preconfigured reports, preconfigured logging
8. Graphic Group 7: <TBD as required>
9. Graphic Group 8: <TBD as required>
10. Graphic Group 9: <TBD as required>

B. Basic Guidelines for PDCS HMI Graphic Screen Naming

1. overview – whole system: Graphic Group 0; generally coded as <AREA CODE>_0.0_000.000_00.00; all SWBNO_0.0_000.000_00.00
2. overview – geographic location: Graphic Group 1; generally coded as <AREA CODE>_1.0_000.000_00.00

3. overview – functional group (may be a ‘logical node’): Graphic Group 2; generally coded as <AREA CODE>_2.0_000.000_00.00
4. detailed view – logical node / switchgear: Graphic Group 3; generally coded as <AREA CODE>_3.0_000.000_00.00
5. detailed view – individual circuit / circuit breaker: Graphic Group 4; generally coded as <AREA CODE>_4.0_000.000_00.00

Graphic File Name Guide:

General Format: <AREA CODE>_<HMI GROUP>_<BUS>.<SEQ#>_<REV>.<VER>	
<AREA CODE>	AREA designation used throughout Project
<HMI GROUP>	HMI Group is a somewhat hierarchical grouping of HMI graphics from general to specific.
<BUS>	BUS is the same numeric identifier used in the IP addressing scheme to enumerate electrical buses within a an AREA
<SEQ#>	SEQ# is simply to differentiate one HMI graphic from another within the same AREA GROUP BUS set; where meaningful the CELL (cubicle) number is a good choice
<REV>	REV is a two digit REVision designation allowing different forms of the same graphic to be within the same next higher level set; often when a major change is made to typical graphic layout as contrasted to a VERsion that is only a minor change; where practical the graphics linking is at this level allowing VERsions to be maintained in the 'uncompiled' file and the compiled file only includes the REVision
<VER>	VER is a two digit VERsion designation allowing different forms of the same graphic to be within the same next higher level set; often when a minor change is made to typical graphic layout as contrasted to a REVision that is a major change; where practical the graphics linking is at the NEXT HIGHER <REV> level allowing versions to be maintained in the 'uncompiled' file and the compiled file only includes the REVision

2.03 FORMAT

A. Particular attention shall be given to the format of PDCS HMI graphics emphasizing consistency purposeful layout, as is consistent with many ICS applications! The value of consistent purposeful format of HMI Graphics (leveraging foundational HFE concepts)

B. Basic Format of PDCS HMI Graphics

1. focus zones/panes
2. central focus zone - main
3. right focus zone - navigation hot-keys, user access
4. bottom focus zone - alarm / critical information summary

C. Basic Colors of PDCS HMI Graphics

1. Red: On or Closed
2. Green: Off or Open
3. Yellow: Alarm, Unacknowledged
4. Amber: Alarm, Acknowledged
5. Blue: Normal indication, positive/confirming indication/information
6. White: general text, no status indicated by color

2.04 FUNCTIONALITY

A. PDCS HMI graphics functionality is intended to enhance the graphical presentation of information and promote safe efficient consistent user interface experience. As emphasized elsewhere in this document, the overarching premise of PDCS HMI graphics is the consistent legible graphical presentation of PDCS information for efficient user interaction and execution. A measure of success for achieving this premise is the ability to access desired information and/or control function in, at most, three steps. These objectives require dynamic graphics that are intelligent. Examples include:

1. intelligent purposeful alarm data in summary level graphics
2. dynamic graphics objects conveying a condition based on graphic characteristics

B. Basic graphic functionalities include, but are not limited to:

1. graphic – dynamic vs static
2. text - dynamic vs static
3. navigation
   a. pick area link to associated graphic
   b. 'Previous'
4. hover (aka 'tool tip')
   a. alternate information
5. dynamic control activation
   a. control feature activation or deactivation based on condition(s)
   b. mode selection
6. user input influenced graphics
   a. trend limits
   b. report selection and/or parameter input

3 TESTING

3.01 TESTING AND INSPECTION - GENERAL

A. See Section 40.94.24PDCS for General Testing and Inspection requirements.

B. PDCS HMI graphics are highly subjective and are challenging to standardize visually, however the structure, format, and functionality shall be fully tested and inspected by the Contractor consistent with the various stages of development.

3.02 FACTORY ACCEPTANCE TESTS

A. See Section 40.94.24PDCS for Factory Acceptance Testing requirements.

B. PDCS HMI graphics are highly subjective and are challenging to standardize visually, however the structure, format, and functionality shall be fully demonstrated by the Contractor during the Factory Acceptance Testing and is improved by close attention to detail during the pre-FAT content development.

3.03 SITE ACCEPTANCE TESTING (SAT)

A. See Section 40.94.24PDCS for Site Acceptance Testing requirements.

B. PDCS HMI graphics are highly subjective and are challenging to standardize visually, however the structure, format, and functionality shall be fully proven by the Contractor during the Site Acceptance Testing. It should be expected that some PDCS HMI graphic content will need to be updated or corrected as a result of the SAT.

3.04 SUPPLEMENTS

A. The supplements listed below, included following “END OF SECTION,” are part of this Supplement.

1. Graphic Group 0 example; << 40.94.24PDCS_SWBNO_PDCSHMIGraphicsStandard_Example_0_SWBNO_0_000.000_00.00_PDCSNODES.pdf>>
2. Graphic Group 1 example; <LATER>
3. Graphic Group 2 example; <LATER>
4. Graphic Group 3 example; <LATER>
5. Graphic Group 4 example; <<40.94.24PDCS_SWBNO_PDCSHMIGraphicsStandard_Example_4_MVPCBEO.01.00.pdf>>
6. Graphic Group 5 example: <LATER>
7. Graphic Group 6 example: <LATER>

END OF SECTION

Development!

GRAPHIC GROUP 0:OVERVIEW-WHOLE SYSTEM:<000_PDCSNODES_000_00_00>:REV0.0

PDCS

CWPCC-0-PDCS-PNL-0

CWPCTG6-0-6-EMV60-SG-3 CENTRAL CONTROL

CWPENG-0-PDCS-PNL-01

CWPPH-0-PDCS-PNL-01

CWPYRD-0-EMV60-SG-201

DPS01-0-EMV60-SG-201

RSOS-0-EMV60-SG-EMV60-SG-201

SSCFC-0-EMV60-SG-201

SSHAM-0-EMV60-SG-201

SSPFC-0-EMV60-SG-201

SSSYC-0-EMV60-SG-201

SSCLA-EMV60-SG-201

Shows Tooltip when mouse hovers over link.

1:22:49 PM
2/8/2021

LOG ON | LOG OFF

CURRENT USER

PDCS NODE LISTING

PLANT OVERVIEW

ALARM SUMMARY

ACTIVITY LOG

Name	Date	Time	State	Type	Value	Limit	Class	Priority	Group	Provider	Operator	Comment

There are no items to show in this view

Security Test | R

Alm Set | Alm Reset | AA

Ack Alarm Selected

Update Successful | Default Query

NODE LISTING screen have links to mainly the one-lines.

GRAPHIC INDEX NO: <AREA CODE>_<HMI GROUP>_<BUS>,<SEQ#>_<REV>.<VER>
GRAPHIC TEMPLATE NO: MVPCBEO.00.00

RST6

FEEDER RS-T6

FULL TAG: RSOS-0-EMV60-FDR-RST6
CIRCUIT NO: RSOS0EMV60FDRRST6
CIRCUIT BREAKER CELL: CWPYRD-0-EMV60-SG-201B-11H

HISTORICAL DATA

####	LAST CLOSED
####	LAST OPENED
####	LAST '43L/R' L
####	LAST '43L/R' R
####	LAST ALARM
####	LAST 'WITHDRAWN'
####	LAST 'INSERTED'
####	24HR AVERAGE AMPS
####	24HR AVERAGE WATTS
####	24HR AVERAGE VARS

REAL TIME ANALOG DATA

####	VOLTS AB
####	VOLTS BC
####	VOLTS CA
####	AMPS A
####	AMPS B
####	AMPS C
####	FREQUENCY
####	WATTS
####	VARS
####	POWER FACTOR

CLOSE PERMISSIVES

- PROTECTION RELAY TROUBLE
- LOSS OF BUS VOLTAGE
- PROTECTION TRIP
- L/R SWITCH IN REMOTE
- CONTROL POWER AVAILABLE
- BREAKER INSERTED
- CLOSE ENABLED

LOTO/MM

CIRCUIT BREAKER OPEN/CLOSE

CLOSED

CONTROL SWITCH

ONLINE

STACK LIGHT
RED
ORANGE
YELLOW
BLUE
WHITE

HMI MODES
REMOTE HMI
LOCAL HMI

CONTROL MODES
REMOTE MANUAL
REMOTE AUTOMATIC
LOCAL MANUAL

SYSTEM TIME

SYSTEM DATE

LOG ON | LOG OFF

USER NAME

PDCS NODE LIST

PLANT OVERVIEW

ALARM PAGE

TRENDS

REPORTS

FIXED PANEL

PREVIOUS

ALARM SUMMARY

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 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. Section 40 90 10, Instrumentation and Control Summary of Work.
2. Section 40 90 13, Concept of Operations Framework
3. Section 40 94 23, PDCS Electrical Control System.
4. Section 40 94 24, PDCS Human Machine Interface.
5. Section 40 94 26, PDCS, Grid Control System.

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. GCS: Grid Control System.

F. HMI: Human-machine interface; a computer-based operator interface for a control system.

G. PAC: Programmable Automation Controller.

H. PCS: Plant Control System.

I. PDCS: Power Distribution Control System.

J. PLC: Programmable Logic Controller.

K. 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. Supplier shall provide communication configuration in advance of Design Review Workshops, defined elsewhere in the Specification, 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 Human Machine Interface.

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

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.

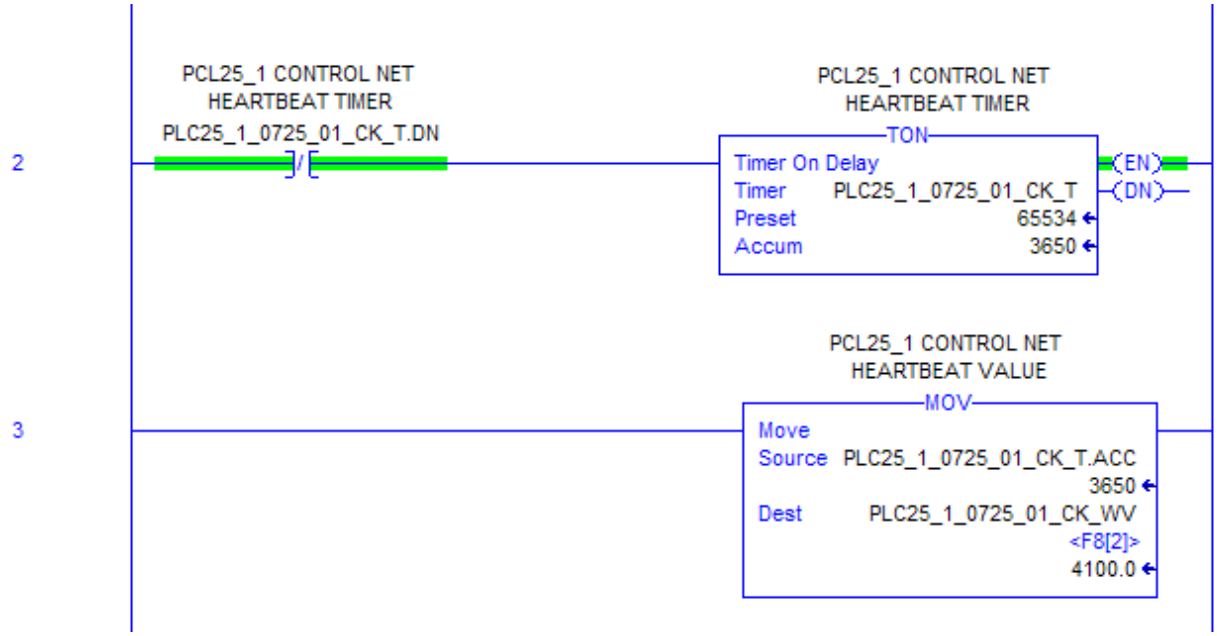
2. The spreadsheet will contain the following information:

    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.

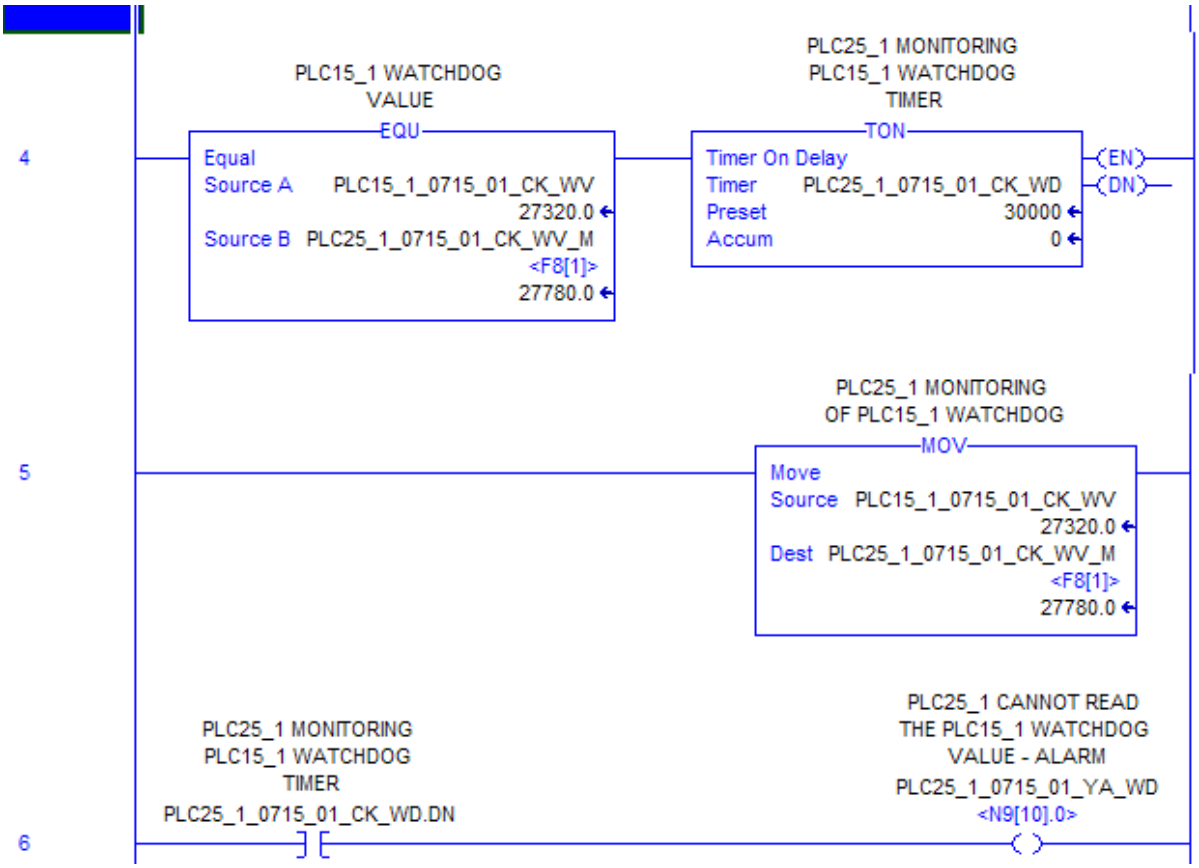
This example does not use specific tag naming standards, but has been presented here to illustrate the specified concept.

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 40 94 26.PDCS
GRID CONTROL SYSTEM

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 Grid Control System (GCS) within the Power Distribution Control System (PDCS), fully integrated for a fully functional system.

B. The overarching premise of the GCS is the automated coordinated control of generation, distribution, and load assets within the managed electrical distribution network along with purpose specific supplementary automation features.

C. The system shall be capable of various modes of operation to ensure reliable and efficient electrical distribution network operation.

D. This specification outlines the primary functionalities, modes of operation, and control mechanisms for the GCS. Implementing such a system will require advanced control algorithms, communication protocols, and hardware components.

E. The Scope includes:

1. All networking, where not part of a shared PDCS network, required for a standalone Operational Technology (OT) control system deterministic network, 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, where not part of a shared PDCS network, that will enable independent Grid Control System (GCS) communication between PDCS components utilizing IEC 61850 communications protocol and managed interfaces with non-PDCS system elements. Network switches shall be managed software defined and block-by-default.
3. All lead, non-equipment specific, GCS hardware required to interface with PDCS equipment specific hardware. Such GCS hardware includes, but is not limited to, control central processing units (CPU) or control modules, remote terminal units, serial port expanders, protocol converters, etcetera, as required to provide a totally functional PDCS GCS.

4. Provide redundant critical GCS equipment where failure of any single equipment would cause loss of GCS function and/or degraded system performance; such as, control CPUs or control modules, network switches, hardware, power supplies, etcetera.
5. All support equipment required to complete the totally functional PDCS GCS.
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 Drawing 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.
7. Control narratives, control logics, HMI graphics, associated documentation, and all associated configuration for a fully functional PDCS GCS.
8. System reports including, but not limited to, as developed by the Supplier and subject to review during the Design Workshops:
    a. Shift GCS report.
    b. GCS configuration report.
    c. GCS asset report.
    d. TBD report #1; to be developed during the execution of the Work.
    e. TBD report #2; to be developed during the execution of the Work.
    f. TBD report #3; to be developed during the execution of the Work.

F. The GCS functional modules, as described herein, shall be supervised and controlled by the PDCS GCS and integrated into the PDCS HMI System, reference requirements specified in Section 40 94 24, PDCS Human Machine Interface (HMI), with comprehensive display, control, and historical data access.

G. The Supplier is responsible for configuration, application programming, testing, and system training to deliver a completely integrated PDCS GCS safely, reliably, and efficiently monitoring and controlling all devices pertinent to the PDCS GCS objective.

H. Hardware-in-the-loop (HIL) testing shall be performed. The HIL testing configuration is expected to prove key GCS functional modules as well as inform key time-domain tuning values. HIL elements shall include, at a minimum but not be limited to, the following:

1. Discrete GCS functional modules.
2. Discrete binary system elements sufficient to demonstrate key system configuration variants.
3. Discrete time-domain system elements that are necessary to prove the dynamic aspects of GCS functional modules.

I. The PDCS GCS shall comply with the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems, to ensure system resilience against cyber threats.

J. The PDCS is comprised of both new and existing equipment, of which some of the existing equipment will require retrofit or upgrade work planned under the Work. 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.

K. This Specification section does not stand alone and must be read with Section 40 94 23, PDCS Electrical Control System (ECS) which specifies the electrical protection and control system. Comprehensive coordination and leveraging of PDCS ECS infrastructure in the execution of PDCS GCS functionality is critical and a guiding PDCS system architecture principle. Comprehensive coordination is required between the PDCS GCS 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 specified and/or shown in the Documents.

L. Careful consideration shall be given to construction sequencing due to the critical nature of the electrical distribution network 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. IEC 60529, Enclosure Protection from Environment.
   b. IEC 61000-4-11, Electromagnetic Compatibility.
   c. IEC 61131, Programmable Controllers.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. IEEE 1050, Generating Station I&C Equipment Grounding.
   b. IEEE C37.90.1, Electrical Surge Withstand Capability.
   c. IEEE C37.90.2, Radio Frequency Interference.
3. International Society of Automation (ISA):
   a. ISA 71, Environmental Conditions for Process Measurement and Control Systems.

b. ISA 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. UL 508, Safety Standard for Industrial Control Equipment.
   b. UL 840, Electrical Equipment Insulation Coordination.
   c. UL 1604, UL Certification for Existing Products.

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 25 05 11, Cybersecurity for Facility Related Control Systems.
5. Section 26 00 00, Electrical General Requirements.
6. Section 26 00 10, Electrical Summary of Work.
7. Section 40 90 10, Instrumentation and Control Summary of Work.
8. Section 40 90 13, Concept of Operations Framework.
9. Section 40 94 23.PDCS, PDCS Electrical Control System.
10. Section 40 94 24.PDCS, PDCS Human Machine Interface.
11. Section 40 94 25.PDCS, 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. GCS – Grid Control System.

F. HIL – Hardware-in-the-loop.

G. HMI - human-machine interface; a computer-based operator interface for a control system.

H. PAC – Programmable Automation Controller.

I. PCS - Plant Control System.

J. PDCS – Power Distribution Control System.

K. PLC - Programmable Logic Controller.

L. 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 (BOM) for all equipment in their design, 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. Communication configuration programming documentation.
17. Controller logic programming documentation, including software backup and recovery plans.
18. HMI screen graphic and pop-up captures.
19. 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.
20. Test plans/procedures and reports (step-by-step instructions) for Hardware-in-the-loop (HIL), Factory Acceptance Test (FAT), and Site Acceptance Tests (SAT).
21. List of recommended spare parts.

C. Supplier shall provide Controller logic and associated control narrative in advance of Design Review Workshops, defined elsewhere in the Specification, for Owner/Engineer review and comment.

D. Supplier shall provide one final hard copy and one electronic copy of all configuration files and associated control narratives after the Hardware-in-the-loop (HIL), Factory Acceptance Test (FAT), and also after the Site Acceptance Test (SAT).

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 final controller program in native format with complete documentation and the final data exchange tables for communications with all GCS 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/Engineer requirements and additional requirements as stated below.

C. Requirements covered by this Purchase Order/Specification shall apply to lower tier subcontractors and vendors, 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. 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 GRID CONTROL SYSTEM HIGH LEVEL IMPLEMENTATION FRAMEWORK

A. The Grid Control System (GCS) is envisioned to be executed/implemented in a phased/part approach consisting of four base parts with future parts defined later. The initial four base parts are generally described as follows:

1. Part 0 – Initialization of GCS.

2. Part 1 – Integration of Balance of Centralized Generation.
3. Part 2 – Integration of Balance of Level 0 Distribution Assets.
4. Part 3 – Integration of Level 1 Distribution Assets.
5. Part(s) <Future> - Future parts to be defined later per GCS Implementation Plan Scoping attachment.

B. The scope and execution of the GCS are organized into these ‘parts’ for clarity and management. The GCS Implementation Plan Scoping tables/datasheets further define specific system objects planned in each part. The scoping tables are organized generally by the basic control module/functions described herein to, again, endeavor to organize and identify specific controlled objects targeted for each scope part.

2.02 GRID CONTROL SYSTEM MODULE/FUNCTION GENERAL DESIGN

A. The GCS solution is intended to be layered onto/into the other PDCS subsystems (PDCS ECS, PDCS HMI, and PDCS DEI) via purpose-specific hardware, software, and configuration.

B. The organization and approach to GCS implementation is based on the following rudimentary GCS rubric: The primary function of an integrated grid control system is to match generation/source to load across/through a finite energy conveyance system (electrical distribution network (<69kV) and/or electrical transmission network (>69kV)) while maintaining stability utilizing both theoretical ‘models’ and actual real-time data to aid in the control. A ‘governor’ model is used for speed/frequency time-domain response. An ‘excitation’ model is used for voltage and power factor time-domain response. An energy conveyance model is used to anticipate energy conveyance system characteristics under dynamic loading conditions. Power quality is an overarching measure of electrical system performance.

1. GCS module/function groups are defined as follows and generally described herein to aid in organizing the technical requirements of the GCS. The terminology module and/or function is intended to suggest that those features are organized by function into a cohesive purpose-specific group, or module, with similar characteristics. A critical aspect of the module/function group is that the solutions are pre-engineered, fully proven, reliable, robust solutions that are more-or-less configured and aggregated to achieve the specified solutions.
   a. Generator/Source Coordination and Control Module/Function.
   b. Distribution Coordination and Control Module/Function.
   c. Load Management Module/Function.
   d. Purpose-specific supplementary automation features.
   e. Grid Control Documentation.

C. Generator/Source Coordination and Control Module/Function: Generation Assets, or more broadly characterized as ‘sources’, are, unless otherwise configured, integrated into the PDCS with a uniform Generation Asset Interface Template <reference Attachment ## - Generation Asset Interface Template> with fundamental generation/source control elements to enable either manual or automated/augmented control. There are envisioned two principle generation/source asset control modes with others as necessary; (i) droop and (ii) isochronous. There is the added functionality of an advanced implementation of the GCS where a dynamic ‘augmented’ mode of control will utilize the predictive ability of time-domain generation/source control to pre-position (bias) the generation/source system elements to improve load addition and/or load reduction.

1. Lead control of dissimilar generation assets – start/stop for N+1 operation, predictable load sharing.
2. Utilize pertinent nameplate and real time data, including run status, current MVA load, and nominal MVA ratings of each generator to ensure proper load balance in real time.
3. Manage generator control functions to ensure a stable electrical distribution network.
   a. Generator operating mode.
      1) Droop.
      2) Isochronous.
      3) Manual.
      4) Dispatched.
      5) Load test.
      6) Maintenance.
      7) Other.
   b. Frequency control.
   c. Voltage control.
   d. Power factor control.
4. Knowledge-base augmented decision making – dynamic data driven based dispatch (generation mix) selection: run-time, economics, availability, heat-rate, emissions, fuel cost, weather, etc.

D. Distribution Coordination and Control Module/Function: Distribution System Assets, switching devices, principally power circuit breakers and associated IEDs, are, unless otherwise configured, integrated into the PDCS with a uniform Distribution Asset Interface Template <reference Attachment ## - Distribution Asset Interface Template> with fundamental distribution switching device (power circuit breaker and associated IED(s)) control and protection elements to enable either manual or automated/augmented control. There are envisioned two principle distribution asset control modes with others as necessary; (i) manual and (ii) automated. There is the added functionality of an advanced implementation of the GCS where a dynamic 'augmented' mode of control will utilize the predictive ability of time-domain distribution network load flow optimization to anticipate and advise system operator(s) of distribution network adverse conditions.

1. Manage distribution control function to ensure a stable electrical distribution network.
   a. Manual Distribution Asset Control Mode.
   b. Automated Distribution Asset Control Mode.
   c. Maintenance Distribution Asset Control Mode.
2. Parallel electrical distribution network operation with external utility source(s):
   a. Load sharing for net-zero utility connection.
3. Lead control of electrical distribution network switching assets including asset 'health.'
4. Remedial action for electrical distribution network disturbance.
5. Real-time dynamic electrical distribution network 'health' – status, loading, voltage, current, frequency, power factor.
6. time-domain based event logging – improves understanding of system events with a synchronized time basis.

E. Load Management Module/Function: Load Control is, as stated elsewhere, considered the 'independent variable' in the generation/source-versus-load balancing equation, influenced by external (to the SWBNO managed electrical network) factors and further complicated by being principally controlled by another control system, the PSS, and therefore is only 'influenced' by the GCS. The PSS will 'request' a large load addition and the PDCS will 'enable' the large load addition, via a 'handshake' or interlocking scheme between the PSS and PDCS, as informed by the GCS generation/source versus load optimization.

1. Manage load control function to ensure a stable electrical distribution network.
   a. Manual Acquisition Load Control Mode.
   b. Automated Acquisition Load Control Mode.
   c. Maintenance Load Control Mode.
2. Asset inventory attribution (static and dynamic) – size (HP/kW), start characteristics, priority, status (available, ON, OFF).

3. Load pick-up knowledge-base augmented decision making – generator control influence based on asset inventory attributes during load pick-up.
4. Load shed (reduction) knowledge-base augmented decision making – load shed (reduction) during power supply disturbance based on prioritized asset inventory attributes to promote electrical distribution network resiliency. As a point of emphasis, this function must be fast enough to maintain electrical distribution network during power supply disturbance.

F. Purpose-specific Supplementary Automation Features; examples and not limited to the following:

1. Electrical distribution network islanding and un-islanding:
   a. Transition logic; to/from islanded system.
   b. Islanded system frequency control.
   c. System synchronization control.
2. Electrical distribution network loading guidance:
   a. Electrical distribution network bus or feeder overload warnings with suggested augmentation.
3. Cogeneration ‘peak shaving’:
   a. When SWBNO electrical network is interconnected with the Utility bulk electric system and ‘co-generating.’
   b. Utility has requested SWBNO limit demand.
   c. GCS dispatch SWBNO generation to demand limit setpoint.
4. Generation asset maintenance guidance:
   a. Ready-for-dispatch run-time prioritization.
   b. Routine maintenance run automation.
   c. Load bank configuration automation.

G. Grid Control Documentation:

1. Shift report augmentation.
2. Event and switching logging.
3. Real-time system monitoring (power system and economics).
   a. Generator status.
   b. Load demand.
   c. Utility interconnection status/quality.
   d. Compliance reporting.

2.03 GRID CONTROL SYSTEM ARCHITECTURE GENERAL DESIGN

A. GCS system architecture design shall be scalable for future system growth, as further defined in the Drawings and/or Data Sheet(s).

B. GCS hardware shall be IEC 61850 compliant.

C. The GCS shall consist of redundant controller modules, power supplies, communication modules, and all required accessories per this Specification to provide a fully functional system.

D. Redundancy:

1. Controllers and data highway communication between controllers are required to be redundant. Controller redundancy is defined as controller's ability to operate completely independent of another redundant controller with uninterrupted overall system operation upon failure of a redundant controller. Restoration of redundant controller shall not interrupt operation of the active system.
2. Power supplies are required to be redundant.
3. Other power supplies shall be redundant if used for multiple functions.

E. System electronics shall be shielded against electromagnetic interferences and shall be capable of withstanding surges in power supplies.

F. All GCS hardware shall be designed with a temperature margin allowance for heat buildup inside the enclosure in which the hardware is mounted.

G. Enclosures for outdoor usage shall be designed to prevent against freezing, wind, rain, saline's, fume, and dust.

H. GCS hardware shall be designed to operate on 120V ac, 60-Hz, single-phase power or 125V dc power.

I. All communication hardware, software, programming to establish communication interfaces shown on the Data Sheets and Drawings or as required for a fully functional system.

J. All fiber optic cable, media converters, patch panels, patch cords, power supplies to support the communication.

K. Supplier shall obtain PDCS Systems Integrator services from demonstrated established experienced specialty PDCS Systems Integrator with electrical protection control system design experience including a minimum 100,000 points and ten 50MW each, or greater, electrical distribution network projects experience utilizing the hardware, software, and configuration specified for the Work. Selected Systems Integrator to provide field support during Construction, Startup, and Commissioning. Selection of the PDCS Systems Integrator is subject to approval by the Engineer based on substantiating proven experience meeting the Specified requirements. Additionally, resumes of key PDCS Systems Integrator personnel performing no less than 60 percent of the Work shall also be the basis of PDCS Systems Integrator selection approval. Non-approval of underqualified PDCS Systems Integrator requiring an alternate qualified PDCS Systems Integrator is not basis for a contract change.

L. All data files and software tools used for setup and configuration programming. Software licenses shall be provided by Supplier to support initial configuration and site commissioning.

M. Integrating, commissioning, and startup of interface equipment, related accessories, and equipment.

2.04 INTENDED USE OF THE SPECIFIED EQUIPMENT

A. The GCS functionality is a subset of PDCS providing overarching electrical distribution network, or ‘grid’, control for reliable resilient fault tolerant operation of the electrical distribution network as shown on the Drawings.

2.05 CHASSIS/RACK

A. Every controller chassis or rack shall have a 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. The Supplier shall consider equipment manufacturers’ spacing, heat, and grounding requirements when mounting the chassis or rack in the enclosure.

D. 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.

E. The Supplier shall connect an equipment grounding conductor from each chassis or rack directly to an individual bolt on the enclosure ground bus.

2.06 POWER SUPPLIES

A. Power supplies shall be provided for:

1. Chassis or rack power supplies.
2. Other functions as required.

B. 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.

C. Power for hardware shall be fed separately from power for non-critical items such as convenience receptacles and lights.

D. Each power supply shall have its own incoming power feed and circuit breaker.

E. 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.

2.07 CONTROLLERS

A. The GCS controller basis of design is the Schweitzer Engineering Laboratory (SEL) Real Time Automation Controller (RTAC). The controllers shall be SEL RTAC "Or-equal," approved.

B. Redundant controllers shall be provided at each GCS centralized node. There shall be a minimum of two centralized GCS nodes within a GCS control area.

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.

D. All controllers shall be provided with enough memory to accommodate 50 percent spare system automation logic. This large spare percentage is due to expected system up-scaling, as further defined in the Drawings and/or Data Sheet(s).

E. Control configuration shall be stored in on-board non-volatile memory.

2.08 COMMUNICATIONS

A. All GCS communication shall be managed by the common PDCS communications scheme.

B. All protection-class GCS 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 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. 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.

F. 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.

G. 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.

H. 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 1000 Mbits per second via fiber.
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.

I. 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.

2.09 CONFIGURATION SOFTWARE

A. Supplier shall provide and configure the interface equipment with Original Equipment Manufacturer (OEM) recommended software. Any other software specifically required for programming of equipment shall be supplied by Supplier, including but not limited to all runtime and development environment licensing; to ensure perpetual operation of GCS as well as support future expansion and development.

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.

2.10 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.

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. 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.
2. 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.
3. 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.
4. All analog input points shall have the capability of being assigned an alarm dead band and time delay for control of nuisance alarms.
5. 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; for a maximum of 24 hours, after which the alarm shall be restored. Upon restoration of alarm functions, the point will be scanned for alarming and, if in alarm, the normal operator indication shall occur.
6. All inhibited alarms shall be automatically logged. A summary of inhibited alarms shall be provided as part of the Shift Alarm Report.
7. Provisions shall be made to avoid erroneous alarms on temperature differences and rate of change alarms when scanning of a point first resumes.
8. High and low alarm set points shall be capable of configuration using a "process curve algorithm" as well as fixed point alarms.
9. 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. Accumulated Pulse Inputs: Scan or store pulse inputs such that the system resolves up to 60 pulses per second.

J. Totalized Pulse Outputs: Shall be configured as necessary to meet the requirements of the Supplier’s system and the Owner’s external interfaces.

K. 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. Lead Controllers will track the appropriate signal when their subordinate controllers have reached a high or low limit. In addition, lead controllers will not be allowed in Auto if their subordinates 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.

L. Digital Controls:

1. Programming of all digital control loops shall be in Ladder Diagram Logic (LDL) format, Function Block Programming (FBP) or 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.

M. 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.

2.11 SECURITY

A. The system shall comply with the requirements of Section 25 05 11, Cybersecurity for Facility Related Control Systems, to ensure system resilience against cyber threats.

B. 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 eight characters, cannot form a name, date, acronym, or a word and contain at least one character from <u>each</u> 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 three 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).

C. The system shall include Anti-Virus and Malware detection software.

D. Software patches and upgrades shall be performed by Owner.

2.12 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.

2.13 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 field testing as required to ensure all equipment and systems are installed per manufacturer’s requirements.
2. 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.

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 software configuration 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, 50 percent, and 75 percent completion of control narrative, control logic, and operator graphic development.

3.03 HARDWARE-IN-THE-LOOP TESTS

A. The Supplier's shall perform hardware-in-the-loop (HIL) test that will be witnessed. The control system shall not be shipped from the place of assembly/configuration until the HIL test(s) have been deemed to have passed by the Owner.

B. HIL procedures/Test Plan shall be submitted to the Owner a minimum of 30 days prior to HIL tests for review/comment. The HIL 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.

C. HIL test shall not be scheduled before approval of the HIL test procedure.

D. The HIL testing configuration is expected to prove key GCS functional modules as well as inform key time-domain tuning values. HIL elements shall include, at a minimum but not be limited to, the following:

1. Discrete GCS functional modules.
2. Discrete binary system elements sufficient to demonstrate key system configuration variants.
3. Discrete time-domain system elements that are necessary to prove the dynamic aspects of GCS functional modules.

E. The HIL test will be considered successful and approved by the Owner when the system has successfully demonstrated the key GCS functional modules and provided key time-domain tuning values to the Owner's satisfaction. The Owner must approve any delayed punch list item not repaired during the HIL test. Faulty and/or incorrect operation will, at the discretion of Owner, be cause for suspension or restart of the HIL test.

3.04 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. 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.

C. FAT test shall not be scheduled before approval of the FAT test procedure.

D. Factory acceptance test simulation shall include discrete items subject to PDCS control. 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 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, process condition feedback 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 Drawings. Simulate I/O actions and observe responses at the HMI. Similarly simulate actions at the HMI and observe responses at the I/O. Simulate and test all control interlocks, sequencing, and control algorithms.

F. 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 the Drawings.

5. Branch circuit fuses shall be inspected for compliance with the 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. All system deficiencies will be corrected by the Supplier prior to shipping unless otherwise agreed to by the Owner.

M. The actual system database will be used for all testing.

N. The Supplier will demonstrate, test, and prove all interconnections and communication between the various interconnected components of the control system.

O. 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.

P. 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.

3.05 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 control system.

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 HMI(s), and all punch list items are resolved to Owner's satisfaction. Successful demonstration that the control system is satisfactorily operating system equipment and related plant equipment. All control algorithms are maintaining correct system operation following a disturbance.

3.06 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 network configuration.
q. Archive database and system configuration information.
r. Upgrading hardware and software.

3.07 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.

3.08 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

INDEX – APPENDIX D
FOR
INSTALLATION AND IMPLEMENTATION OF A GRID CONTROL SYSTEM

FILE	DESCRIPTION
023560 SWBNO GCS FEED report_20240524	**SWBNO GRID CONTROL SYSTEM FEED STUDY**

SEL Engineering Services, Inc.

SWBNO Grid Control System FEED Study

POWER Engineers, Inc.

20240524

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1	20240524	Final issue—incorporated the comments from SWBNO, Jacobs and POWER Engineers	VK	AK	MK

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ACRONYMS AND ABBREVIATIONS

AGC	automatic generation control
AI	analog input
CFC	Carrollton frequency converter
CLS	contingency-based load shedding
CLSP	contingency-based load-shedding processor
CT	current transformer
CTG	combustion turbine generator
CWP	Carrollton Water Plant
df/dt	rate-of-change of frequency
DI	digital input
DO	digital output
DPS	drainage pumping station
EDG	emergency diesel generator
EMD	Electro-Motive Diesel
FC	frequency converter
FEED	front-end engineering design
FEP	front-end processor
GCS	grid control system
GenCS	generation control system
GOOSE	Generic Object-Oriented Substation Event
HIL	hardware-in-the-loop
HMI	human-machine interface
HTTP	HyperText Transfer Protocol
Hz	hertz
ICS	island control system
IED	intelligent electronic device
I/O	input/output
IRM	incremental reserve margin
ISOC	isochronous
IT	information technology
LSP	load-shedding processor
LSS	load-shedding system
MVA	megavolt-ampere
MVAR	megavolt-ampere reactive
NGVL	Network Global Variable List
OLTC	on-load tap changer
OS	operating system
OT	operational technology
P	active power
PCC	point of common coupling
PDCS	power distribution control system
PF	power factor
PLC	programmable logic controller
PT	potential transformer
pu	per unit
Q	reactive power
RFC	rotary frequency converter
ROCOF	rate-of-change of frequency
SDN	software-defined networking
RTDS	Real Time Digital Simulator
SCADA	supervisory control and data acquisition
SEL	Schweitzer Engineering Laboratories, Inc.
SEL ES	SEL Engineering Services, Inc.
SER	Sequential Events Recorder
SFC	static frequency converter
SLD	single-line diagram
SNMP	Simple Network Management Protocol
STG	steam turbine generator
SWBNO	Sewerage & Water Board of New Orleans
UF	underfrequency
UFLS	underfrequency-based load shedding
UFLSP	underfrequency-based load-shedding processor
USB	Universal Serial Bus
UV	undervoltage
VAR	volt-ampere reactive
VCS	voltage control system
VFD	variable-frequency drive
WPC	West Power Complex

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SECTION 1 INTRODUCTION

SEL Engineering Services, Inc. (SEL ES) is providing this document to POWER Engineers, Inc. the Sewerage & Water Board of New Orleans (SWBNO) to describe the conceptual design of a grid control system (GCS) for the SWBNO. This FEED document is generated as a result of the field visit by SEL for POWER Engineers at SWBNO, New Orleans.

The data presented in this document is based on the following data sources:

- Documents shared by POWER Engineers/Jacobs Engineering.
- Data gathered during the field visit conducted by SEL engineers on January 23–25, 2024 at the SWBNO water plant and pumping stations.
- Information gathered based on an interview with SWBNO official and engineers from Jacobs Engineering.
- Data confirmed during regular project meetings and documented in the minutes of the meetings.
- Publicly available information from SWBNO's website.

OVERVIEW OF FEED STUDY

The GCS project at SWBNO is aimed at the modernization of the SWBNO managed electric infrastructure to incorporate reliability and resilience to the complex, age-old power system that has one-of-a-kind 25 Hz generators, along with the latest 60 Hz generators and modern static frequency converters (SFCs). The GCS, once implemented, will be an application deployed in the existing power distribution control system (PDCS) environment and will have advanced controlling abilities such as generation control, load shedding, etc.

As per the requirements of this project, a full feed study was not required at this stage; the goal of this FEED study is to evaluate the status of SWBNO's existing electrical system to better understand the requirements for a GCS and to develop a GCS philosophy with the required modules and typical interface requirements.

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SECTION 2 GCS PHILOSOPHY AND PRELIMINARY SYSTEM DESIGN

INTRODUCTION

GCS is the intelligent application that comprises of several high-speed algorithms running on the PDCS environment. GCS is primarily a power management system that is responsible for the reliable operations of the SWBNO power system.

As per the expectation of SWBNO and Jacobs Engineering, this FEED study provides a preliminary system design for a GCS that is an application deployed on the PDCS environment. However, note that most, if not all, of the algorithms of GCS require fast operation and round-trip time of less than 100 ms with breaker operations.

The round-trip time suggested here is merely a suggestion and the exact requirement can be finalized by modeling the system using a Hardware-in-the loop and conducting a transient stability analysis for the whole power system. An accurate modeling of the generators and SFCs will be critical in deciding the outcome of the study.

This preliminary system design is considered as a software application assuming that the PDCS network and system will have the capability to support the fast response required for the stability of the system. If it is later discovered that the PDCS cannot provide a high-speed infrastructure, a modifications for PDCS infrastructure need to be deployed.

OBJECTIVES OF GCS

- To provide automated control of generation and high-speed load shedding in the SWBNO power system.
- To effectively manage the power mix of 25 Hz and 60 Hz loads and generation and balance the generation vs. load.
- To provide a reliable power supply at all times to SWBNO city water distribution and drainage loads.

REQUIREMENTS OF GCS

The GCS application will consist of the following essential features:

- Generation control (GenCS) during islanded condition and parallel operation with the grid.
  - Automatic generation control (AGC)
  - Voltage control system (VCS)
  - Island control system (ICS)
- Load shedding
  - Contingency-based load shedding (CLS)
  - Underfrequency-based load shedding (UFLS)
  - Progressive overload shedding (PLS)

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- Black start and load restoration
- Autosynchronization between different electrical islands
- Islanding and decoupling
- Generator exercise mode
- Unit commitment (UC)

SYSTEM DESIGN

As stated earlier, since the GCS is conceived as a software application in the PDCS environment, the system is designed to use the PDCS infrastructure as the field remote terminal units. However, since several heavy algorithms will run on the GCS application, a separate redundant controller is proposed for the GCS application. This redundant GCS controller will interface with the PDCS controllers to receive the field inputs and send controlling commands to the generators and loads via PDCS node FEPs and controllers.

A simple block diagram of the system architecture is provided in Figure 2.1:

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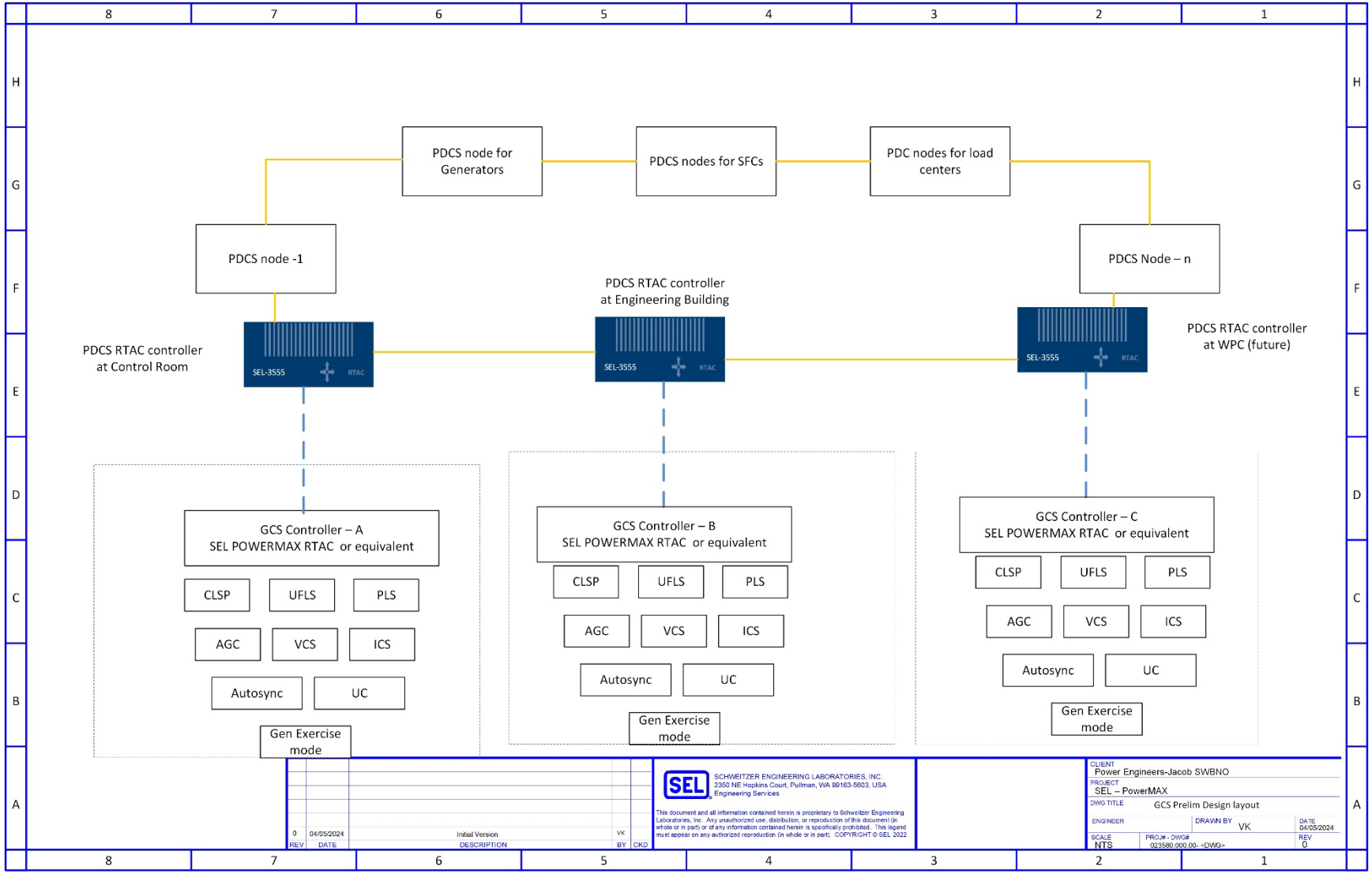

Figure 2.1: Simple Block Diagram (Representational)

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Operational Requirements

The operational philosophy of SWBNO is influenced on the weather conditions in the city of New Orleans. Accordingly, three operational scenarios are envisioned:

- Normal/sunny day operation
- Storm/hurricane mode operation
- Utility support mode

NORMAL/SUNNY DAY OPERATION

Under this scenario, the total load on the system will not be more than 10 MW including both the 25 Hz and 60 Hz assets. Therefore, during a normal day, the power system will completely rely on the utility Entergy. The 60 Hz loads will be fed by the 60 Hz distribution system connected to the 24 kV WPC temporary switchgear. The SFCs will convert the 60 Hz power to 25 Hz and feed the 25 Hz loads downstream.

STORM/HURRICANE MODE

During storm conditions, the chances of grid failure or interruption is high. Therefore, during these conditions, the internal generation will be maximized, and the utility will be kept on float with strict islanding settings. The sequence of operation will start with dispatching the 60 Hz generators, first feeding the 60 Hz loads and then the 25 Hz loads (through SFC). However, if required, the 25 Hz generators also will be dispatched. One or both the 25 Hz generators can be dispatched to meet the load requirements.

UTILITY SUPPORT MODE

In this mode, the power mix will be shared by both the captive generators and the utility. The percentage of sharing will be governed by the operator. The 60 Hz and 25 Hz load distribution will be done in the same sequence as the previous cases.

System Features

GENERATION CONTROL SYSTEM

Under the generation control scheme, the objective is to manage the power generation according to the load requirements and the import targets. GenCS regulates the power output of the turbine generators and SFCs to satisfy power demand and utility export/import requirements while controlling the system frequency (if islanded), bus voltages, and power transfer in the tie lines. These algorithms provide frequency control, active load sharing, reactive (MVAR) load sharing, optimal voltage control, turbine generator operating mode control, island tracking, and turbine generator dispatch for automatic synchronization systems. The GCS HMI provides a user interface to operate, monitor, maintain, troubleshoot, and diagnose events.

A key factor in designing the GCS is to balance the generation for the load requirements between the 60 Hz and the 25 Hz systems. The algorithm needs to ensure that the 60 Hz generation limits, voltage/VAR control, etc. takes into account the 25 Hz generator conditions. If required to maintain zero power flow across the SFC, the GenCS algorithm needs to generate separate instructions for the 25 Hz generators and the 60 Hz generators. The operational philosophy is an automated process controlled by an operator.

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Isochronous (ISOC)/Droop Modes of operations:

The SWBNO power system is considered to be nominally a two-island system:

- 60 Hz island
- 25 Hz island

During parallel operation with the grid, the running generators at 60 Hz system (CTG-6 and/or CTG-7) will operate on Droop mode. However, during islanded condition one of the generators will run on ISOC mode while the other generator continues to run in Droop mode following the frequency control of the ISOC generator. This command to the generators to shift from Droop mode to ISOC mode is a fast signal and the generator governor should take fast action to change the operating modes.

In the case of a 25 Hz island, the SFCs that interconnects the 60 Hz system to the 25 Hz system can run on both Droop and ISOC modes. When one or both the 25 Hz generators are running, one of these generators (STG-4 or CTG-5) will assume the ISOC mode and the SFCs will continue to run in Droop mode. In case of no running generators in the 25 Hz island, the GCS will provide the frequency set point for the SFCs. Final generators mode operation will be determined in the project detail design phase.

LOAD SHEDDING

The ultimate aim of a load shedding system is to respond on the loss of any utility feeders, generators, bus ties or bus coupler breakers and prevent overloading on the generators by shedding loads in predetermined priorities. There are three types of load shedding conceived for this system:

- CLS
- Underfrequency-based load shedding (UFLS)
- Progressive overload shedding (PLS)

An important consideration for load shedding is the topology tracking mechanism where the GCS needs to identify exactly which section requires load shedding. This is achieved by monitoring the breaker status of all topology breakers. Any change in the status of the topology breakers needs to be communicated to the GCS to make necessary changes to the system topology.

Conceptually, the load-shedding system (LSS) is divided into two functional categories: Pre-event calculations and event actions. The system performs pre-event calculations to dynamically determine which loads to shed and to build a load-shedding table. The system monitors contingency trigger signals and generates load-shedding signals when a trigger is detected based on the load-shedding table. Figure 2.2 illustrates the conceptual architecture of the LSS.

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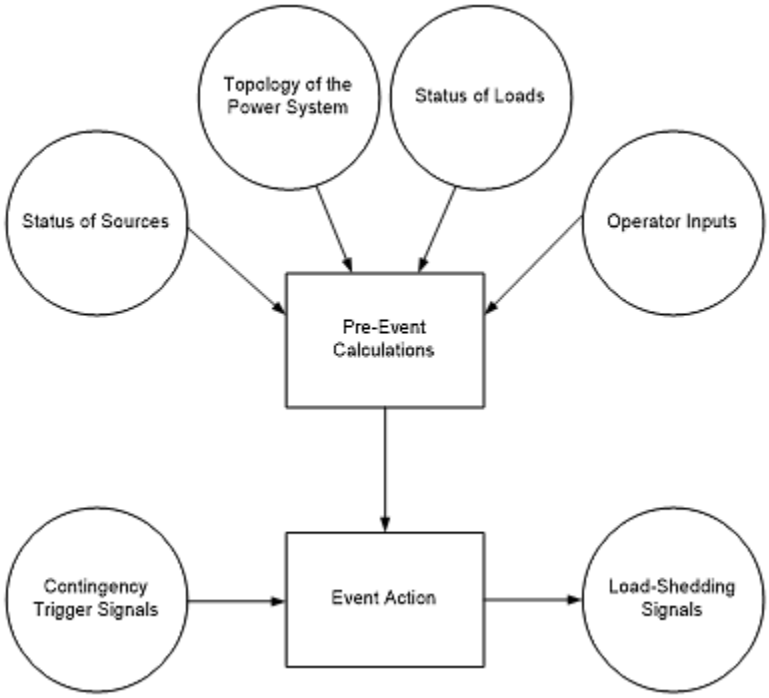

Figure 2.2: Conceptual Architecture of LSS

CLS: As "contingency-based" suggests, the purpose of this scheme to shed any excess MW loads when a contingency triggers. The MW reduction is achieved by shedding the loads in order of priorities. A contingency is usually defined as the tripping of any incoming power supply breakers—generators, SFCs, utility incomers, etc.

Some of the examples of contingencies in SWBNO power system are as follows:

- At 60 Hz island:
  - Loss of either one or both the 60 Hz generators CTG-6 and/or CTG-7
  - Loss of utility incomers at point of common coupling (PCC)
- At 25 Hz island:
  - Tripping of SFC Incomer breakers—Breakers 4, 5, and 6 at interim 24 kV switchgear
  - Tripping of SFCs
  - Loss of either one or both the generators STG-4 and/or CTG-5
  - Tripping of Bus Tie -2 (Breaker No. 16 at SSCC-0-EMV25-SG102B

UFLS: This scheme works as a backup the CLS. The UFLS works on the fact that sudden mismatch between generation and loads that reduces the frequency of the power output from the generators. On receiving an underfrequency (UF) input, usually from a relay at the sensing bus, the load-shed algorithm decides how much load to be reduced and sheds these loads in order of the operator-defined priority.

For the SWBNO system, the UFLS scheme design outline is as follows:

- 60 Hz island—The UFLS scheme will generally remain inactive as long as the SWBNO generators are running in parallel with the grid. However, in case of islanded operations, the

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UFLS will act to shed load when the frequency begins to drop. The UFLS will shed load stage wise to restore the system frequency to nominal.

- 25 Hz island—The UFLS scheme will remain active all the time, even when the system is running in parallel with the grid, and shed load in the 25 Hz island when the frequency drops.
- The frequency sensing point for 60 Hz shall be the bus PTs at the 24 kV 60 Hz switchgear side whereas the frequency sensing point for 25 Hz shall be at 6.6 kV 25 Hz bus.

PLS: Progressive overload shedding scheme is used to trip excess load in case of overloads. For the SWBNO system, the PLS scheme shall be deployed at following locations:

- 60 Hz island:
  - Overloading monitoring at utility incomers.
  - Overloading monitoring at CTG-6 and CTG-7 (overloading of generators / generator transformers).
- 25Hz island:
  - Overloading monitoring at SFCs
  - Overloading monitoring at CTG-5 and STG-4 (overloading of generators / generator transformers)
  - Overloading monitoring at SFC incomer breakers

The load shedding scheme works based on shedding the loads in the order of priority set by the operators. The operator needs to have a user interface in the HMI screen on which the priorities of each of the loads can be set and periodically reviewed.

It is to be noted that, the priorities for 60 Hz island and 25 Hz island needs to be set separately and the load shedding signal should be sent only to the island where load shedding is required.

- **Black-start restoration:**

  There are five 25 Hz EDGs and one 60 Hz EDG that can be used for black-start condition. Additionally, CTG-6 has its own diesel generator that is connected to the CTG-6 bus. The algorithm for black-start restoration should focus on what assets need to be periodically brought into the system so that the rest of the power generator sources can initiate the start sequence.

  Currently, the RFCs help in black start by drawing power from the Entergy incomers and converting them into 24 Hz power output. This scheme can continue in practice; however, the GCS will not control the CFCs.

  One of the important considerations while designing the black-start scheme is the time to restore. The city potable water distribution system can continue to function on black out condition with the help of water head in the storage tanks. The time duration of continuing the city water distribution operations without interruptions was not made clear during the site visit, however, the GCS vendor needs to take this time into consideration while designing the black-start sequence.

- **Autosynchronization:**

  The intention behind this scheme is to resync back to the grid after islanding. This scheme will be applicable only to Breakers 1 and 8 and other sources. In this scheme, the autosynchronization to the grid shall be manually triggered and the process shall be accomplished by the GCS control logic.

- **Islanding:**

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The reason for islanding or decoupling is to prevent any disturbance on the external grid from affecting the captive power generators. The islanding relays will be deployed at the PCC and will issue the decoupling command to the breakers.

After grid islanding, the GCS controllers should immediately send a command to the generators and SFCs to change the mode of the generation as will be agreed in the detailed design phase.

- **Unit Commitment:**

  The purpose of this feature is to track the hours of operation of each generator and decide which generator to be run or shut off, calculate the spinning reserve, and recommend to the operator which generator should be turned ON. The GCS vendor needs to work with SWBNO team in detail during the detailed design phase to decide unit commitment.

- **Generator exercise mode:**

  The generator exercise mode is a periodic trial operation to ensure the healthiness of the generator. The GCS system shall have the feature to run the generators on exercise mode by the operator through the HMI screen. The details of all generators/SFCs to run on exercise mode to be discussed in detail during the detailed design phase.

The GCS has these listed overall functions. To exactly determine the cases for consideration and the time performance criteria, a detailed system modeling study needs to be performed. Also, the GCS should have the capability to act on the operator-entered value to decide the spinning reserve.

GCS REDUNDANCY

The existing PDCS has a triple redundancy system. GCS controller redundancy will follow the philosophy of PDCS controllers (i.e., all three GCS controllers that interface with the three PDCS controllers will act as independent primary controllers running all the control algorithms and the outputs will be sent to the PDCS controllers).

A critical step in achieving this triple redundancy is the quality check of signals. Special watchdog algorithms need to be deployed to identify bad quality controller action and raise an alarm on the HMI.

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SECTION 3 SWBNO OVERVIEW

This section describes the function and importance of SWBNO to the city of New Orleans, LA. The publicly available information from SWBNO's website is referenced for the contents in this section.

SWBNO serves the city of New Orleans by providing essential services related to drainage, sewerage collection, and drinking water. Some of the key aspects of SWBNO systems are as follows:

CITY WATER DISTRIBUTION

- Water treatment plants: SWBNO operates water treatment plants that purify water from the Mississippi River. These plants remove impurities, disinfect the water, and make it suitable for consumption.
- Water mains and pipes: SWBNO maintains a vast network of water mains and pipes that transport potable drinking water throughout the city. These underground pipes connect homes, businesses, and fire hydrants to the water supply.

SEWAGE MANAGEMENT

- Sanitary sewage removal: SWBNO is responsible for removing and treating sewage from homes and businesses. They maintain sewer lines, pumping stations, and treatment facilities.
- Wastewater treatment plants: The board operates wastewater treatment plants that process sewage before releasing it into water bodies. These plants remove contaminants and ensure environmental safety.
- Sewerage collection system: The extensive sewerage collection system includes pipes, manholes, and lift stations. It transports sewage from individual properties to treatment facilities.

DRAINAGE SYSTEM

- Historical challenge: New Orleans faces a unique drainage challenge because of its low-lying geography. The city is a series of basins connected like an inverted tortoise shell, stretching toward Lake Pontchartrain. When it rains, parts of New Orleans could fill with water.
- Drainage pumping stations (DPSs): SWBNO operates 24 DPSs with small and large pumps. These pumps actively mitigate rainwater and prevent flooding by pumping excess water into Lake Pontchartrain.
- Unique power frequency: The SWBNO drainage systems have a combination of old electrical motors that operates in a unique 25 Hz frequency due to the age of these machines. Over a period of time, some of these 25 Hz loads have been replaced with newer 60 Hz electrical machines.

Out of all the functions, the drainage system is of utmost importance to prevent the city from flooding during storms and hurricanes and to ensure the livelihood of the residents of the city of New Orleans. The complexity of the mix of older and newer power generation sources, the age of the electrical loads, the wide-area distribution of the pumping stations and the dynamic operational requirements make the day-to-day operations of SWBNO complex.

Figure 3.1 shows the New Orleans storm water pumping station and the drainage paths (canals) through which the rainwater is drained at Lake Pontchartrain. The red dots shown in the figure represent the pumping stations. (source: SWBNO website: Sewerage & Water Board of New Orleans (swbno.org))

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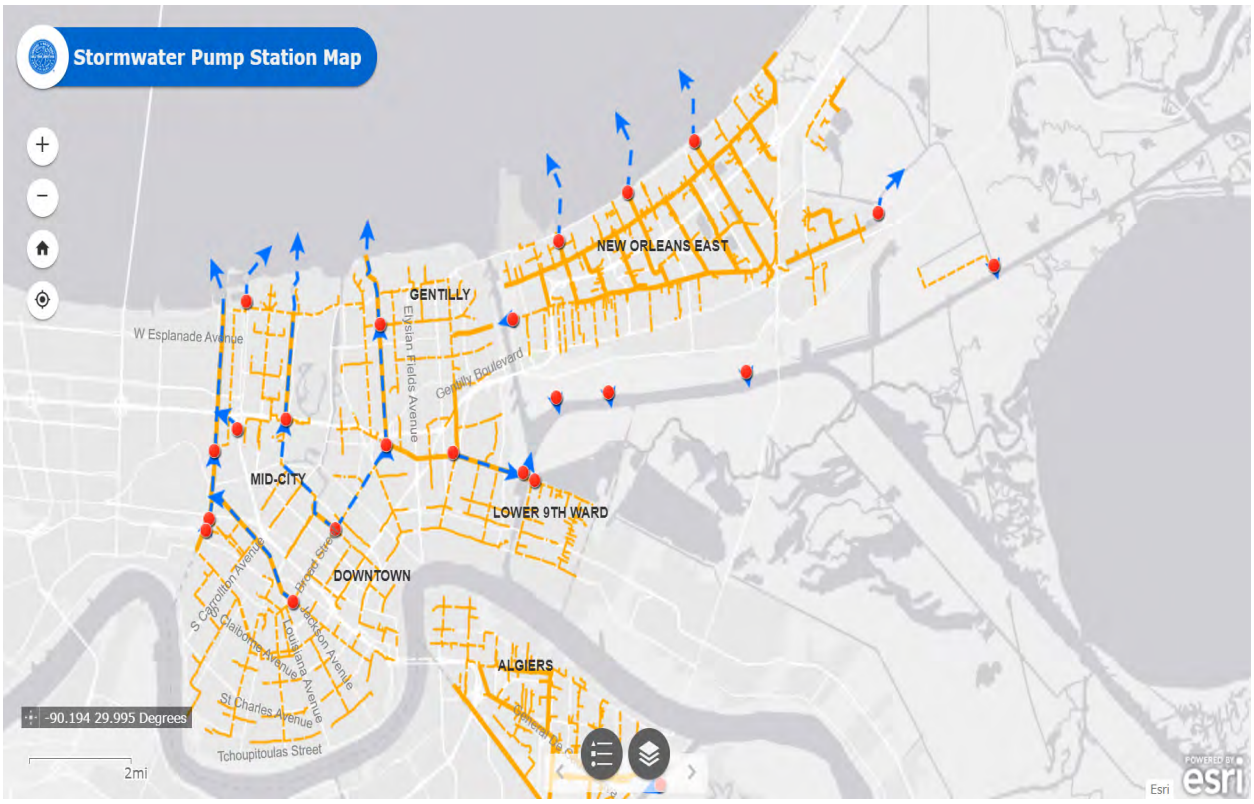

Figure 3.1: New Orleans Storm Water Pumping Stations and Drainage Map

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SECTION 4 EXISTING DRAWING REVIEW

Single-line diagrams (SLDs) were shared with SEL by POWER Engineers/Jacobs for this FEED study project. These drawings contained information about the existing SWBNO power system, the future expansion plans with an interim 24 kV switchgear (Phase 1) and the further expansion plans with West Power Complex Operations Center (Phase-2).

SEL engineers reviewed the drawings shared and prepared a simplified SLD with a focus of power infrastructure that will be under the scope of GCS. This SLD is based on the information gathered from the drawings shared and the inputs provided by Jacobs and SWBNO during the project meetings and site visit. This drawing is for understanding purpose only and focuses only on the electrical assets in the Carrolton Water Plant complex.

SWBNO SIMPLIFIED SLD

Figure 4.1 shows the simplified SLD of the SWBNO power system. This SLD has the elements that are currently available at site and also shows the assets that will be added to the SWBNO power system in the future.

For understanding, different color boxes have been used for breakers to denote the capabilities of each feeder relay. The explanation of the legend is as follows:

- Purple-colored bus sections denote the 25 Hz power system.
- Black-colored bus sections denote the 60 Hz power system.
- Blue-colored breakers denote fully monitored feeders (i.e., feeders with relays) by PDCS with the latest IEC 61850 capabilities for monitoring and control.
- Yellow-colored breakers denote partially controllable feeders (i.e., feeders that do not have a relay) by PDCS. These feeders have hardwired connections to PDCS through SEL-2240 Axion® I/O modules, which provides the feeders ON/OFF status and can also receive high-speed trip signals for load shedding. These breakers have no analog data source, and the values needs to be entered by the operator using the HMI, if used for load shedding.
- Orange-colored breakers also denote partially controllable feeders by PDCS with one difference being the analog data from these feeders, which can be obtained from a SCADA system.
- Gray-colored boxes are spare breakers for future use.
- PDCS nodes denote the presence of a PDCS rack, which houses the SEL Real-Time Automation Controllers (RTACs), SEL Axion modules, and SEL software-defined networking (SDN) switches.
- Existing frequency converters are the FCs and the Rotary motor generator frequency changers (RFCs) that generate 24 Hz power supply from the 60 Hz power input. These FCs are planned to be retired during the time of GCS implementation, and they are shown here only for the purpose of understanding the current system.

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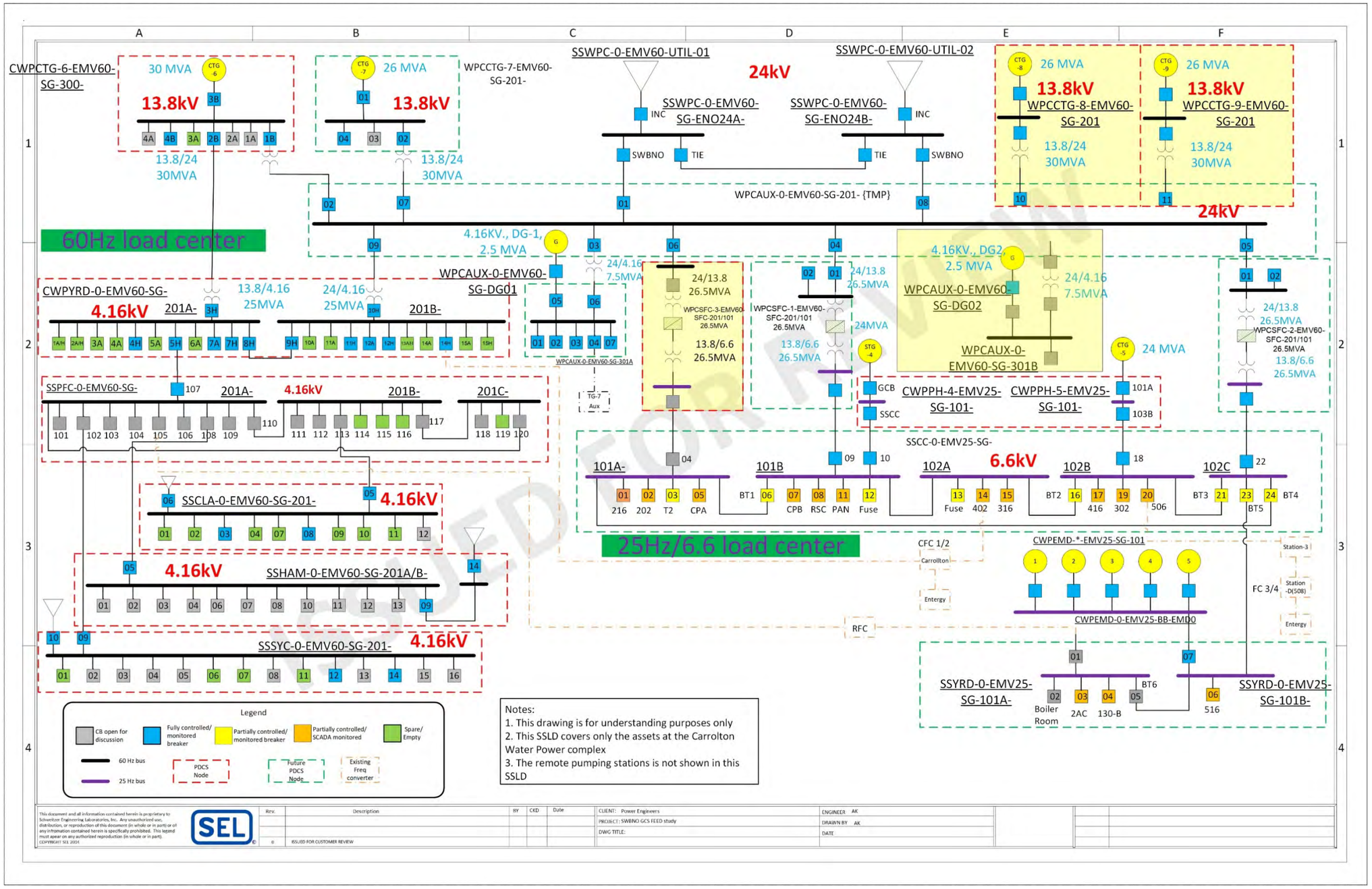

Figure 4.1: Simplified SLD of SWBNO Current Power System

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SECTION 5 POWER DISTRIBUTION CONTROL SYSTEM OVERVIEW

The PDCS is a supervisory monitoring and control system that is built on the SEL platform using SEL hardware (mainly SEL RTACs, Axion I/O modules, and SEL SDN switches). The PDCS is located at CWP within which the boundaries of the PDCS network is established.

The PDCS is a triple-redundant system with three controller panels at different locations.

- Engineering building
- Control center
- WPC (future)

Figure 5.1 shows a typical PDCS free-standing controller cabinet in the Main Control Room (MCR) node. The PDCS interfaces with local PDCS nodes at seven different locations via a ring established inside the CWP.

Figure 5.1: PDCS Controller Cabinet

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The PDCS uses Wonderware HMI to display the live data at the control center and the engineering building. There are three operator workstations running virtual machines on a VMware workstation.

The network layout of all PDCS nodes is shown in Figure 5.4. A dual-ring fiber network is established between the PDCS nodes. All the generators and SFCs will have their own PDCS equipment nodes with the same setup of Axion modules and RTAC controllers to interface with the generator governors and excitation systems.

At the PDCS equipment nodes, a wall-mounted cabinet houses the SEL-2241 RTAC data concentrators, Axion modules, and the SEL digital input (DI)/digital output (DO) cards, as shown in Figure 5.2. The purpose of this PDCS node is to interface with the local feeders both via IEC 61850 (for newer relays) and through hardwiring for feeders with older relays. These PDCS equipment nodes also have their local HMI (see Figure 5.3).

Figure 5.2: PDCS Field Interface I/O Module

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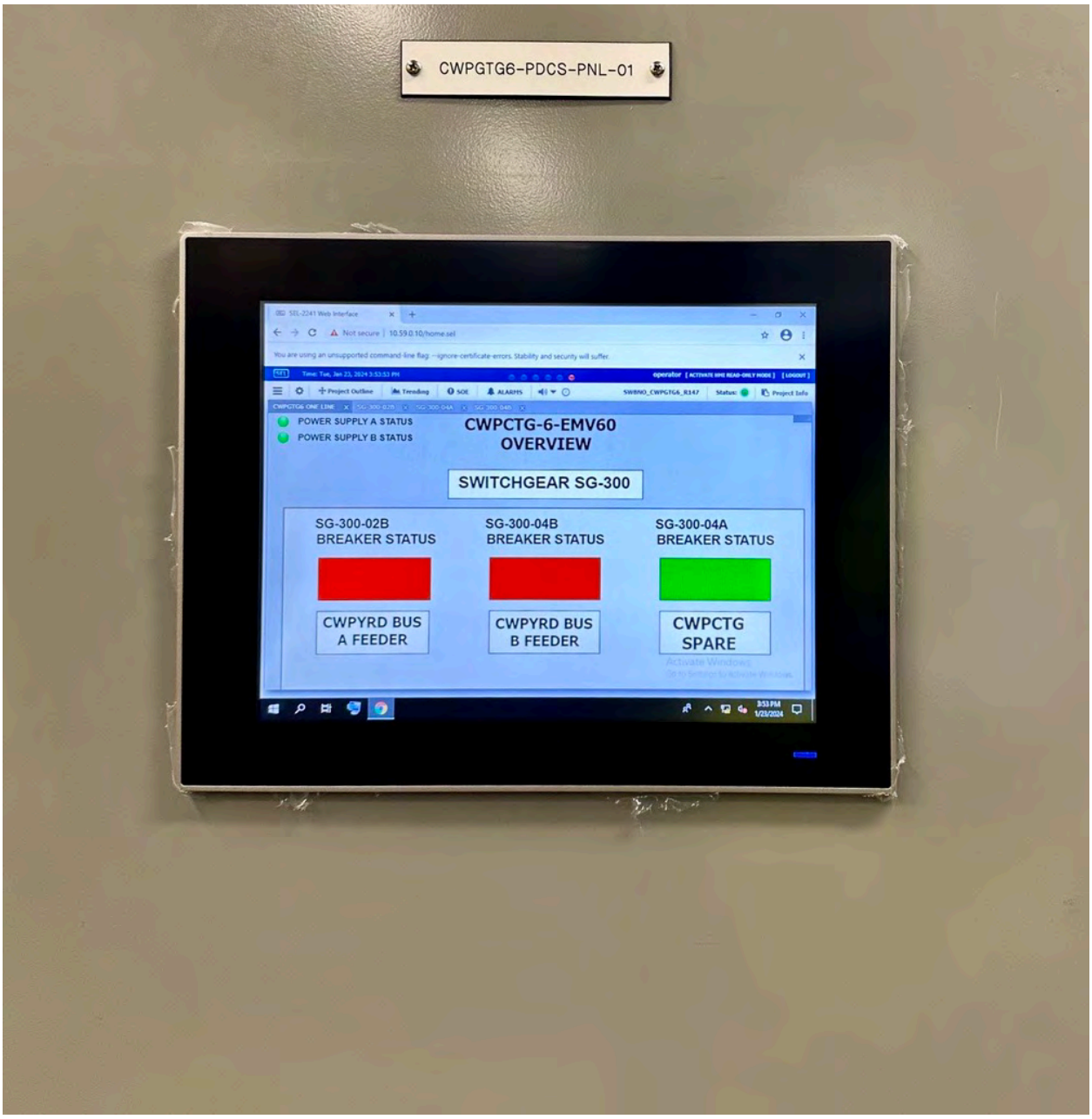

Figure 5.3: PDCS Equipment Node Local HMI

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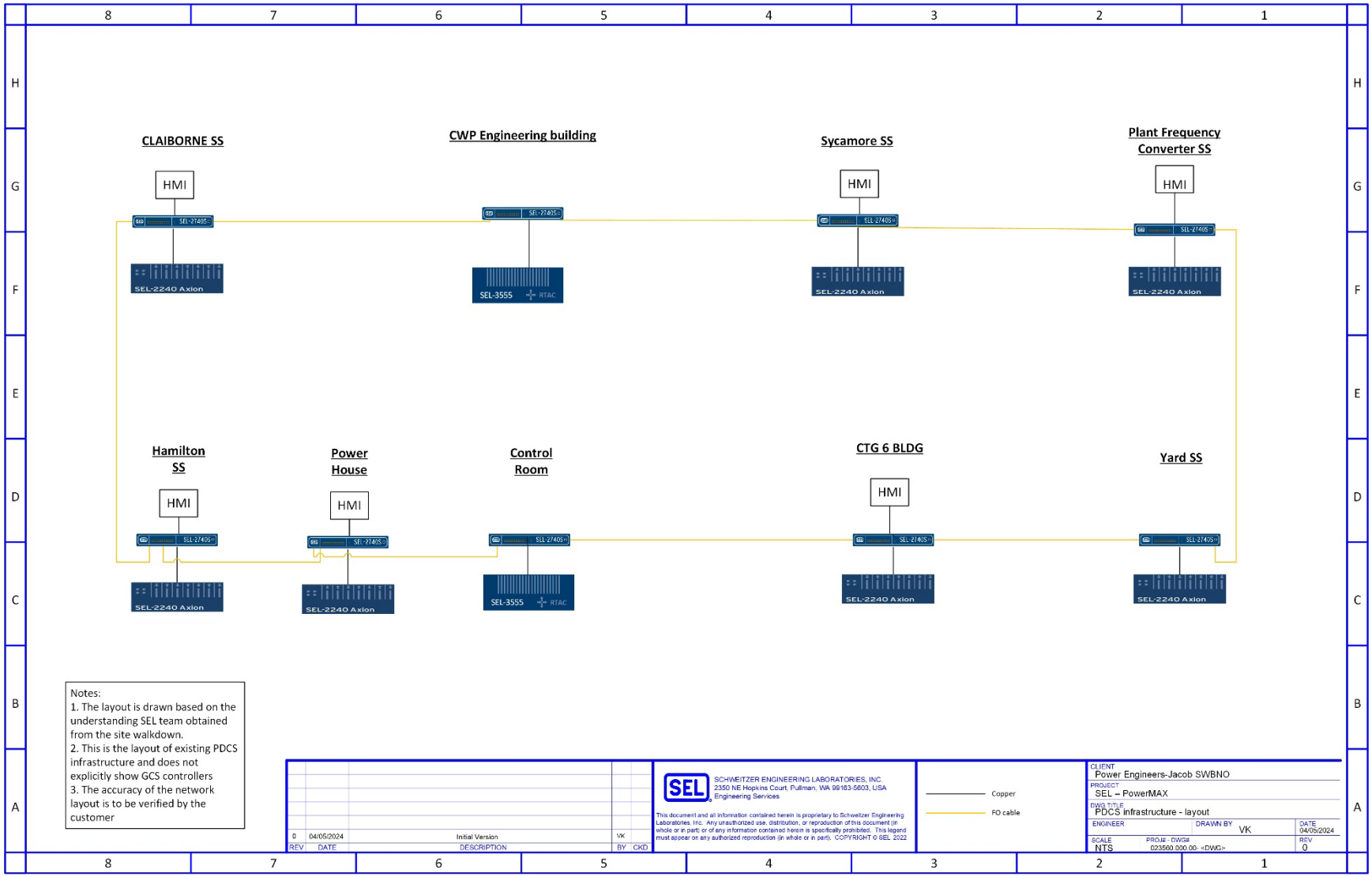

Figure 5.4: PDCS Network Layout

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SECTION 6 SWBNO POWER SYSTEM

This chapter summarizes the SWBNO power system.

The SWBNO power system is comprised of a mix of 60 Hz and 25 Hz electrical loads and captive generation sources. While the majority of generation sources and points of interconnection with the utility is located in the CWP complex, the loads comprised of motor-driven and a few steam-driven (which will be retired in the future) pumps for city water distribution, sewerage, and drainage applications are located at the CWP and also distributed across the city of New Orleans.

ASSET DETAILS

A simplified single-line diagram (SLD) is provided in Figure 4.1. A brief outline of the SWBNO managed electrical system (in the CWP complex) is as follows:

60 Hz System

- Generation source:
  - Combustion gas turbine (CTG)-6, 13.8 kV, 30 MVA
  - CTG-7, 13.8 kV, 26 MVA
  - West Power Complex (WPC) Auxiliary Diesel Generator, 2.5 MVA
- Utility source:
  - Two 24 kV incoming feeders from Entergy LA at WPC Aux. Switchgear (Tmp)
  - One 24kV/4.16 kV incoming feeder from Entergy NO at Sycamore Substation
  - One 24kV/4.16 kV incoming feeder from Entergy NO at Hamilton Substation
  - One 24kV/4.16 kV incoming feeder from Entergy NO at Claiborne Substation
- Distribution voltage levels:
  - 24 kV, 60 Hz
  - 13.8 kV, 60 Hz
  - 4.16 kV, 60 Hz

25 Hz/24 Hz System

- Generation source:
  - Steam turbine generator (STG)-4, 6.6 kV, 24 MVA.
  - Combustion gas turbine (CTG)-5, 6.6 kV, 24 MVA.
  - SFC 1, 2, and 3 24/13.8 kV:13.8/6.6 kV, 26.5 MVA.
    - SFC 1 and 2 will be commissioned before implementation of the GCS.
    - SFC 3 will be added to the GCS control philosophy when it will get commissioned in the future.
  - Carrollton frequency converter (CFC), 24 Hz **.
  - Plant frequency converter (PFC), 24 Hz **.

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- Station C frequency converter (FC), 24 Hz**.
- Station D FC, 24 Hz**.
- EMD generators 1, 2, 3, 4, and 5, 6.6 kV, 3 MVA each.
  - **Existing, however, might be retired in near future and not part of the GCS.

- Distribution voltage level:
  - 6.6 kV, 25 Hz.

Note that the GCS control scope will be limited to the CWP complex; the remote pumping stations will not be monitored by GCS application and therefore not shown in the simplified SLD.

CURRENT OPERATIONAL PHILOSOPHY

The SWBNO power system has a complex operational scheme currently, majority due to its 25 Hz and 60 Hz generation sources and loads. Some of the unique operational sequences have been identified and listed down below for understanding the complex nature of the power system.

25 Hz Loads and Generators

Currently, the 25 Hz loads are supplied primarily through captive generators STG-4 and CTG-5. Since there is no automated load-shedding or load-sharing mechanism in place, STG-4 and CTG-5 are operated in independent ISOC mode on separate islands.

The 25 Hz 6.6 kV central control room switchgears 101A, 101B, 102A, 102B, and 102C are connected in a ring bus system. When one of the 25 Hz generators is operational, these buses are connected in a ring bus configuration and the downstream loads (DPSs) are fed from this section. However, when another 25 Hz generator is to be added to the system, both the generators are paralleled momentarily in ISOC Load Sharing mode.

When both the generators are sharing the load, the bus ties are open to run the generators in Islanded mode. This entire operation is performed manually by the operators from the synchronization panel in the control room.

In addition to STG-4 and CTG-5, there are five EMD generators connected to the 25 Hz ring bus system for providing emergency power. During an inclement weather event or during known trouble in the 25 Hz generation system, the EMD generators are primed and ready to be operated. Even under these conditions, a 15- to 20-minute delay is expected before the EMD generators can actively be loaded. During cold start, the EMD generators take more than 1 hour to be loaded and the entire operation is through manual control.

24 HZ SUPPLEMENTAL SOURCE

In addition to the 25 Hz generators, the two RFCs in Carrolton Water Plant is used to power the 25 Hz loads. Since the RFC generates 24 Hz power output, this is used to supply power to the 25 Hz loads in the drainage pump stations as long as it is not running in parallel with the 25 Hz generators. This is also used for providing black-start support to the 25 Hz generators.

60 HZ POWER SYSTEM

Currently, the 30 MVA CTG-6 and 26 MVA CTG-7 are the functional 60 Hz generators. These generators feed 60 Hz loads that are connected primarily to Sycamore, Claiborne, and Hamilton

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substations. Each of these three substations also has an incoming 24 kV feeder from Entergy New Orleans which is further stepped down to 4.16 kV that cannot be paralleled with the 60 Hz captive generation sources.

STATIC FREQUENCY CONVERTER (FUTURE)

SFC 1, 2, and 3 are connected to the 24 kV WPC temporary bus. These SFCs convert the 60 Hz power at the 24 kV side and delivers the 25 Hz power output at the 6.6 kV bus level. The current plan is to commission two SFCs by the time of GCS implementation, however SFC 3 will be in the future with no committed timelines.

West Power Complex

The WPC is a pivotal infrastructure project by SWBNO designed to modernize and sustain the city's water, wastewater, and drainage systems. The facility will house a dedicated substation to draw power from Entergy's transmission grid, static frequency changers to adapt modern electricity for older pumps, and modern turbine generators for efficient, reliable backup power.

The project is divided into two phases, with Phase 1 focusing on integrating grid power and adding a new turbine generator. The WPC operations center will be commissioned in Phase 2 of the project.

The WPC operations center will house a 24 kV switchgear in a M-T-M (main tie main) configuration that will be the PCC of the SWBNO captive power generation facilities with Entergy Louisiana utility. However, because of financial reasons, the WPC operations center is scheduled for a future implementation.

INTERIM 24 KV SWITCHGEAR

Until the WPC is commissioned, an interim 24 kV switchgear will be commissioned, which will serve as the PCC. This 24 kV interim switchgear will be housed in a power distribution center(PDC) near the WPC.

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SECTION 7 SITE OBSERVATIONS AND FINDINGS

The site observation and findings listed here are based on SEL's understanding from the inputs provided by various stakeholders during the site visit. The details mentioned in this section is only for the purpose of understanding and to be determined during the GCS implementation phase.

GENERAL

- The city of New Orleans receives heavy rainfall every year and without a reliable storm water pumping system, the city suffers from a deluge during storms/hurricane season.
- The major electrical loads in terms of rating and criticality are the water pumps that are responsible for the city water distribution and the drainage pumps located at the DPSs.

Potable Water

- There are eight water pumps in total, out of which five are 60 Hz pumps, two are both 25 Hz and 60 Hz pumps, and one steam-driven pump.
- For ensuring the city water distribution, four out of eight pumps are operated.
- The typical operational mix is two 60 Hz pumps, one 25 Hz pump, and one steam-driven pump. However, this is subjected to change.
- The portable water pumps are in the following stations:
  - Two pumps (one steam + one electric) in yard.
  - Two pumps in Sycamore substation (fed from Panola substation). The interesting fact about the two pumps is that both the 25 Hz and the 60 Hz motors are coupled on the same shaft, providing a redundancy to the pump.
  - Four pumps are fed from Claiborne substation. These pumps are fed through Siemens variable-frequency drives (VFDs) and have the option to be fed through either 25 Hz or 60 Hz source at the VFD incoming. The selection is made at the field by the operator with the help of toggle switches.

Drainage Pumping Stations

- The DPSs have the following sources of power:
  - Local utility incomer supplying 60 Hz power.
  - 25 Hz supply from SWBNO managed electrical network.
  - RFC connected to 60 Hz system and generating 24 Hz power.
  - Local diesel generators to sustain operations in cases of power blackout.
- The DPS are locally controlled and most of the major DPS are manned 24/7.
- In remote pumping stations, the older electromechanical relays are getting upgraded to newer SEL microprocessor relays with IEC 61850 and Modbus capabilities. However, the retrofitting job is done based on opportunities whenever the existing electromechanical relays faulter.
- Varying operational and control philosophy observed for sources and loads. Load center load requirement and management needs to be studied in detail at all 24 DPS during the detailed design phase.

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- The motor generator sets with capabilities of ac/dc conversion is present in some of the DPS. This dc source generated is used to charge the field of synchronous high-duty pumps.

POWER SYSTEM

Current

- The SWBNO power system at CWP currently is comprised of two 60 Hz captive generators and two 25 Hz captive generators with rotary FCs to convert 60 Hz into a 24 Hz system. These generators are supported by five 25 Hz EMD generators.
- In addition to the captive generators, three utility feeders from Entergy support the 60 Hz loads at the 4.16 kV level at Claiborne, Hamilton, and Sycamore substations. These utility incomers are connected to the 4.16 kV bus on a main-main configuration (one incomer from utility and one incomer from SWBNO generator).
- Under normal circumstances, the 4.16 kV utility incomers are kept closed and the loads are fed through the utility power while keeping the SWBNO incomers open. It is to be noted that, an interlock scheme is implemented in these 4.16 kV switchgears that prevents the parallel operations of utility incomers and SWBNO incomers.
- In the remote pumping stations, the power requirement is managed by a mixture of source feeders from the SWBNO managed power system and local utility incomers from Entergy.
- In the future, WPC, which is under construction (and the temporary 24 kV switchgear), the captive generators at CWP can parallel with the utility power from Entergy New Orleans.
- STG-4 depends on steam availability from the boiler to start. Electro-Motive Diesel (EMD) Generators 1, 2, 3, 4, and 5 support in providing power to the boiler auxiliaries on a blackout condition. However, if the EDGs are not primed, the duration to start the engine and load the generators will be more than one hour.
- In case of unavailability of EDGs, the rotary FCs are used to supply the 25 Hz source to the boiler loads.
- CTG-5 takes 45 minutes to be started and synchronized to the system.
- CTG-6 has its own black-start EDG to support startup.
- GTG-7 has cold start capabilities and can be synchronized in under 10 minutes. However, the auxiliaries require power from EDG01 for black start.
- STG-4 has a new excitation system with interfacing capabilities, where CTG-5 has the old exciter.

Operations

CURRENT

- Currently, STG-4 and CTG-5 are operated on two separate buses.
- Since there is no LSS available presently, the parallel operations of the generators might lead to a potential overload and blackout condition if one of the generators were to trip.
- The governor and excitor control are done manually from the control room by operators.

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- To do a load transfer, the bus reconfiguration is done manually where the CTG-5 is synchronized to the live running ring bus. Once the CTG-5 is synchronized, the tie breakers are opened and divided into two sections.
- During this operation, both the generators continue to run on ISOC Sharing mode.
- STG-4 can be loaded only up to 12–15 MW and only on favorable temperature conditions.
- CTG-5 can be loaded to a maximum of 15 MW.
- CTG-6 can run on both natural gas and diesel. When running on natural gas, the maximum power output is 25 MW, however, on diesel the generator can be ramped up to 30 MW generation.

FUTURE

- The desired operational philosophy in the future is to maximize utility import to take care of the entire load.
- STG-4 will continue to be a part of the future system but will eventually be retired when CTG-8 and CTG-9 are commissioned.
- CTG-8 and CTG-9 are future goals; currently, no implementation plan or funding allocation has been done.
- The RFCs will be retired in the future and SFCs will support the 25 Hz load requirement.
- SFCs will have the capability for bidirectional power flow. However, unlike a transformer, the direction reverse will be off-loaded through manual intervention.
- SFC 1 and 2 will be commissioned around the time of GCS implementation, however, GCS 3 will be a future addition.
- The SFCs have a maximum loading capacity of 26 MW.
- The maximum utility contribution can be 65*2 =130MVA.

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PDCS

- The PDCS MCR controllers are triple-redundant and are in three different locations:
  - Engineering building
  - WPC (future)
  - Control room
- The redundancy of the PDCS is built in a way that, in case of any disaster at one of the PDCS MCR controller locations, the system should still be running.
- A PDCS equipment node with RTAC data concentrator is already present at all generator locations to interface the governors and excitors.
- A similar PDCS equipment node with RTAC controller will be installed at the SFCs to interface and control the SFCs.
- The physical I/O interface between the generators and the PDCS is not a part of the GCS scope and will be performed by the PDCS vendor.

Process SCADA System

- The process SCADA system utilizes different ICS (industrial control system) PLC that roles up to an Ifix HMI infrastructure.
- AVEVA PI Vision is used as a data aggregation tool and publishes data from the DPS to the business network dashboard.
- The PI system lies on the information technology (IT) network and all DPSs have a PI node present. These nodes have automation direct programmable logic controllers (PLCs) that are acquiring data from the field relays and breakers. The display of data from the PLC is done on the PI server.
- The local nodes communicate with the central PI server located at CWP over a leased fiber line.
- Because of cybersecurity concerns, the PI server is not integrated with the PDCS.

Cybersecurity

- An operational technology (OT) cybersecurity policy is current being developed based on National Institute of Standards and Technology recommendations.
- SWBNO is planning to provide remote connectivity to the SFC vendors for support. Since the SFC is integrated with PDCS and thereby GCS, the modus operandi of establishing a remote connection needs to be established with all secure measures.

FINDINGS

- The interface capabilities of the generators STG-4, CTG-5 & CTG-6 was not made clear during the site visit. Detailed generator interface information will be required during the detailed design phase.
- None of the generators have been operated in Droop mode or power factor (PF) Control mode so far. The capabilities of the generators to run in a synchronized system needs more investigation during detailed study.

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- The capabilities and operations of the SFC were not made clear during the site visit. This will be studied in detail during the detailed design phase by the GCS vendor.
- The SWBNO recommended operational philosophy for the DPS is to maximize the operation of 60 Hz constant-duty and heavy-duty pumps (when required). However, this operation philosophy is not standard across all the DPS, where operators decide the operation sequence based on onsite availability of the pumps and the clearance from the central control room based on the 25 Hz power reserve margin.
- The master asset list of all motors, generators, relays and SEL RTACs is not available, however, SWBNO has plans to create and maintain this list in the future.
- Operational philosophy of source and load management needs to be studied in detail during design and implementation phase by the GCS vendor.
- The controlling zone under the GCS scope will be limited to CWP. The remote DPS will not be a part of the GCS LSS.
- The GCS is conceived as software lying in the application layer of the PDCS environment. All field interfaces for data collection or controlling will be done through the PDCS.
- Underfrequency study needs to be performed separately by the GCS supplier in coordination with SWBNO for calculating the Underfrequency load shedding stage and load to shed.

Refer to Appendix A for site photos from the SWBNO site.

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SECTION 8 RISKS AND MITIGATION PLAN

This section discusses the possible risks identified during the site visit and discussion and also suggests mitigation plans that need to be considered while designing the GCS and implementing the project. Note that this list is not comprehensive and only talks about those risks based on the information gathered during the site visit. Also, since the GCS scope is limited to a software application, much importance is not placed on field interfaces.

Table 8.1: Risks and Mitigation

Type of Risk	Risk Identified	Possibility of Occurrence and Impact	Mitigation Plan
Project implementation schedule	The success of GCS is completely dependent on the full completion of PDCS infrastructure with load and generator interfaces. Additionally, the commissioning schedule of new SFCs and generators also could possibly impact the GCS design, development, and implementation plan. In case the rest of the project development schedule is delayed, GCS project development efforts could be hampered.	High	Close communication and meticulous planning between SWBNO and the GCS implementor is required before and after the start of the project. The models of new generator controllers and SFCs are to be provided prior to project implementation so that the GCS developer can model the generators during the system study.
PDCS infrastructure capabilities	GCS is envisioned to be a software application deployed on the PDCS infrastructure. The round-trip time and the quality of data transmission are two critical requirements for the successful functioning of the GCS. If the PDCS network and infrastructure does not support the requirements for the successful functioning of GCS algorithms, the control actions of the GCS will not function effectively.	Medium	If the PDCS infrastructure does not support the requirements, a modification to the hardware infrastructure needs to be established in the field to interface between GCS controllers, generator controllers, and loads. Additionally, a separate GCS controller hardware is required to run the GCS algorithms. The GCS vendor is responsible for reviewing the network requirements and evaluating the performance of the existing PDCS network infrastructure.
Generator interface capabilities	It is understood that the generator field interfaces will be done to the local PDCS FEPs, which is not in the scope of the GCS developer. If all the required I/O signals are not interfaced with PDCS, some of the GCS algorithms cannot function successfully.	High	SWBNO to ensure that all I/O required by GCS developer needs to be made available at the PDCS controller end.

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Type of Risk	Risk Identified	Possibility of Occurrence and Impact	Mitigation Plan
			Detailed list of generator I/O interface needs to be provided by the GCS vendor.
Hardware-in-the-loop (HIL)	The SWBNO power system has complex and diverse generators and loads. Since there is no transient stability and load flow analysis report available for the system, the generator responses cannot be estimated completely.	High	A detailed transient stability analysis study needs to be done on the system by the GCS supplier, before implementing the controlling and load-shedding logics. A HIL loop test can be performed by the GCS supplier before the implementation to validate system performance.
Model validation and availability	Since most of the SWBNO assets are older, the availability of generator models is a question. Without precise data, the HIL modeling for these generator controllers needs to be done purely on the basis of technical competence of the system designer.	High	The GCS supplier needs to have power system experts on board to conduct the transient stability analysis.
UF Study	Underfrequency study has not been done.	High	Detailed underfrequency study for different load and generation configurations needs to be performed separately by the GCS supplier by SWBNO to arrive at the UF load-shed set points and load to be shed at each level.
Testing and validation	The SWBNO modernization project is a phased-wise long-duration project. The testing and validation of the GCS depends on the availability of all other source assets.	High	SWBNO to work closely with the GCS developer to mutually agree on a commissioning schedule.

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SECTION 9 TYPICAL I/O LIST

This section discusses the GCS interface to the turbine generator and the other power supply assets and provides an idea for a typical system. The interface requirement needs to be studied in detail and augmented during the detail design phase.

There are a total of four generators—STG-4 (25 Hz), CTG-5 (25 Hz), CTG-6 (60 Hz), and CTG-7(60 Hz)—along with three SFCs. SEL understands that all the generators and SFCs will be interfaced with the PDCS and can be controlled through it. This interface list is considering that the GenCS algorithm will interface with PDCS and receive/send the control action through the PDCS channel. However, if the system response time of the existing PDCS infrastructure is not sufficient to support reliable control actions, separate I/O modules need to be introduced to directly control the generators from the GCS.

The power source interface list and the response time calculation will be done during the detailed design phase.

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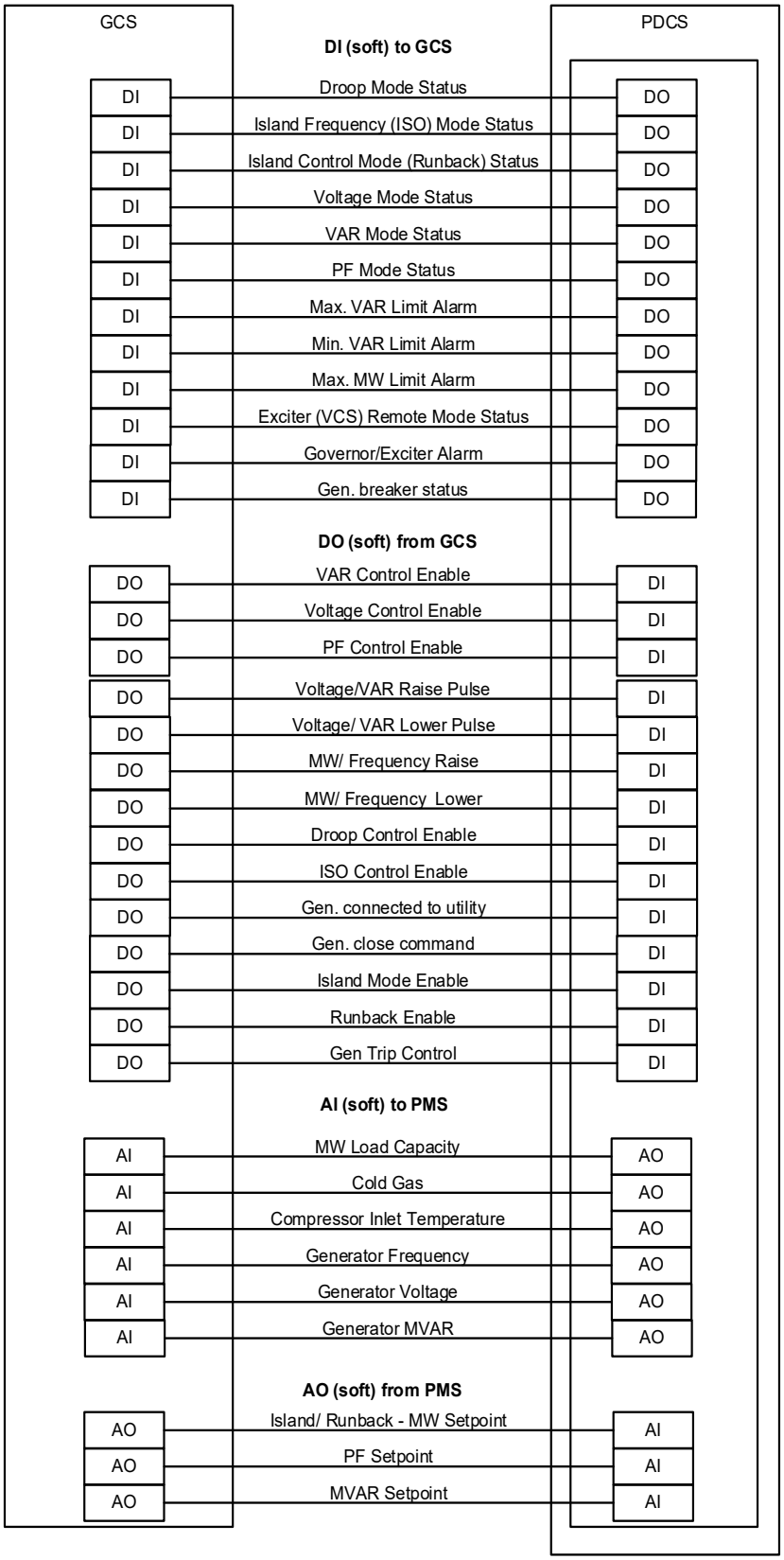

Figure 9.1: Typical GCS–PDCS Interface for Generators

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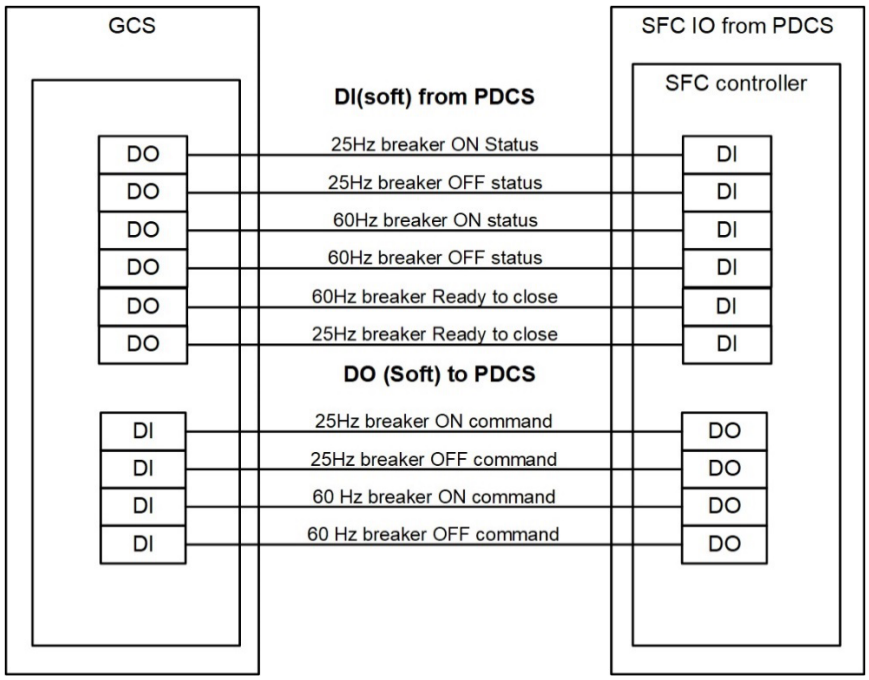

Figure 9.2: Typical GCS–PDCS Interface for SFC

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SECTION 10 CYBERSECURITY OVERVIEW

This section describes the overview of cybersecurity requirements. Since the GCS is envisaged as merely a software application deployed in the PDCS environment, the cybersecurity controls suggested here are common for the entire PDCS network. All the cybersecurity controls implemented in the PDCS system shall be incorporated in the GCS controller hardware by the GCS supplier.

The cybersecurity policies shall be drawn from National Institute of Standards and Technology (NIST), the Network and Information Security Directive, and North American Electric Reliability Corporation requirements. As a standard approach, the PDCS vendor needs to use the NIST Cybersecurity Framework (CSF), which focuses on using business drivers to guide cybersecurity activities and considering cybersecurity risks as part of the organization's risk management processes.

This framework is not prescriptive in using a specific technology or control. Instead, the framework seeks to implement a defense-in-depth approach using a systematic philosophy to identify areas where existing controls or processes may require improvements or new controls and processes may be implemented. While playing a key role, it is important to note that technology alone cannot provide complete system security. Technology can automate some tasks and help provide visibility; however, robust security policies and procedures must be identified and mandated as part of a mature security program.

Any security project that has a cost should be grounded in real-world system improvements and risk reduction. Typically, the clearest way to organize priority is to run a quantitative risk assessment that considers the following:

- Probability of a cost-event (cyber attack/system failure) occurring.
- The types of impacts an event will have (physical property damage, loss of productivity, loss of control, loss of safety, loss of information).
- An educated assessment of the monetary impact ranges an event could have.

Once this is understood, simulations and statistical analysis can be performed to compare the cost of these events against the cost of mitigating security controls to determine which controls have the greatest risk reduction. To perform an accurate risk assessment would require a detailed understanding of the organizational environment and financial picture.

In general, however, system architecture improvements tend to provide the most security value and the least economic impact. Offensive security strategies, on the other hand, offer very little value for the cost and may have undesired ethical and legal implications. Figure 10.1 represents the sliding cost scale of security control mitigations.

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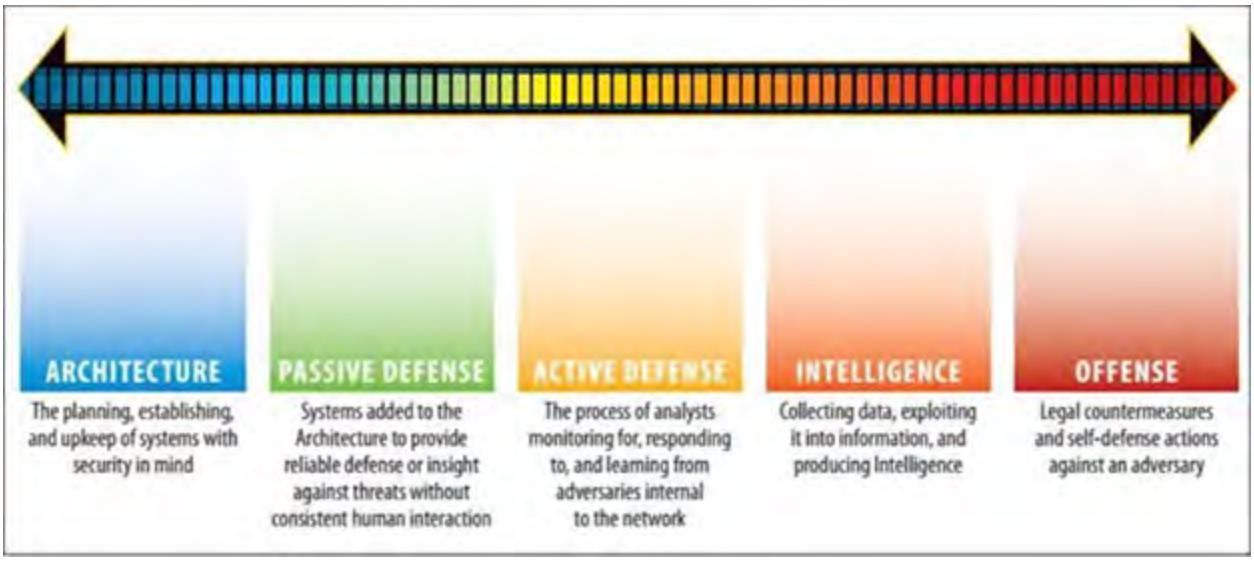

Figure 10.1: Sliding Scale of Security Controls

GENERAL BEST PRACTICES/RECOMMENDATIONS FOR CYBERSECURITY

Cybersecurity Requirements for Computers

The Microsoft Windows-based OS needs to be configured to include the following security requirements:

- Disabling of AutoRun and AutoPlay properties for all USB drives.
- Enforcing strong passwords (a minimum of seven characters, including a combination of numbers and letters).
- Ensuring that no blank or default passwords are used unless otherwise required.
- Disabling the Microsoft Windows guest account.
- Enabling the OS security log.
- Disabling file sharing or setting security permissions accurately.
- Applying the OS security updates.
- Enabling anti-malware (e.g., antivirus, whitelist).
- Enabling the OS firewall and blocking of appropriate ports.

Cybersecurity Requirements for Network Devices

The network device settings should be created to include the following security requirements:

- Restricting remote access as appropriate.
- Enabling security logging as appropriate.
- Ensuring that no blank or default passwords are used unless otherwise requested by the customer.
- Ensuring SDN network is designed to only allow communication protocols between devices based on the functionality outlined in this document. All other communications will be denied on this network.

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- Disabling or restricting plaintext protocols (e.g., Telnet, HTTP, and SNMP) as appropriate.
- Encrypting any wireless devices and using nondefault, strong passwords as appropriate.
- Updating firmware to the latest security release.

Cybersecurity Requirements for Communications Processors and Relays

IED settings should be created to include the following security requirements:

- Automatic password changes for SEL relays on a periodic basis or on demand.
- Ensuring that no default passwords are used unless requested by the customer.
- Disabling unused communications ports as appropriate.

USB Mass Data Storage Devices

USB devices are a known transport mechanism for malware. USB devices must not be inserted into any equipment at any time unless all inserted USB devices are identified and archived in a log to provide a history of potential security breaches.

All unused USB ports on the Microsoft Windows-based HMIs and workstations are to be disabled. All controllers and FEPs should not have active USB port capabilities. Note that this does not provide complete protection from malware.

Password Management

A password management solution with the ability to automatically change the relay passwords on a periodic basis needs to be incorporated. Since the SWBNO site has SEL relays, the SEL-3620 Ethernet Security Gateway or equivalent other OEM products combined with appropriate software can be used for this purpose. User can access the relays by logging into the password management devices and, based on their access level, can then log in to relays to view and/or edit relay settings.

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APPENDIX A PHOTOS FROM SWBNO SITE VISIT

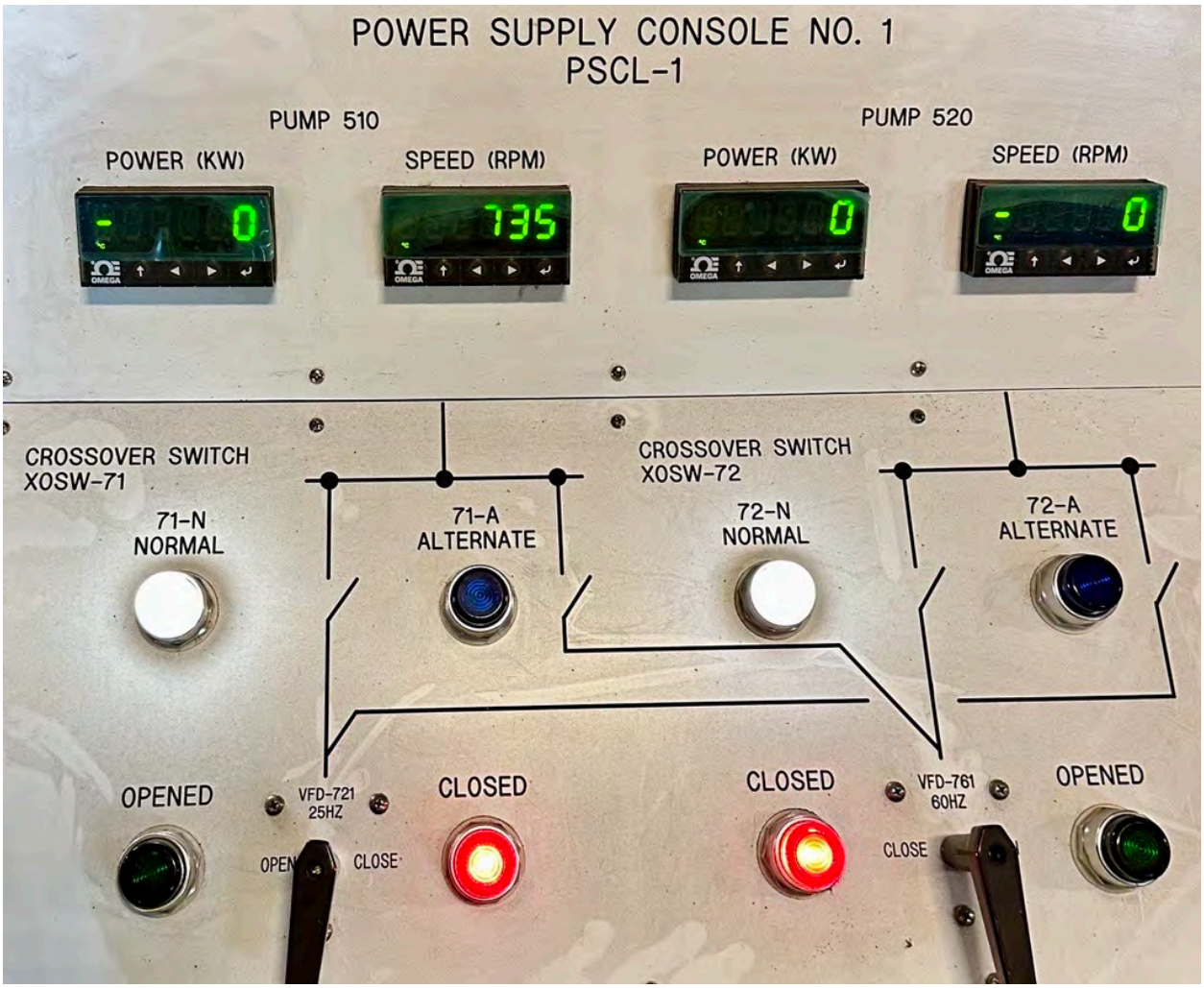

Figure A.1: Selector Switches to Choose 25 Hz or 60 Hz Incoming Supply to VFDs for Water Pumps

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Figure A.2: RFC (60 Hz–25 Hz)

Figure A.3: DC Excitation System for RFC

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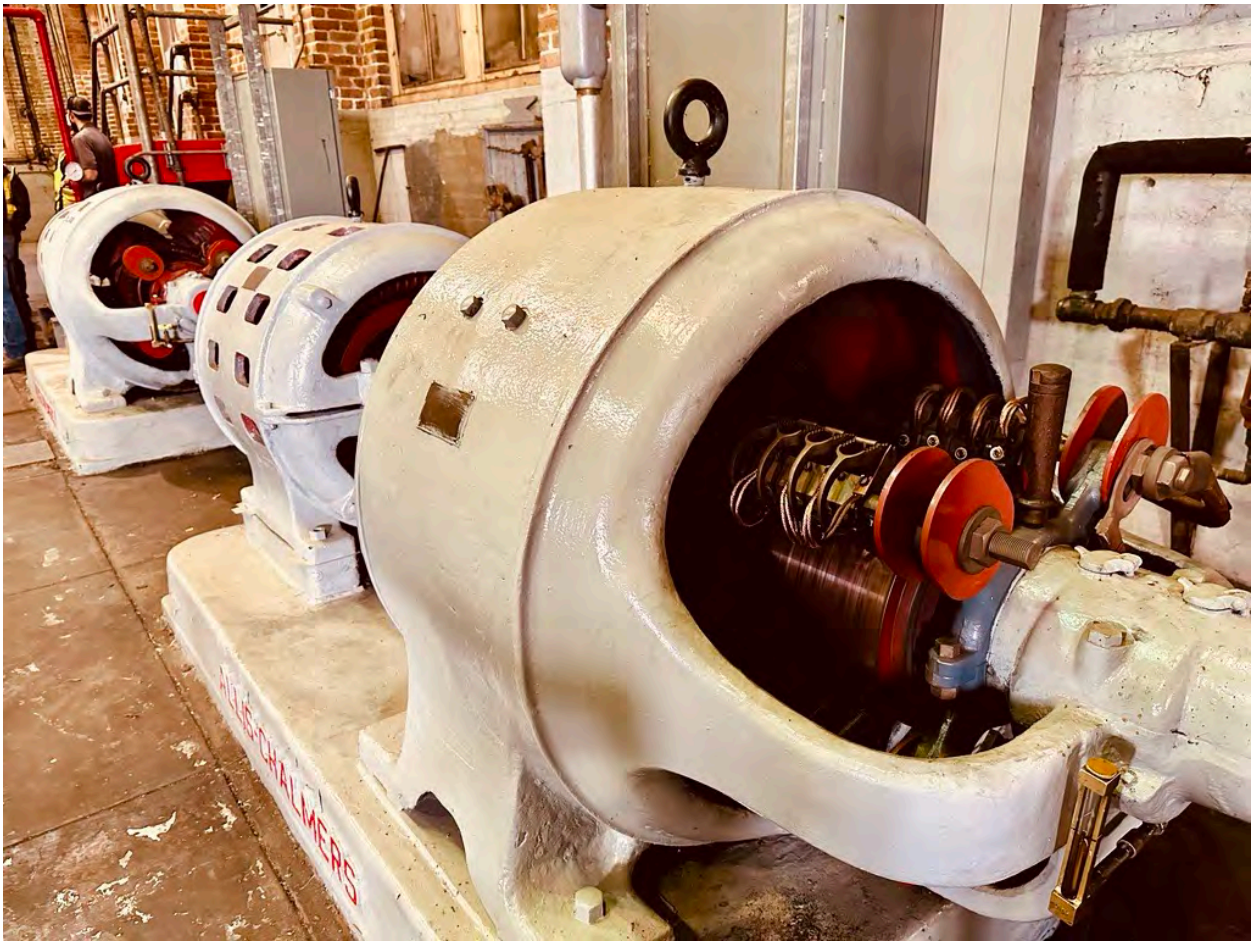

Figure A.4: Motor Generator set for generating DC power

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Figure A.5: Specially Configured SEL Relay That Can Work on 25 Hz Nominal Frequency

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Figure A.6: AVEVA PI Vision

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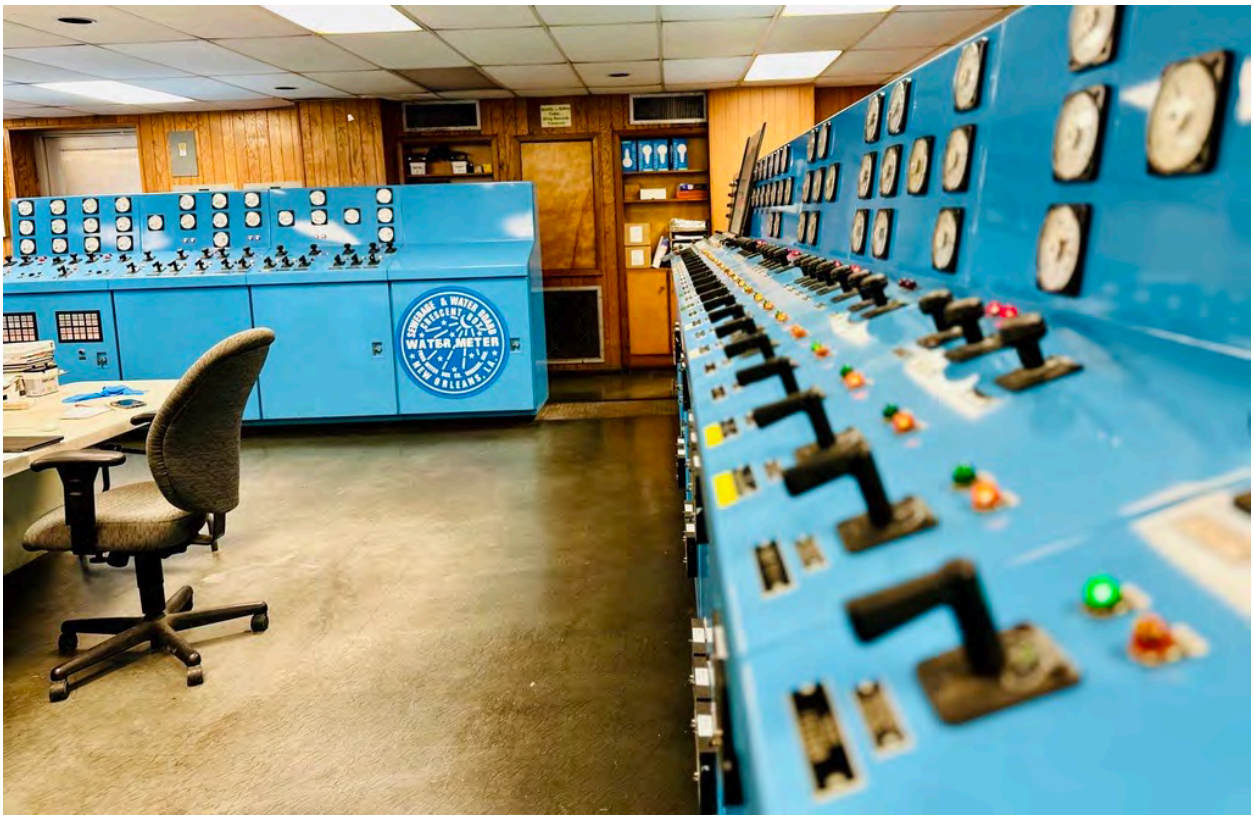

Figure A.7: Control Room at DPS

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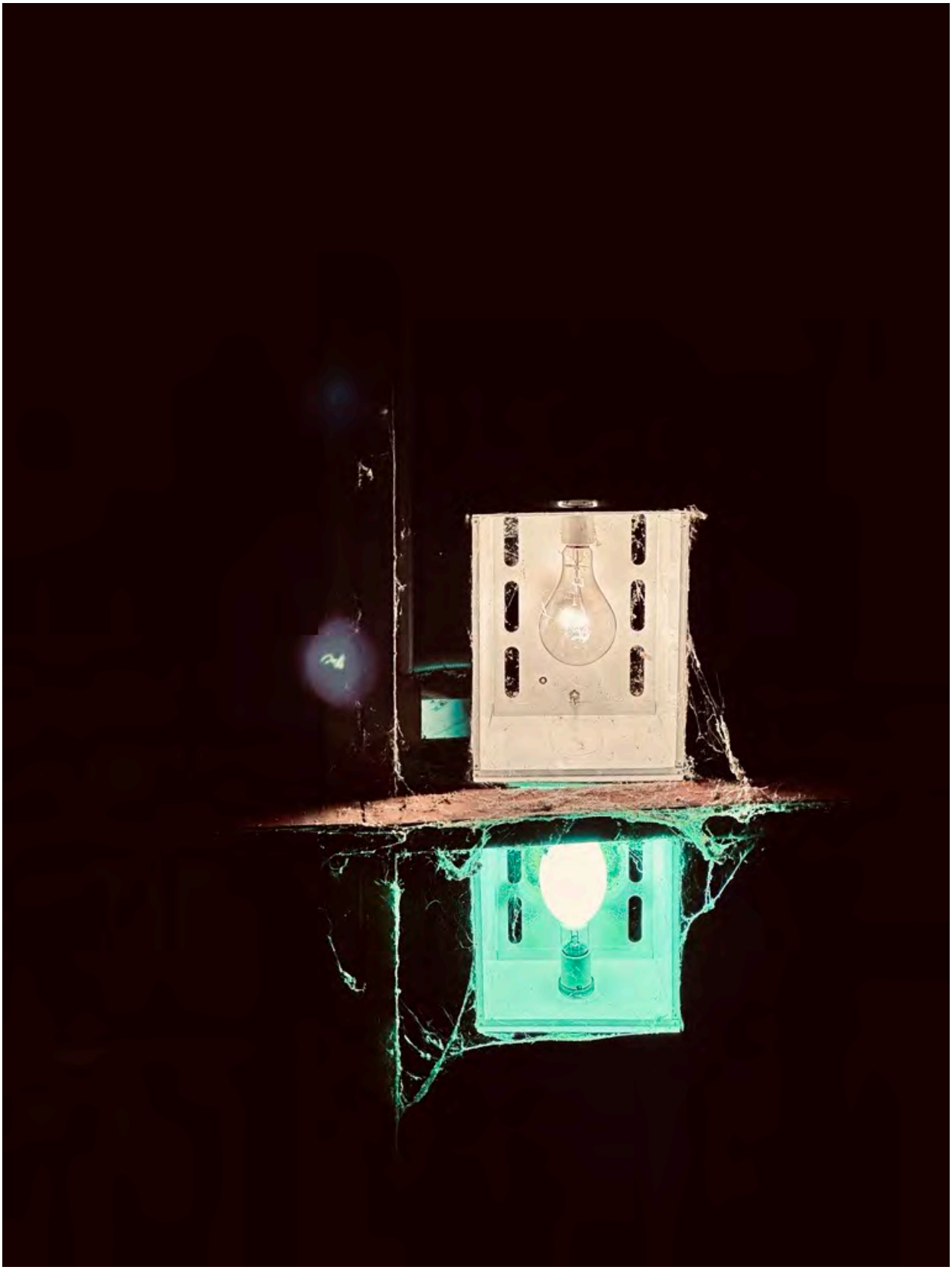

Figure A.8: One Incandescent Bulb Operating at 25 Hz and One at 60 Hz

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Figure A.9: Synchronization Panel at Control Center

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Request for Proposals
"Installation and Implementation of a Grid Control System (GCS)"

"November 06, 2024"

Appendix "E"

Sample Contract for: Installation and Implementation of a Grid Control System (GCS)

PROFESSIONAL SERVICES AGREEMENT
BETWEEN
SEWERAGE AND WATER BOARD OF NEW ORLEANS
AND
NAME OF CONTRACTOR
RFQ/RFP NUMBER
TITLE OF RFQ/RFP

Sample

THIS PROFESSIONAL SERVICES AGREEMENT (the "**Agreement**") is entered into by and between the Sewerage & Water Board of New Orleans, represented by **GHASSAN KORBAN, EXECUTIVE DIRECTOR** (the "**Board**"), and **NAME OF CONTRACTOR**, represented by **NAME AND TITLE OF INDIVIDUAL INDICATED IN PROOF OF SIGNING AUTHORITY** (the "**Contractor**"). The Board and the Contractor may sometimes be collectively referred to as the "**Parties**." The Agreement is effective as of the date of execution by the Board (the "**Effective Date**").

RECITALS

WHEREAS, on **DATE OF RFQ**, the Board issued a request for proposals **RFQ NUMBER** seeking qualified persons to provide professional services including **SHORT DESCRIPTION OF SERVICES** (the "**RFQ**");

WHEREAS, the Contractor submitted a proposal dated **DATE OF PROPOSAL**, and the Board has selected the Contractor to perform the professional services described in the RFQ.

WHEREAS, on **DATE OF RFP**, the Board issued a request for proposals **RFP NUMBER** to qualified contractors under the RFQ to provide professional services including **SHORT DESCRIPTION OF SERVICES** (the "**RFP**"); and

WHEREAS, the Contractor submitted a proposal dated **DATE OF PROPOSAL**, and the Board has selected the Contractor to perform the professional services described in the RFP.

WHEREAS, on **DATE OF RFP**, the Board issued a request for proposals **RFP NUMBER** seeking qualified persons to provide professional services including **SHORT DESCRIPTION OF SERVICES** (the "**RFP**"); and

WHEREAS, the Contractor submitted a proposal dated **DATE OF PROPOSAL**, and the Board has selected the Contractor to perform the professional services described in the RFP.

NOW THEREFORE, the Board and the Contractor agree as follows:

ARTICLE I - THE CONTRACTOR'S OBLIGATIONS

A. ***Services*****.** The Contractor will, in accordance with the schedule approved by the Board:

1. INSERT SCOPE OF SERVICES, TASKS, DELIVERABLES, ELSE IN ACCORDANCE WITH EITHER THE RFQ/RFP OR CONTRACTOR'S PROPOSAL;

2. Perform all other services and obligations as set forth in any the following documents that are incorporated fully into this Agreement: the RFQ AND/OR RFP; the Contractor's proposal dated **DATE OF PROPOSAL**.

3. Submit complete and accurate invoices, maintain records, submit to audits and inspections, maintain insurance, and perform all other obligations of the Contractor as set forth in this Agreement;

4. Promptly correct any errors or omissions and any work deemed unsatisfactory or unacceptable by the Board, at no additional compensation;

5. Monitor, supervise, and otherwise control and be solely responsible for all persons performing work on its behalf;

6. Perform all requirements set forth in La. R.S. 38:2192, including without limitation the payment of any associated costs, and submit a copy of any recorded documents to the Board within 30 days after the approval of the associated plan change or amendment; and

7. Cooperate with the Board and any person performing work for the Board.

The Board's officers and employees are not authorized to request or instruct the Contractor to perform any work beyond the scope or duration of this Agreement in the absence of an executed amendment to this Agreement.

B. ***Standards*****.** The Contractor, and any person performing work on its behalf, will perform all work under this Agreement in accordance with **IDENTITY ANY PROFESSIONAL OR OTHER STANDARDS YOU ARE AWARE OF AND THAT ARE SPECIFICALLY APPLICABLE TO THESE SERVICES**.

C. ***Compliance with Laws*****.** The Contractor, and any person performing work on its behalf, will comply with all applicable federal, state, and local laws and ordinances, including, without limitation, **IDENTIFY ANY LEGAL REQUIREMENTS THAT YOU ARE AWARE OF AND THAT ARE SPECIFICALLY APPLICABLE TO THESE SERVICES**.

D. ***Schedule*****.**

1. The Contractor will perform all work under this Agreement according to the following schedule:

INSERT APPLICABLE SCHEDULE

The Contractor will submit a proposed progress schedule to the Board within 14 calendar days of receiving written authorization to proceed from the Board. At a minimum, the proposed progress schedule must include the following information and be arranged so that actual progress can be shown as work is completed: **INSERT ANY APPLICABLE SCHEDULE REQUIREMENTS**.

2. The Board has the sole right to approve, reject, or require changes to all schedules relating to the performance of this Agreement, including, without limitation, any proposed progress schedule and any requests for modifications.

3. The Contractor acknowledges and agrees that time is of the essence in the performance of this Agreement.

E. ***Invoices*****.**

1. The Contractor will submit **INSERT CHOICE BETWEEN MONTHLY – QUARTERLY – OR OTHER** invoices for work performed under this Agreement to the Board no later than 10 calendar days following the end of the period covered by the invoice. Untimely invoices may result in delayed payment for which the Board is not liable. At a minimum, each invoice must include the following information and supporting documentation: **LIST INFORMATION AND DOCUMENTS REQUIRED TO BE SUBMITTED WITH INVOICE**.

2. All invoices must be signed by an authorized representative of the Contractor under penalty of perjury attesting to the validity and accuracy of the invoice.

3. The Board may require changes to the form of the invoice and may require additional supporting documentation to be submitted with invoices.

F. ***Records and Reporting*****.**

1. The Contractor will maintain all books, documents, papers, accounting records, invoices, materials records, payrolls, work papers, personnel records, and other evidence pertaining to the performance of services under this Agreement, including, without limitation, of costs incurred through the

Sample

later of *[3 years under Public Records Law unless a different number is required by specific law or policy/regulation]* years from: (a) the completion of this Agreement (including any renewal or extension periods); or (b) from the resolution of any dispute relating to the Agreement. If this Agreement is terminated for any reason, the Contractor will deliver to the Board all plans and records of work compiled through the date of termination.

2. The Contractor will identify any reporting requirements, including the frequency, method and contents.

3. The Contractor is solely responsible for the relevance and accuracy of all items and details included in any reports relating to the work performed under this Agreement, regardless of any review by the Board.

G. ***Audit and Inspection*.**

1. The Contractor will submit to any Board audit, inspection, and review and, at the Board's request, will make available all documents relating or pertaining to this Agreement maintained by or under the control of the Contractor, its employees, agents, assigns, successors and subcontractors, during normal business hours at the Contractor's office or place of business in Louisiana. If no such location is available, the Contractor will make the documents available at a time and location that is convenient for the Board.

2. Administrative and financial records shall be made and kept by the contractor in accordance with generally accepted accounting principles and practices. Records shall include, but are not limited to, accounting records, daily reports, change order requests, correspondences and subcontract files (hard copies as well as computer readable data, if can be made available). Records must be retained and made available upon request for a minimum of five (5) years following completion or formal acceptance of the contracted project

3. The Contractor will abide by all provisions of Board Code § 2-1120, including but not limited to Board Code § 2-1120(12), which requires the Contractor to provide the Office of Inspector General with documents and information as requested. Failure to comply with such requests shall constitute a material breach of the contract. The Contractor agrees that it is subject to the jurisdiction of the Orleans Parish Civil District Court for purposes of challenging a subpoena.

H. ***Insurance*.**

1. Except as otherwise noted, always during this agreement or the performance of work required by this Agreement, the Contractor will maintain the following insurance in full force and effect for the duration of the work under this Agreement:

a. **Minimum Requirements**:

Contractor shall maintain at his own expense and in good standing, such insurance as will protect the Board, the City of New Orleans, their officers, officials, employees, boards, commissions, and volunteers, and the Contractor himself, 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. The coverage shall contain no special limitations on the scope of protection afforded to the Board or the City. Both the Board and the City shall appear as "Additional Insured" on all Commercial General Liability and Business Automobile Insurance. Any failure to comply with reporting provisions of the policy shall not affect coverage provided to the Board and the City, their officers, officials, employees, boards and commissions, and volunteers. The Contractor's insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

Sample

If this transaction requires the Contractor or subcontractor's employees to enter the Board's facilities or job sites, a senior employee of the Contractor and/or any subcontractor will review the Board's Safety Orientation Notice (Notice), and will explain this Notice to every employee who will enter Board facilities. This Notice is included as a part of the specifications for this contract.

Contractor and its insurers shall agree to waive all rights of subrogation, except on their Professional Liability Policy, against the Board, the City, and their officers, officials, employees, boards and commissions, and volunteers for losses arising from work performed by the Contractor for the Board and the City. Each insurance policy required by this contract shall be endorsed to state that coverage shall not be suspended, voided or canceled by either party, or reduced in coverage or in limits except after thirty (30) days prior written notice by certified mail, return receipt requested, that has been given to the Risk Manager of the Board. In general, insurance is to be placed with insurers with a Best's rating of at least A-, although this requirement may be reviewed and modified by the Risk Manager of the Board in the best interest of the Board. The Risk Manager may also consider performing such review upon written request from Contractor. Contractor shall furnish the Board with certificates of insurance affecting coverage required by this contract. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf.

The certificates of insurance are to be received and approved by the Risk Manager of the Board before work commences. In the event of a claim, Contractor shall make applicable insurance policies available for review by the Board. Contractor shall retain its rights to restrict disclosure of Contractor's proprietary information.

The following are the types of insurance policies and the minimum limits of insurance coverage which shall be maintained by Contractor during the entire term of the Contract:

1. WORKER'S COMPENSATION AND EMPLOYER'S LIABILITY INSURANCE, as will protect him from claims under Worker's Compensation Laws. The Worker's Compensation section of the policy shall afford statutory limits and be in accordance with all Louisiana Worker's Compensation Statutes. The Employers' Liability limit shall not be less than $1,000,000 each accident for bodily injury by accident and $1,000,000 each employee/policy limit for bodily injury by disease. Whenever any vessel or floating equipment is involved, the insurance shall afford coverage under the Federal Longshoremen's and Harbor Worker's Act, and shall also include protection for injuries and/or death to Master's and Members of the crews of vessels with statutory limits in accordance with the Jones Act.

2. COMMERCIAL LIABILITY INSURANCE, with a limit of not less than $1,000,000 each occurrence and $2,000,000 general aggregate, including Explosion, Collapse, and Underground Property Damage Hazards. The Products-Completed Operations aggregate limit shall not be less than $1,000,000 each occurrence. The general aggregate limit shall apply separately to this project.

3. BUSINESS AUTOMOBILE INSURANCE, which shall cover liability arising from any auto (including owned, hired, and non-owned vehicle). The limit of liability shall not be less than $1,000,000 combined single limit each

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accident for all injuries, property damage and/or death resulting from any one occurrence.

b. Other Insurance Provisions. The insurance policies are to contain, or be endorsed to contain, the following provisions:

i. Additional Insured Status. **The Contractor will provide, and maintain current, a Certificate of Insurance naming The Board of New Orleans, its departments, political subdivisions, officers, officials, employees, and volunteers are to be covered as "Additional Insureds"** on the CGL policy with respect to liability arising out of the performance of this agreement. General liability coverage can be provided in the form of an endorsement to the Contractor's insurance (at least as broad as ISO Form CG 20 10 11 85 or both CG 20 10 and CG 20 37 forms if later revisions used). The Certificate of Insurance, as evidence of all required coverage, should name the Sewerage and Water Board of New Orleans Risk Manager as Certificate holder and be delivered via U.S. Mail to _____, New Orleans, LA _____.

ii. Primary Coverage. For any claims related to this contract, **the Contractor's insurance coverage shall be primary** insurance as respects the Board, its departments, political subdivisions, officers, officials, employees, and volunteers. Any insurance or self-insurance maintained by the Board shall be non- contributing to the Contractor's coverage.

iii. Claims Made Policies. If applicable, the retroactive date must be shown and must be before the date of the contract or the beginning of work. If the coverage is canceled or non-renewed, and not replaced with another claims-made policy, Contractor must purchase "extended reporting" coverage for minimum of 5 years after the termination of this agreement

iv. Waiver of Subrogation. **The Contractor and its insurers agree to waive any right of subrogation** which any insurer may acquire against the Board by virtue of the payment of any loss under insurance required by this contract.

v. Notice of Cancellation. Each insurance policy required above shall provide that **coverage shall not be canceled, except with prior notice to the Board of no less than 60 days**.

vi. Acceptability of Insurers. Insurance is to be placed with **insurers licensed and authorized to do business in the State of Louisiana with a current A.M. Best's rating of no less than A: VII**, unless otherwise acceptable to the Board.

2. The Contractor will provide the Board's Risk Manager (at Sewerage and Water Board of New Orleans Attn: Risk Manager, _____, New Orleans, LA 70165 – Ref.: **INSERT TITLE AND NUMBER OF RFQ OR RFP**) within 10 calendar days of the Effective Date and at any other time at the Board's request the following documents:

a. Proof of coverage for each policy of insurance required by this Agreement;

b. Copy of the fully executed Agreement;

c. Copies of all policies of insurance, including all policies, forms, and endorsements; and

d. Statements disclosing any policy aggregate limit.

3. Without notice from the Board, the Contractor will:

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a. Replenish any policy aggregate limit that is impaired before commencement of any work or continuation of any work under this Agreement;

b. Substitute insurance coverage acceptable to the Board within 30 calendar days if any insurance company providing any insurance with respect to this Agreement is declared bankrupt, becomes insolvent, loses the right to do business in Louisiana, or ceases to meet the requirements of this Agreement; and

c. Notify the Board's Risk Manager in writing within 48 hours of its receipt of any notice of non-renewal, cancellation, or reduction in coverage or limits affecting any policy of insurance maintained under this Agreement.

I. ***Indemnity*.**

1. To the fullest extent permitted by law, the Contractor will indemnify, defend, and hold harmless the Board, its agents, employees, officials, insurers, self-insurance funds, and assigns (collectively, the "**Indemnified Parties**") from and against any and all claims, demands, suits, and judgments of sums of money accruing against the Indemnified Parties: for loss of life or injury or damage to persons or property arising from or relating to any act or omission or the operation of the Contractor, its agents, subcontractors, or employees while engaged in or in connection with the discharge or performance of any work under this Agreement; and for any and all claims and/or liens for labor, services, or materials furnished to the Contractor in connection with the performance of work under this Agreement.

2. Limitation. The Contractor's indemnity does not extend to any loss arising from the gross negligence or willful misconduct of any of the Indemnified Parties, provided that neither the Contractor nor any of its agents, subcontractors, or employees contributed to such gross negligence or willful misconduct.

3. Independent Duty. The Contractor has an immediate and independent obligation to, at the Board's option: (a) defend the Board from or (b) reimburse the Board for its costs incurred in the defense of any claim that actually or potentially falls within this indemnity, even if: (a) the allegations are or may be groundless, false, or fraudulent; or (b) the Contractor is ultimately absolved from liability.

4. Expenses. Notwithstanding any provision to the contrary, the Contractor shall bear the expenses including, but not limited to, the Board's reasonable attorney fees and expenses, incurred by the Board in enforcing this indemnity.

ARTICLE II - REPRESENTATIONS AND WARRANTIES

A. The Contractor represents and warrants to the Board that:

1. The Contractor, through its duly authorized representative, has the full power and authority to enter into and execute this Agreement;

2. The Contractor has the requisite expertise, qualifications, staff, materials, equipment, licenses, permits, consents, registrations, and certifications in place and available for the performance of all work required under this Agreement;

3. The Contractor is bonded, if required by law, and fully and adequately insured for any injury or loss to its employees and any other person resulting from the actions or omissions of the Contractor, its employees, or its subcontractors in the performance of this Agreement;

4. The Contractor is not under any obligation to any other person that is inconsistent or in conflict with this Agreement or that could prevent, limit, or impair the Contractor's performance of this Agreement;

5. The Contractor has no knowledge of any facts that could prevent, limit, or impair the performance of this Agreement, except as otherwise disclosed to the Board and incorporated into this Agreement;

6. The Contractor is not in breach of any federal, state, or local statute or regulation applicable to the Contractor or its operations;

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7. Any rate of compensation established for the performance of services under this Agreement are no higher than those charged to the Contractor's most favored customer for the same or substantially similar services;

8. The Contractor has read and fully understands this Agreement and is executing this Agreement willingly and voluntarily; and

9. All of the representations and warranties in this Article and elsewhere in this Agreement are true and correct as of the date of this Agreement by the Contractor and the execution of this Agreement by the Contractor's representative constitutes a sworn statement, under penalty of perjury, by the Contractor as to the truth of the foregoing representations and warranties.

B. ***Convicted Felon Statement*****.** The Contractor complies with Board Code § 2-8(c) and no principal, member, or officer of the Contractor has, within the preceding 5 years, been convicted of, or pled guilty to, a felony under state or federal statutes for embezzlement, theft of public funds, bribery, or falsification or destruction of public records.

C. ***Non-Solicitation Statement*****.** The Contractor has not employed or retained any company or person, other than a bona fide employee working solely for it, to solicit or secure this Agreement. The Contractor has not paid or agreed to pay any person, other than a bona fide employee working for it, any fee, commission, percentage, gift, or any other consideration contingent upon or resulting from this Agreement.

D. ***Conflict of Interest*****.** The Contractor expressly acknowledges that this Agreement is for the performance of professional legal services on behalf of the Client, the Board. Therefore, Contractor further acknowledges that it is bound by the Louisiana Rules of Professional Conduct. Contractor represents that it has performed a conflict check and affirms that no actual, perceived or potential conflicts exist. Contractor acknowledges that it has an ongoing obligation to identify potential conflicts and to decline representation which presents a conflict. Any request for a conflict waiver must be presented to the Board Attorney in writing in accordance with the Louisiana Rules of Professional Conduct. Nevertheless, the Board Attorney is under no obligation to approve conflict waiver requests.

E. ***Employee Verification*****.** The Contractor swears that (i) it is registered and participates in a status verification system to verify that all employees in the State of Louisiana are legal citizens of the United States or are legal aliens; (ii) it shall continue, during the term of this Agreement, to utilize a status verification system to verify the legal status of all new employees in the State of Louisiana; and (iii) it shall require all subcontractors to submit to the Contractor a sworn affidavit verifying compliance with items (i) and (ii) above. Any violation of the provisions of this paragraph may subject this Agreement to termination and may further result in the Contractor being ineligible for any public contract for a period of 3 years from the date the violation is discovered. The Contractor further acknowledges and agrees that it shall be liable for any additional costs incurred by the Board occasioned by the termination of this Agreement or the loss of any license or permit to do business in the State of Louisiana resulting from a violation of this provision. The Contractor will provide to the Board an affidavit attesting to the above provisions if requested by the Board. The Board may terminate this Agreement for cause if the Contractor fails to provide such the requested affidavit or violates any provision of this paragraph.

> ***Employee Verification*****.** The Contractor swears that (i) it is in compliance with La. R.S. 38:2212.10, and is registered and participates in a status verification system to verify that all employees in the State of Louisiana are legal citizens of the United States or are legal aliens; (ii) it shall continue, during the term of this Agreement, to utilize a status verification system to verify the legal status of all new employees in the State of Louisiana; and (iii) it shall require all subcontractors to submit to the Contractor a sworn affidavit verifying compliance with items (i) and (ii) above. Any violation of the provisions of this paragraph may subject this Agreement to termination and may further result in the Contractor being

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ineligible for any public contract for a period of 3 years from the date the violation is discovered. The Contractor further acknowledges and agrees that it shall be liable for any additional costs incurred by the Board occasioned by the termination of this Agreement or the loss of any license or permit to do business in the State of Louisiana resulting from a violation of La. R.S. 38:2212.10. The Contractor will provide to the Board an affidavit attesting to the above provisions if requested by the Board. The Board may terminate this Agreement for cause if the Contractor fails to provide such the requested affidavit or violates any provision of this paragraph.

F. The Contractor acknowledges that the Board is relying on these representations and warranties and Contractor's expertise, skill, and knowledge and that the Contractor's obligations and liabilities will not be diminished by reason of any approval by the Board.

ARTICLE III - THE BOARD'S OBLIGATIONS

A. ***Administration*.** The Board will:

1. Administer this Agreement through the **NAME OF THE BOARD DEPARTMENT RESPONSIBLE FOR MONITORING THIS AGREEMENT**;

2. Provide the Contractor **IDENTIFY ANY SPECIFIC DOCUMENTS TO BE PROVIDED** and other documents deemed necessary for the Contractor's performance of any work required under this Agreement;

3. Provide access to Department personnel to discuss the required services during normal working hours, as requested by the Contractor; and

4. **INSERT ANY ADDITIONAL OBLIGATIONS FOR THE BOARD**.

B. ***Payment*.** The Board will make payments to the Contractor at the rate of compensation established in this Agreement based upon the Contractor's certified invoices, except:

1. The Board's obligation to pay is contingent upon the Contractor's: (a) submission of a complete and accurate invoice; (b) satisfactory performance of the services and conditions required by this Agreement;

2. The Board, in its discretion, may withhold payment of any disputed amounts, and no interest shall accrue on any amount withheld pending the resolution of the dispute;

3. The Board may set off any amounts due to the Contractor against any amounts deemed by the Board to be owed to the Board by the Contractor pursuant to this Agreement; and

4. All compensation owed to the Contractor under this Agreement is contingent upon the appropriation and allocation of funds for work under this Agreement by the Board.

5. The Board is not obligated under any circumstances to pay for any work performed or costs incurred by the Contractor that: exceed the maximum aggregate amount payable established by this Agreement; are beyond the scope or duration of this Agreement; arise from or relate to the any change order within the scope of the Agreement; are for services performed on days on which services were suspended, due to circumstances beyond the control of the Board, and no work has taken place; arise from or relate to the correction of errors or omissions of the Contractor or its subcontractors; or the Board is not expressly obligated to pay under this Agreement.

6. If this Agreement is terminated for any reason, the Board will pay the Contractor only for the work requested by the Board and satisfactorily performed by the Contractor through the date of termination, except as otherwise provided in this Agreement.

ARTICLE IV - COMPENSATION

A. ***Rate of Compensation*.**

1. The Board will pay the Contractor in accordance with the following rate: **INSERT RATE OF COMPENSATION**.

2. This Agreement does not guarantee any amount of work or compensation except as specifically authorized by the Board in accordance with the terms and conditions of this Agreement.

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3. The stated compensation is inclusive, and includes no additional amounts for, the Contractor's costs, including without limitation all expenses relating to overhead, administration, subcontractors, employees, bid preparation, bonds, scheduling, invoicing, insurance, record retention, reporting, inspections, audits, the correction of errors and omissions, or minor changes within the scope of this Agreement. The Board will not consider or be obligated to pay or reimburse the Contractor any other charges or fees and the Contractor will not be entitled to any additional compensation or reimbursement, except otherwise specifically provided in the Agreement.

4. The Contractor immediately will notify the Board in writing of any reduction to the rate of compensation for its most favored customer and the rate of compensation established by this Agreement automatically will adjust to the reduced rate effective as of the effective date of the reduction for the most favored customer.

B. ***Maximum Amount*****.** The maximum aggregate amount payable by the Board under this Agreement is $**INSERT NUMERICAL MAXIMUM DOLLAR AMOUNT AND ALSO SPELL IT OUT TO AVOID CONFUSION OR NUMERICAL TYPOS**.

ARTICLE V - DURATION AND TERMINATION

A. ***Initial Term*****.** A contract period up to four (4) years is anticipated with initiation of the contract period following approval by the SWBNO Board of Directors and issuance of Notice to Proceed. The tentative date is scheduled for (date) and will end (date). However, SWBNO reserves the right to, at its discretion and with the agreement of the selected contractor to extend the contract for one (1) additional year if needed. The term of the base contract and any extensions shall not exceed five (5) years

B. ***Termination for Convenience*****.** The Board may terminate this Agreement at any time during the term of the Agreement by giving the Contractor written notice of the termination at least 30 calendar days before the intended date of termination.

C. ***Termination for Non-Appropriation*****.** This Agreement will terminate immediately in the event of non-appropriation of funds enough to maintain this Agreement without the requirement of notice and the Board will not be liable for any amounts beyond the funds appropriated and encumbered for this Agreement.

D. ***Termination for Cause*****.** The Board may terminate this Agreement immediately for cause by sending written notice to the Contractor. "Cause" includes, without limitation any failure to perform any obligation or abide by any condition of this Agreement or the failure of any representation or warranty in this Agreement, including without limitation any failure to comply with the requirements of the Board's Disadvantaged Business Enterprise program and any failure to comply with any provision of Board Code § 2-1120 or requests of the Office of Inspector General. If a termination for cause is subsequently challenged in a court of law and the challenging party prevails, the termination will be deemed to be a termination for convenience effective 30 days from the date of the original written notice of termination for cause was sent to the challenging party; no further notice will be required.

E. ***Suspension*****.** The Board may suspend this Agreement at any time and for any reason by giving 2 business day's written notice to the Contractor. The Contractor will resume work upon 5 business day's written notice from the Board.

ARTICLE VI – DECLARED DISASTER

A. ***Declaration*****.** During the declaration of an emergency by federal, state, and/or local government, the Contractor shall provide support to the Board on an as-needed and task-order-driven basis. Because of the uncertainty of the scale and/or type of emergency, the services to be provided by the Contractor will vary and may need to be adjusted as needs are identified. The Contractor may be requested to provide a range of services. Said services may need to be rendered on a continual basis (24 hours / 7 days per week) during the declaration of an emergency.

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B. *Task Order. Notification and Personnel*. Prior or during the declaration of an emergency, the Board will notify the Contractor via task order if the Board requires the Contractor's support. Upon activation by task order, the Contractor will provide the Board with contact information of personnel assigned to the task order; and coordinate with the Board to identify any personnel available to meet the Board's needs.

C. *Purchase Order*. Once services are identified, the Board will issue a purchase order to the Contractor. The Board will issue a subsequent purchase order in case of additional needs for services or may issue a modified purchase order if changes are made to the initial purchase order.

D. The Contractor will ensure that the Board is provided with timely and accurate reports and other documentation, as requested.

ARTICLE VII - PERFORMANCE MEASURES

A. *Factors*. The Board will measure the performance of the Contractor according to the following non-exhaustive factors: work performed in compliance with the terms of the Agreement; staff availability; staff training; staff professionalism; staff experience; customer service; communication and accessibility; prompt and effective correction of situations and conditions; timeliness and completeness of submission of requested documentation (such as records, receipts, invoices, insurance certificates, and computer-generated reports).

B. *Failure to Perform*. If the Contractor fails to perform according to the Agreement, the Board will notify the Contractor. If there is a continued lack of performance after notification, the Board may declare the Contractor in default and may pursue any appropriate remedies available under the Agreement and/or any applicable law. In the event of a notification of default, the Board will invoice the defaulting contractor for any increase in costs and other damages sustained by the Board. Further, the Board will seek full recovery from the defaulting contractor.

ARTICLE VIII - LIVING WAGES

To the fullest extent permitted by law, the Contractor agrees to abide by Board Code sections 70-801, *et seq.*, which requires payment of a wage to covered employees equal to the amounts defined in the Code ("**Living Wage**"). If the Contractor fails to comply with the requirements of the Living Wage during the term of the Agreement, said failure may result in termination of the Agreement or the pursuit of other remedies by the Board.

ARTICLE IX - DISADVANTAGED BUSINESS ENTERPRISE ("DBE") PROGRAM

In accordance with the adoption of Resolution R231-97, the Sewerage and Water Board of New Orleans has established a race and gender-neutral Disadvantaged Business Enterprise (DBE) Plan. The prime contractor shall be required to make a demonstrated good faith effort to award (7%) percent of the amount of the contract to certified disadvantaged business enterprises as **service providers or suppliers performing commercial useful functions which are consistent with the services or supplies required on this contract.** The percent participation having been determined for this specific contract by recommendation of the **Staff Contract Review Committee (SCRC),** which is comprised of Sewerage and Water Board staff members. This percentage requirement shall be considered an informality which is subject to modifications and may be waived or adjusted by the Sewerage and Water Board of New Orleans if the prime contractor, after having demonstrated a good faith effort, is unable to comply with the requirement.

DEMONSTRATED GOOD FAITH EFFORTS

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Before receiving an award of the contract, the contractor must meet the DBE goals or prove that he/she has made a demonstrated good faith effort. To determine whether a particular contract bidder has made demonstrated good faith efforts to reach the DBE participation goal, the Board and its staff will consider the following:

a. whether the contractor attended all pre-bid meetings that may have been scheduled by the Board to inform DBE firms of subcontracting opportunities and/or requested the Board Directory of Certified DBE firms;

b. whether the contractor advertised in general circulation and trade association publications, concerning the DBE subcontracting opportunities, and allowed the subcontractors reasonable time to respond;

c. whether the contractor provided written notice to a reasonable number of individually named DBE firms and allowed enough time for the DBE firms to participate effectively;

d. whether the contractor followed up initial solicitations of interest by contacting DBEs to determine with certainty whether the DBEs were interested in bidding;

e. whether the contractor selected specific portions of the work to be performed by DBEs in order to increase the likelihood of meeting the DBE goals (including breaking down contracts into smaller units to facilitate DBE participation);

f. whether the contractor provided interested DBEs with adequate information about the plans, specifications and requirements of the contract;

g. whether the contractor negotiated in "good faith" with interested DBEs and did not reject DBEs as unqualified without sound reasons based on a thorough investigation of their capabilities;

h. if the contractor did reject a DBE as unqualified, the contractor must state his or her reason for doing so in writing;

i. whether the contractor has used the services of available community organizations and small and/or disadvantaged business groups, local, state and federal small or disadvantage business assistance offices; and other organizations that aid in the recruitment and placement of DBE firms;

j. whether the contractor has made enough efforts to negotiate with DBEs for specific sub-bids, including at a minimum:

(1) names, addresses, telephone numbers of DBEs that the contractor contacted,

(2) a description of information provided to those DBE firms, and

(3) a statement of why additional agreements with DBEs were not reached to include but not limited to proof the DBEs' price exceeded that of non-DBEs.

1. <u>Policy</u>:

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It is the policy of the Board that DBE firms, as defined in the Board's Disadvantaged Business Enterprise Plan, shall have the maximum allowable opportunity to compete for the award of the participation in the performance of the Board's publicly bid contracts. Consequently, the SCRC and the Board have set the DBE participation goal applicable to this Professional Service and/or Goods and Service contract.

2. DBE Obligation:

The Board and its contractors agree to ensure that DBEs, as defined in the Board's Disadvantaged Business Enterprises Plan, shall have the maximum allowable opportunity to compete for the award of the participation in the performance of contracts and subcontracts provided under this agreement. In this regard, contractors shall take all necessary and reasonable steps in accordance with this DBE Plan to ensure that DBEs have the maximum allowable opportunity to compete for such contracts. The Board and its contractors shall not discriminate based on race, color, national origin, or sex in the award and performance of the Board's publicly bid contracts.

3. Utilization of DBE Vendor Listings:

All bidders are required to utilize the most recent Sewerage and Water Board State-Local Disadvantaged Business Enterprise Program Approved Vendor Listings for **Goods & Services/Professional Services**, in their selection of DBE entities to meet DBE participation goals. **Bidders are required to utilize DBE's as service providers or suppliers only in the areas for which they are certified. A description of the areas of work that DBE's can provide is contained in the vendor listings.** In addition, an alphabetical list of vendors/contractors is provided indicating the name of the company, address, name of owner, telephone number, fax number, the date the company became certified, and a description of the work that these entities are certified to perform. **Companies that are already certified as a DBE cannot fulfill the DBE requirements by listing themselves as the subcontractor to meet the DBE goal. The prime contractor shall select another DBE from the Sewerage and Water Board's Approved Vendor Listing.**

4. Contacting DBE's and Obtaining a Firm Price:

All prime contractors/vendors are required to contact DBE's and obtain a firm price before listing the DBE's on the Participation Summary Sheet. As confirmation of established contact, bidder will include with their Participation Summary Sheet submission a signed correspondence from the SLDBE subcontractor on their own letterhead that reaffirms negotiated terms such as scope of work and monetary compensation.

5. Failure to Comply with DBE Bid Specifications:

All bidders for this Board contract are hereby notified that failure to comply with the above DBE specifications may constitute the bid as being non-responsive, and sufficient cause for rejection.

6. Failure to Carry Out DBE Policy:

All bidders, potential contractors, or subcontractors for this Board contract are hereby notified that failure to comply with the DBE policy and DBE obligations, set forth above, shall constitute a breach of contract which may result in termination of the contract or such other remedy as deemed appropriate by the Board, to include excluding bidder from bidding on future Board contracts.

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7. Setting Minimum Participation Goals:

The stated minimum percentage DBE participation goal recommended by SCRC and approved by the Board applies to the work of this contract. Bids which are not accompanied by a properly completed Schedule of DBE Participation Summary Sheet showing that at least the percentage goal of the total contract bid price will be subcontracted or otherwise awarded through procurement action to DBEs shall be considered unresponsive, unless:

a. An affidavit is furnished by the bidder with its bid showing that the DBE goals cannot be met for the following reasons:

1) No DBE firms made offers. Here, it must be shown, documented and demonstrated that good faith efforts (as defined in Part III, D, 2. of the Board's DBE plan) were made by the bidder to obtain the participation of DBE firms and that they did not respond, or

2) The DBE offers made and accepted for subcontract and/or material supplies do not total the stated goal for participation, but total a lesser percentage, and

3) The bidder was unable to obtain DBE further participation, despite his or her demonstrated good faith efforts (as defined in Part III, D, 2 of the Board's DBE Plan) to obtain additional participation by DBE firms.

b. Each of the assertions made by the bidder must be supported by documentary evidence.

8. Other Clauses Unaffected:

Nothing contained herein shall invalidate, change, annul, release, restrict, or affect the liability on the bonds or insurance given by the contractor or the time required for completion of the contract.

9. Determination of Efforts to Meet Goals:

Initial determination of bidder efforts to meet the DBE participation goal shall be based on the DBE participation representations submitted with the bid. Bidders shall submit all the forms required herein with their bids, and the DBE office will examine the contents thereof. The Board's DBE Officer may, if deemed advisable, request further information, explanation, or justification from any bidder.

10. Contract Monitoring:

a. The Board's DBE Office will monitor contractor during the operation of the contract to ensure that the contractor meets all its DBE obligations as specified in the contract bid. The Board's DBE office shall establish rules and regulations, to be approved by the Board, for the ongoing monitoring of contractor compliance.

b. Disadvantaged Business Enterprise Program Office personnel or their designated representative shall be allowed to conduct periodic monitoring of contractors' compliance with the agreed to Disadvantaged Business Enterprise Program participation requirements. Contractors shall be required to complete and return to the Disadvantaged Business Enterprise Program Office in the time required all requests for information and data relative to the contractors' activities in meeting

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the required Disadvantaged Business Enterprise participation goal. Additionally, Disadvantaged Business Enterprise Office personnel or their designated representative shall have access to contractor and subcontractor(s) records pertaining to, but not specifically limited to labor, costs and materials supplied and used on the Board contract, as well as inspection and photocopying of any and all contracts, agreements and correspondence relative to the Disadvantaged Business Enterprise contract participation requirements. Such inspection will be performed during normal business hours and will be conducted in such a fashion so as to minimize interference with production of the contract. Visits may be made to job sites, as well as to administrative offices of the contractor and subcontractor(s) participants. Such inspection and on-site visits may be scheduled with or without prior notice to the contractor or Disadvantaged Business Enterprise subcontractor participant. Contractors' failure to comply with these monitoring requirements may result in termination of the contract or such other remedy as deemed appropriate by Board.

11. Maintaining Records:

Subsequent to the completion of a contract, contractors are required to maintain for three (3) years such records as are necessary to determine compliance with their DBE obligations. During construction, or performance of the DBE obligations, contractors shall submit reports as requested to enable the DBE Office to monitor this compliance.

12. Umbrella Bonding:

On contracts where subcontracting exists and where practicable (i.e., when a substantial risk or financial hardship would not be incurred by the prime contractor), the contractor may use an umbrella bond to encompass the DBE firm.

13. Board Action to Seek Compliance:

The contractor consents to such appropriate actions taken to ensure that prime contractors and subcontractors comply with the DBE provisions, to include but not limited to:

a. desk audits to review all material, and information concerning the contractor's compliance;

b. on-site reviews that may include interviews, visits to project locations, and inspection of documents and/or information not available at the desk audit that pertains to the contractor's compliance;

c. any additional investigation that may be called for by a lack of proper record keeping, failure of the prime contractor to cooperate; failure of DBEs to cooperate; visible evidence unsatisfactory performance; other evidence as may warrant further investigation.

14. Non-Compliance Finding:

The Board staff will make compliance determinations regarding its prime contractors. Documentation of noncompliance will include the specific areas in which the contractors failed to

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comply. In these instances, appropriate legal action consistent with the DBE and other contract provisions will be taken.

15. Contractor's Duties

a. Record Keeping

Successful bidders shall establish and maintain records and submit regular reports to the DBE office as required, which will identify and assess progress in achieving DBE subcontract goals and other DBE participation efforts.

b. Failure to Comply with EDBP Participation Requirements

Failure to comply with any of the EDBP requirements of this contract shall constitute a violation of the terms and conditions of this contract and a cause for the termination of the contract at the option of the Board.

Such violations shall include, but not limited to:

Failing to meet the percentage participation requirements as set out in the contract documents.

Failing to use certified EDBP contractors/vendors in performing the scope of work as identified in the contract documents (EDBP participation summary sheet).

Failing to comply with the "monitoring of EDBP requirements" included herein as part of the contract, such as contractors:

Failure to submit quarterly report and any other necessary reports timely and adequately as required by the EDBP Office.

Failure to grant access to contractor/subcontractor records by EDBP Office personnel, and

Failure to allow on-site investigations and visits, etc.

Failing to report the removal or termination of a certified EDBP vendor/subcontractor.

Failing to secure authorization for replacement of certified EDBP subcontractors from the Director of the Economically Disadvantaged Business Program.

In Lieu of termination the Board, through the EDBP Office, may impose the following penalties:

Withhold from the contractor in violation up to 10% of all future payments due to the contractor, until such time as the violations have been corrected.

Withhold from the contractor in violation, all future payments until such time as the violations have been corrected.

c. Subcontract Clause

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All bidders and potential contractors must assure the Board that they will include the above clauses in all agreements, which offer further subcontracting opportunities.

d. Contract Award

Bidders are hereby advised that meeting DBE subcontract goals or making a demonstrated good faith effort to meet such goals are conditions of being awarded and maintaining construction, procurement, or professional services contracts by the Board.

e. Restrictions on DBE Subcontracting

No **DBE** subcontractor or vendor selected to perform work as a **DBE** on a Sewerage and Water Board contract will be allowed to subcontract any portion of its work to a Non-Board certified **DBE**, unless the work to be performed is necessary for the execution of the contract and there are no Board certified **DBE's** available to perform such work.

This process will require that each **DBE** participant performing work on a Sewerage and Water Board funded contract submit a request to subcontract out any portion of work deemed necessary for execution of the contract to the Board's **EDBP** office. On a form provided by the **EDBP** office, the **DBE** contractor or vendor will indicate the dollar amount of work to be subcontracted, the specific scope or nature of the work, the percentage of the total amount of work to be performed by the **DBE** subcontractor and vendor, and the entity to whom the work will be subcontracted.

Both prime and **DBE** subcontractors are advised that the failure to comply with these requirements may result in the loss of **DBE** certification and non-compliance by the prime contractor in meeting **DBE** contractual obligations.

f. Changes in DBE Participation

The prime contractor will not be allowed to make changes in DBE participation without submittal of a written request explaining reason, a revised Participation Summary Sheet and approval by the Director of the Economically Disadvantaged Business Program. Failure to comply with these requirements may result in non-compliance by the prime contractor in meeting DBE contractual obligations.

16. <u>POLICY TO ENHANCE THE USE OF DBE VENDORS</u>

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

The Sewerage and Water Board has a long-standing commitment to fairness and equal opportunity in hiring and contracting. As such, the workforce of contractors/vendors is encouraged to be representative of a diverse population. Achievement of the full benefits of diversity will only come when an attitude of inclusion is adopted.

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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.

17. 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.

ARTICLE X - NON-DISCRIMINATION

A. ***Equal Employment Opportunity*.** In all hiring or employment made possible by, or resulting from this Agreement, the Contractor (1) will not be discriminate against any employee or applicant for employment because of race, sex, color, religion, gender, age, physical or mental disability, national origin, sexual orientation, gender identity, creed, culture, or ancestry, and (2) where applicable, will take affirmative action to ensure that the Contractor's employees are treated during employment without regard to their race, sex, color, religion, gender, age, physical or mental disability, national origin, sexual orientation, gender identity, creed, culture, or ancestry. This requirement shall apply to, 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. All solicitations or advertisements for employment shall state that all qualified applicants will receive consideration for employment without regard to race, sex, color, religion, gender, age, physical or mental disability, national origin, sexual orientation, gender identity, creed, culture, or ancestry.

B. ***Non-Discrimination*.** In the performance of this Agreement, the Contractor will not discriminate on the basis, whether in fact or perception, of a person's race, color, creed, religion, national origin, ancestry, age, sex, gender, sexual orientation, gender identity, domestic partner status, marital status, physical or mental disability, or AIDS or HIV-status against (1) any employee of the Board working with the Contractor in any of the Contractor's operations within Orleans Parish or (2) any person seeking accommodations, advantages, facilities, privileges, services, or membership in all business, social, or other establishments or organizations operated by the Contractor. The Contractor agrees to comply with and abide by all applicable federal, state and local laws relating to non-discrimination, including, without limitation, Title VI of the Civil Rights Act of 1964, Section V of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990.

C. ***Incorporation into Subcontracts*.** The Contractor will incorporate the terms and conditions of this Article into all subcontracts, by reference or otherwise, and will require all subcontractors to comply with those provisions.

D. The Board may terminate this Agreement for cause if the Contractor fails to comply with any obligation in this Article, which failure is a material breach of this Agreement.

ARTICLE XI - INDEPENDENT CONTRACTOR

A. ***Independent Contractor Status*.** The Contractor is an independent contractor and shall not be deemed an employee, servant, agent, partner, or joint venture of the Board and will not hold itself or any of its employees, subcontractors or agents to be an employee, partner, or agent of the Board.

B. ***Exclusion of Worker's Compensation Coverage*.** The Board will not be liable to the Contractor, as an independent contractor as defined in La. R.S. 23:1021(6), for any benefits or coverage as provided by the Workmen's Compensation Law of the State of Louisiana. Under the provisions of La.

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R.S. 23:1034, any person employed by the Contractor will not be considered an employee of the Board for the purpose of Worker's Compensation coverage.

C. ***Exclusion of Unemployment Compensation Coverage*****.** The Contractor, as an independent contractor, is being hired by the Board under this Agreement for hire and defined in La. R.S. 23:1472(E) and neither the Contractor nor anyone employed by it will be considered an employee of the Board for the purpose of unemployment compensation coverage, which coverage same being hereby expressly waived and excluded by the parties, because: (a) the Contractor has been and will be free from any control or direction by the Board over the performance of the services covered by this contract; (b) the services to be performed by the Contractor are outside the normal course and scope of the Board's usual business; and (c) the Contractor has been independently engaged in performing the services required under this Agreement prior to the date of this Agreement.

D. ***Waiver of Benefits*****.** The Contractor, as an independent contractor, will not receive from the Board any sick and annual leave benefits, medical insurance, life insurance, paid vacations, paid holidays, sick leave, pension, or Social Security for any services rendered to the Board under this Agreement.

ARTICLE XII - NOTICE

A. ***In General*****.** Except for any routine communication, any notice, demand, communication, or request required or permitted under this Agreement will be given in writing and delivered in person or by certified mail, return receipt requested as follows:

1. To the Sewerage & Water Board of New Orleans:

   NAME AND ADDRESS OF THE BOARD DEPARTMENT RESPONSIBLE FOR MONITORING THIS AGREEMENT

   &

Sewerage & Water Board of New Orleans Office of the Special Counsel

   _____

   _____

   New Orleans, LA _____

2. To the Contractor:

   NAME AND ADDRESS OF POINT OF CONTACT FOR CONTRACTOR TO RECEIVE NOTICES

B. ***Effectiveness*****.** Notices are effective when received, except any notice that is not received due to the intended recipient's refusal or avoidance of delivery is deemed received as of the date of the first attempted delivery.

C. ***Notification of Change*****.** Each party is responsible for notifying the other in writing that references this Agreement of any changes in its address(es) set forth above.

ARTICLE XIII - ADDITIONAL PROVISIONS

A. ***Amendment*****.** No amendment of or modification to this Agreement shall be valid unless and until executed in writing by the duly authorized representatives of both parties to this Agreement.

B. ***Assignment*****.** This Agreement and any part of the Contractor's interest in it are not assignable or transferable without the Board's prior written consent.

C. ***Choice of Law*****.** This Agreement will be construed and enforced in accordance with the laws of the State of Louisiana without regard to its conflict of laws provisions.

D. ***Conflicting Employment*****.** To ensure that the Contractor's efforts do not conflict with the Board's interests, and in recognition of the Contractor's obligations to the Board, the Contractor will decline any offer of other employment if its performance of this Agreement is likely to be adversely affected by the acceptance of the other employment. The Contractor will promptly notify the Board in writing of its intention to accept the other employment and will disclose all possible effects of the other employment

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on the Contractor's performance of this Agreement. The Board will make the final determination whether the Contractor may accept the other employment.

E. ***Construction of Agreement*****.** Neither party will be deemed to have drafted this Agreement. This Agreement has been reviewed by all parties and shall be construed and interpreted according to the ordinary meaning of the words used so as to fairly accomplish the purposes and intentions of all parties. No term of this Agreement shall be construed or resolved in favor of or against the Board or the Contractor on the basis of which party drafted the uncertain or ambiguous language. The headings and captions of this Agreement are provided for convenience only and are not intended to have effect in the construction or interpretation of this Agreement. Where appropriate, the singular includes the plural and neutral words and words of any gender shall include the neutral and other gender.

F. ***Entire Agreement*****.** This Agreement, including all incorporated documents, constitutes the final and complete agreement and understanding between the parties. All prior and contemporaneous agreements and understandings, whether oral or written, are superseded by this Agreement and are without effect to vary or alter any terms or conditions of this Agreement.

G. ***Exhibits*****.** The following exhibits will be and are incorporated into this Agreement:

H. ***Jurisdiction*****.** The Contractor consents and yields to the jurisdiction of the Civil District Court of the Parish of Orleans and formally waives any pleas or exceptions of jurisdiction on account of the residence of the Contractor.

I. ***Limitations of the Board's Obligations*****.** The Board has no obligations not explicitly set forth in this Agreement or any incorporated documents or expressly imposed by law.

J. ***No Third-Party Beneficiaries*****.** This Agreement is entered into for the exclusive benefit of the parties and the parties expressly disclaim any intent to benefit anyone not a party to this Agreement.

K. ***Non-Exclusivity*****.** This Agreement is non-exclusive and the Contractor may provide services to other clients, subject to the Board's approval of any potential conflicts with the performance of this Agreement and the Board may engage the services of others for the provision of some or all of the work to be performed under this Agreement.

L. ***Non-Waiver*****.** The failure of either party to insist upon strict compliance with any provision of this Agreement, to enforce any right or to seek any remedy upon discovery of any default or breach of the other party at such time as the initial discovery of the existence of such noncompliance, right, default or breach shall not affect or constitute a waiver of either party's right to insist upon such compliance, exercise such right or seek such remedy with respect to that default or breach or any prior contemporaneous or subsequent default or breach.

M. ***Order of Documents*****.** In the event of any conflict between the provisions of this Agreement any incorporated documents, the terms and conditions of the documents will apply in this order: The Agreement;

N. ***Ownership Interest Disclosure*****.** The Contractor will provide a sworn affidavit listing all natural or artificial persons with an ownership interest in the Contractor and stating that no other person holds an ownership interest in the Contractor via a counter letter. For the purposes of this provision, an "ownership interest" shall not be deemed to include ownership of stock in a publicly traded corporation or ownership of an interest in a mutual fund or trust that holds an interest in a publicly traded corporation. If the Contractor fails to submit the required affidavits, the Board may, after 30 days' written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payments until such the required affidavits are submitted.

O. ***Ownership of Records*****.** All data collected and all products of work prepared, created or modified by Contractor in the performance of this Agreement, including without limitation any and all notes, tables,

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graphs, reports, files, computer programs, source code, documents, records, disks, original drawings or other such material, regardless of form and whether finished or unfinished, but excluding the Contractor's personnel and administrative records and any tools, systems, and information used by the Contractor to perform the services under this Agreement, including computer software (object code and source code), know-how, methodologies, equipment, and processes and any related intellectual property (collectively, "Work Product") will be the exclusive property of Board and the Board will have all right, title and interest in any Work Product, including without limitation the right to secure and maintain any copyright, trademark, or patent of Work Product in the Board's name. No Work Product may be reproduced in any form without the Board's express written consent. The Board may use and distribute any Work Product for any purpose the Board deems appropriate without the Contractor's consent and for no additional consideration to the Contractor.

P. ***Prohibition of Financial Interest in Agreement*.** No elected official or employee of the Board shall have a financial interest, direct or indirect, in this Agreement. For purposes of this provision, a financial interest held by the spouse, child, or parent of any elected official or employee of the Board shall be deemed to be a financial interest of such elected official or employee of the Board. Any willful violation of this provision, with the expressed or implied knowledge of Contractor, shall render this Agreement voidable by the Board and shall enable the Board to recover, in addition to any other rights and remedies available to the Board, all monies paid by the Board to Contractor pursuant to this Agreement without regard to Contractor's otherwise satisfactory performance of the Agreement.

Q. ***Remedies Cumulative*.** No remedy set forth in the Agreement or otherwise conferred upon or reserved to any party shall be considered exclusive of any other remedy available to a party. Rather, each remedy shall be deemed distinct, separate and cumulative and each may be exercised from time to time as often as the occasion may arise or as may be deemed expedient.

R. ***Severability*.** Should a court of competent jurisdiction find any provision of this Agreement to be unenforceable as written, the unenforceable provision should be reformed, if possible, so that it is enforceable to the maximum extent permitted by law or, if reformation is not possible, the unenforceable provision shall be fully severable and the remaining provisions of the Agreement remain in full force and effect and shall be construed and enforced as if the unenforceable provision was never a part the Agreement.

S. ***Subcontractor Reporting*.** The Contractor will provide a list of all natural or artificial persons who are retained by the Contractor at the time of the Agreement's execution and who are expected to perform work as subcontractors in connection with the Contractor's work for the Board. For any subcontractor proposed to be retained by the Contractor to perform work on the Agreement with the Board, the Contractor must provide notice to the Board within 30 days of retaining that subcontractor. If the Contractor fails to submit the required lists and notices, the Board may, after thirty 30 days' written notice to the Contractor, take any action it deems necessary, including, without limitation, causing the suspension of any payments, until the required lists and notices are submitted.

T. ***Survival of Certain Provisions*.** All representations and warranties and all obligations concerning record retention, inspections, audits, ownership, indemnification, payment, remedies, jurisdiction, choice of law, and **IDENTIFY ANY OTHER PROVISIONS THAT SHOULD SURVIVE TERMINATION** shall survive the expiration, suspension, or termination of this Agreement and continue in full force and effect.

U. ***Terms Binding*.** The terms and conditions of this Agreement are binding on any heirs, successors, transferees, and assigns.

ARTICLE XIV – COUNTERPARTS

This Agreement may be executed in one or more counterparts, each of which shall be deemed to

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be an original copy of this Agreement, but all of which, when taken together, shall constitute one and the same agreement.

ARTICLE XV - ELECTRONIC SIGNATURE AND DELIVERY

The Parties agree that a manually signed copy of this Agreement and any other document(s) attached to this Agreement delivered by email shall be deemed to have the same legal effect as delivery of an original signed copy of this Agreement. No legally binding obligation shall be created with respect to a party until such party has delivered or caused to be delivered a manually signed copy of this Agreement.

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IN WITNESS WHEREOF, the Board and the Contractor, through their duly authorized representatives, execute this Agreement.

SEWERAGE AND WATER BOARD OF NEW ORLEANS

BY: _____
GHASSAN KORBAN, EXECUTIVE DIRECTOR

Executed on this _____of _____, 201___

FORM AND LEGALITY APPROVED:
Legal Department

By: _____

Printed Name: _____

NAME OF CONTRACTOR

BY: _____
NAME AND TITLE OF INDIVIDUAL INDICATED IN PROOF OF SIGNING AUTHORITY

_____
FEDERAL TAX I.D. OR SOCIAL SECURITY NO.

[EXHIBIT(S) XXXX C CONTAINED ON NEXT PAGE(S) OR ATTACHED SEPARATELY (if too voluminous)]

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