



**SOUTH VALLEY WATER RECLAMATION FACILITY  
WEST JORDAN, UTAH**

**GENERATOR REPLACEMENT PROJECT**

**CONTRACT/TECHNICAL SPECIFICATIONS**

**BID SET**

**VOLUME 1 OF 2**

**MARCH 2021**

Digitally signed by Christopher Alan Carvalho  
Contact Info: Carollo Engineers, Inc.  
Date: 2021.03.25 12:00:43 -0600





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## SECTION 00030 - NOTICE INVITING BIDS

RECEIPT OF BIDS: Sealed Bids will be received at the office of the South Valley Water Reclamation Facility; OWNER of the WORK located at 7495 South 1300 West, West Jordan, Utah 84084, **until 1:00 pm MST, April 13, 2021**, for construction of South Valley Water Reclamation Facility Generator Replacement Project. Any Bids received after the specified time and date will not be considered.

OPENING OF BIDS: The Bids will be publicly opened and read at **1:00 pm MST, April 13, 2021**, at the above-mentioned office of the OWNER.

COMPLETION OF WORK: The WORK shall be completed as described below:

- a) Contractor shall procure new equipment, demolish and remove existing equipment to be replaced, and install the new equipment. Contractor shall provide all materials required for the Work described. The Work shall be completed by the date set forth in the Agreement (00500).

DESCRIPTION OF WORK: The project consists of the following Items:

The Work consists of construction of new diesel generator, including modifications to existing Generator Building, removal of existing diesel generator, new diesel generator EGU-3510, new switchgear lineup, new PLC Control Panel PCM-3500, new field wiring, and provision of temporary generators.

SITE OF WORK: The site of the WORK is located at the OWNER's water reclamation facility at 7495 South 1300 West, West Jordan, Utah.

OBTAINING CONTRACT DOCUMENTS: The Contract Documents will be available starting March 29, 2021 and are entitled "South Valley Water Reclamation Facility – Generator Replacement Project". Electronic copies may be obtained by downloading from SVWRF website ([www.svwwater.com](http://www.svwwater.com)) or from Utah Public Procurement Place [Supplier Login or Join JAGGAER Supplier Network \(scquest.com\)](#). Hard copies will not be made available by SVWRF.

BID SECURITY: Each Bid shall be accompanied by a certified check or cashier's check or Bid Bond in the amount of 5 percent of the Total Bid Price payable to the OWNER as a guarantee that the Bidder, if its Bid is accepted, will promptly execute the Agreement. A bid shall not be considered unless one of the forms of Bidder's security is enclosed with it.

BIDS TO REMAIN OPEN: The Bidder shall guarantee the Total Bid Price for a period of 60 calendar days from the date of bid opening.

MANDATORY PRE-BID VISIT TO WORK SITE: For a bid to be considered complete, prospective bidders are **required** to attend a mandatory pre-bid walk-through of the proposed work site, which will be conducted by the OWNER at **10:00 AM on April 5, 2021**. The object of the walk through is to acquaint bidders with the site conditions. The pre-bid visit will start at the office of the OWNER located at 7495 South 1300 West, West Jordan City, Utah. **Masks must be worn and social distancing will be enforced in accordance with SVWRF COVID-19 policies. Please bring hard hats.** Contact Taigon Worthen, P.E. of the SVWRF with questions ((801) 566-7711).

PROJECT ADMINISTRATION: Technical communications relative to this WORK shall be directed to the ENGINEER prior to opening of the Bids. Communications relative to obtaining Bid Documents shall be directed to the OWNER.

ENGINEER  
Carollo Engineers, Inc.,  
7090 S. Union Park Avenue, Suite 600  
Midvale, Utah 84047  
Attention: Brad Jeppson  
e-mail: [bjepson@carollo.com](mailto:bjepson@carollo.com)

SOUTH VALLEY WATER RECLAMATION FACILITY  
7495 South 1300 West  
West Jordan, Utah 84084  
Telephone: 801-495-5469  
e-mail: [tworthen@svwater.com](mailto:tworthen@svwater.com)  
Attention: Taigon Worthen, P.E.

OWNER'S RIGHTS RESERVED: The OWNER reserves the right to reject any or all bids, to waive any informality in a bid, and to make awards to the lowest responsive, responsible bidder as the OWNER in its sole discretion shall determine may best serve the interest of the OWNER.

- END OF NOTICE INVITING BIDS -



## **SECTION 00100 - INSTRUCTIONS TO BIDDERS**

1. **DEFINED TERMS.** Terms used in these Instructions to Bidders and the Notice Inviting Bids which are defined in the General Conditions have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to OWNER, as distinct from a sub-bidder, who submits a price or quote to a Bidder.
2. **INTERPRETATIONS AND ADDENDA.**
  - 2.1 All questions about the meaning or intent of the Contract Documents are to be directed to the ENGINEER. Additions, deletions, or revisions to the Contract Documents considered necessary by the ENGINEER in response to such questions will be issued by Addenda, mailed, emailed, or delivered to all parties recorded by the OWNER as having received the Contract Documents. Questions received less than 5 days prior to the date of Bids may not be answered. Only answers to such questions issued by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.
  - 2.2 Addenda may also be issued to make other additions, deletions, or revisions to the Contract Documents.
  - 2.3 Bidders shall make no special interpretation or inference of intent from differing formats in the Technical Specifications.
3. **BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE.**
  - 3.1 It is the responsibility of each Bidder before submitting a Bid:
    - A. To examine thoroughly the Contract Documents and other related data identified in the Bidding Documents (including "technical" data referred to below);
    - B. To visit the site to become familiar with local conditions that may affect cost, progress, or performance, of the WORK;
    - C. To consider federal, state, and local Laws and Regulations that may affect cost, progress, or performance of the WORK;
    - D. To study and carefully correlate the Bidder's observations with the Contract Documents; and
    - E. To notify the OWNER of all conflicts, errors, ambiguities, or discrepancies in or between the Contract Documents and such other related data.
  - 3.2 (Not Used)
  - 3.3 It is also the responsibility of each Bidder before submitting a Bid to examine thoroughly those reports of physical conditions in or relating to existing surface and subsurface conditions (except underground utilities as defined in Article 1 of the General Conditions) which are at or adjacent to the site and which were utilized by the OWNER in the preparation of the Contract Documents. Copies of such report and drawings are available for information at the office of the OWNER.
  - 3.4 Information and data reflected in the Contract Documents with respect to Underground Utilities at or contiguous to the site are based upon information and data furnished to the

OWNER by the owners of such Underground Utilities or others, and the OWNER does not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary General Conditions or Section 01530 - Protection of Existing Facilities.

- 3.5 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Utilities, and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraphs 4.02, 4.03, and 4.04 of the General Conditions.
- 3.6 Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests, and studies and obtain any additional information and data which pertain to the physical conditions (surface, subsurface, and Underground Utilities) at or contiguous to the site or otherwise which may affect cost, progress, or performance of the WORK and which the Bidder deems necessary to determine its Bid for performing the WORK in accordance with the time, price, and other terms and conditions of the Contract Documents.
- 3.7 On reasonable request in advance, the OWNER will provide each Bidder access to the site to conduct such examinations, investigations, explorations, tests, and studies as each Bidder deems necessary for submission of a Bid. Location of any excavation or boring shall be subject to prior approval of OWNER and applicable agencies. Bidder shall fill all holes, restore all pavement to match existing structural section, and shall clean up and restore the site to its former condition upon completion of such explorations. OWNER reserves the right to require Bidder to execute an Access Agreement with the OWNER prior to accessing the site.
- 3.8 The lands upon which the WORK is to be performed, rights-of-way, and easements for access thereto and other lands designated for use by the CONTRACTOR in performing the WORK are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by the CONTRACTOR. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by the OWNER unless otherwise provided in the Contract Documents.
- 3.9 The submission of a Bid will constitute an absolute representation by the Bidder that the Bidder has complied with every requirement of this Paragraph 3 and the following:
  - A. That the Bid is premised upon performing the WORK required by the Contract Documents without exception and such means, methods, techniques, sequences, or procedures of construction (if any) as may be required by the Contract Documents;
  - B. That Bidder has given the OWNER written notice of all conflicts, errors, ambiguities, and discrepancies in the Contract Documents and the written resolution thereof by the OWNER is acceptable to the Bidder; and
  - C. That the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the WORK.
4. BID FORMS. The Bid shall be submitted on the Bid Forms bound herein. All blanks on the Bid Forms shall be completed in ink. All names must be printed below the signatures. The Bid shall be submitted in a sealed envelope which shall be plainly marked in the upper left hand corner with the name and address of the Bidder and shall bear the words "BID FORM" followed by the title of the Contract Documents for the WORK, the name of the

OWNER, the address where Bids are to be delivered or mailed to, and the date and hour of opening of Bids.

5. CERTIFICATES.

5.1 Bids by corporations must be executed in the corporate name by the president, a vice-president, or other corporate officer. Such Bid shall be accompanied by the enclosed Certificate of Authority to sign, attested by the secretary or assistant secretary, and with the corporate seal affixed. The corporate address and state of incorporation must appear below the signature.

5.2 Bids by partnerships must be executed in the partnership name and be signed by a managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the partnership must appear below the signature.

5.3 Bids by joint ventures must be executed in the joint venture name and be signed by a joint venture managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the joint venture must appear below the signature.

6. DISQUALIFICATION OF BIDDERS. More than one Bid from an individual, firm, partnership, corporation, or association under the same or different names will not be considered. If the OWNER believes that any Bidder has financial interest in more than one Bid for the WORK contemplated, all Bids in which such Bidder is interested will be rejected. If the OWNER reasonably believes that collusion exists among the Bidders, all Bids will be rejected. A party who has quoted prices to a Bidder is not hereby disqualified from quoting prices to other Bidders, but is disqualified from submitting a Bid directly for the WORK.

7. QUANTITIES OF WORK. The quantities of work or material stated in unit price items of the Bid are supplied only to give an indication of the general scope of the WORK; the OWNER does not expressly or by implication agree that the actual amount of work or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any unit price item of the WORK by an amount up to and including 25 percent of any Bid item, without a change in the unit price, and shall include the right to delete any Bid item in its entirety, or to add additional Bid items up to and including an aggregate total amount not to exceed 25 percent of the Bid price.

8. COMPETENCY OF BIDDERS. Only qualified B100 and E100 licensed CONTRACTORS specializing in mechanical construction may submit a bid for the performance of the WORK.

9. SUBMISSION OF BIDS. The Bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. It is the Bidder's sole responsibility to see that its Bid is received in proper time and at the proper place.

10. BID SECURITY, BONDS, AND INSURANCE. Each Bid shall be accompanied by a certified or cashier's check or approved Bid Bond in the amount stated in the Notice Inviting Bids. Said check or bond shall be made payable to the OWNER and shall be given as a guarantee that the Bidder, if awarded the WORK, will enter into an Agreement with the OWNER, and will furnish the necessary insurance certificates, Payment Bond, and Performance Bond; each of said bonds to be in the amount stated in the Supplementary General Conditions. In case of refusal or failure to enter into said

Agreement, the check or Bid Bond, as the case may be, shall be forfeited to the OWNER. If the Bidder elects to furnish a Bid Bond as its Bid security, the Bidder shall use the Bid Bond form bound herein, or one conforming substantially to it in form. Bid Bonds shall comply with the requirements applicable to payment and performance bonds in the General Conditions.

11. **DISCREPANCIES IN BIDS.** In the event there is more than one Bid item in a Bid Schedule, the Bidder shall furnish a price for all Bid items in the Schedule, and failure to do so will render the Bid non-responsive and shall cause its rejection. In the event there are unit price Bid items in a Bidding schedule and the amount indicated for a unit price Bid item does not equal the product of the unit price and quantity, the unit price shall govern and the amount will be corrected accordingly, and the BIDDER shall be bound by said correction. In the event there is more than one Bid item in a Bid Schedule and the total indicated for the Schedule does not agree with the sum of the prices Bid on the individual items, the prices Bid on the individual items shall govern and the total for the Schedule will be corrected accordingly, and the BIDDER shall be bound by said correction.
12. **MODIFICATIONS AND UNAUTHORIZED ALTERNATIVE BIDS.** Unauthorized conditions, limitations, or provisos attached to the Bid shall render it informal and may cause its rejection as being non-responsive. The Bid forms shall be completed without interlineations, alterations, or erasures in the printed text. Alternative Bids will not be considered unless called for. Oral, telegraphic, telephonic or electronic Bids or modifications will not be considered.
13. **WITHDRAWAL OF BID.** The Bid may be withdrawn by the Bidder by means of a written request, signed by the Bidder or its properly authorized representative. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of Bids prior to the scheduled closing time for receipt of Bids.
14. **AWARD OF CONTRACT.** Award of the contract, if awarded, will be made to the lowest responsive, responsible Bidder whose Bid complies with the requirements of the Contract Documents. Unless otherwise specified, any such award will be made within the period stated in the Notice Inviting Bids that the bids are to remain open. Unless otherwise indicated, a single award will be made for all the Bid items in an individual Bid Schedule.
15. **RETURN OF BID SECURITY.** Within 14 days after award of the contract, the OWNER will, if requested, return the Bid securities accompanying such Bids that are not being considered in making the award. All other Bid securities will be held until the Agreement has been finally executed. They will then be returned, if requested, to the respective Bidders whose Bids they accompany.
16. **EXECUTION OF AGREEMENT.** The Bidder to whom award is made shall execute a written Agreement with the OWNER on the form of agreement provided, shall secure all insurance, and shall furnish all certificates and bonds required by the Contract Documents within 14 calendar days after receipt of the agreement forms from the OWNER. Failure or refusal to enter into an Agreement as herein provided or to conform to any of the stipulated requirements in connection therewith shall be just cause for annulment of the award and forfeiture of the Bid security. If the lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the OWNER may award the Contract to the second lowest responsive, responsible Bidder. If the second lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the OWNER may award the contract to the third lowest responsive, responsible Bidder. On the failure or refusal of such second or third lowest Bidder to execute the Agreement, each such Bidder's Bid securities shall be likewise forfeited to the OWNER.

17. LIQUIDATED DAMAGES. Provisions for liquidated damages, if any, are set forth in the Agreement.
18. PREFERENCE FOR RESIDENT CONTRACTORS. The OWNER will apply the provisions of Utah Procurement Code 63G-6-405. titled Preference for Resident Contractors (Utah Code -- Title 63G -- Chapter 6) wherein it is stated "(2) (a) When awarding contracts for construction, a public procurement unit shall grant a resident contractor a reciprocal preference as against a nonresident contractor from any state that gives or requires a preference to contractors from that state. (b) The amount of the reciprocal preference shall be equal to the amount of the preference applied by the state of the nonresident contractor."

- END OF INSTRUCTIONS TO BIDDERS -



## SECTION 00300 - BID FORMS

### BID

BID TO: South Valley Water Reclamation Facility

1. The undersigned Bidder proposes and agrees, if this Bid is accepted to enter into an Agreement with the OWNER in the form included in the Contract Documents to perform the WORK as specified or indicated in said Contract Documents entitled "South Valley Water Reclamation Facility - Generator Replacement Project."
2. Bidder accepts all of the terms and conditions of the Contract Documents, including without limitation those in the Notice Inviting Bids and Instructions to Bidders, dealing with the dispositions of the Bid security.
3. This Bid will remain open for the period stated in the "Notice Inviting Bids" unless otherwise required by law. Bidder will enter into an Agreement within the time and in the manner required in the "Notice Inviting Bids" and the "Instructions to Bidders", required by the Contract Documents.
4. Bidder has examined copies of all the Contract Documents including the following Addenda (receipt of all of which is hereby acknowledged):

Number:

Date:

1

2

3

4

5

Failure to acknowledge addenda shall render the bid non-responsive and shall be cause for its rejection.

5. Bidder has familiarized itself with the nature and extent of the Contract Documents, WORK, site, locality where the WORK is to be performed, the legal requirements (federal, state, and local laws, ordinances, rules, and regulations), and the conditions affecting cost, progress or performance of the WORK and has made such independent investigations as Bidder deems necessary.

To all the foregoing, and including all Bid Forms contained in the Bid, said Bidder further agrees to complete the WORK required under the Contract Documents within the Contract Time stipulated in said Contract Documents, and to accept in full payment therefore the Contract Price based on the Total Bid Price(s) named in the aforementioned Bid forms.

Dated: \_\_\_\_\_

Bidder: \_\_\_\_\_

By: \_\_\_\_\_

Title: \_\_\_\_\_

**BID CERTIFICATE**

**(if Corporation)**

STATE OF                    )  
                                  )     SS:  
COUNTY OF                )

I HEREBY CERTIFY that a meeting of the Board of Directors of the \_\_\_\_\_

\_\_\_\_\_

a corporation existing under the laws of the State of \_\_\_\_\_, held  
on \_\_\_\_\_, 20 \_\_\_\_\_, the following resolution was duly passed and  
adopted:

“RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of this  
Corporation, be and is hereby authorized to execute the Bid dated \_\_\_\_\_,  
20\_\_\_\_, to the South Valley Water Reclamation Facility by this Corporation and that his/her  
execution thereof, attested by the Secretary of this Corporation, and with the Corporate Seal  
affixed, shall be the official act and deed of this Corporation.”

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the  
corporation this \_\_\_\_\_, day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
Secretary

(SEAL)



**BID CERTIFICATE**

**(if Partnership)**

STATE OF                    )  
                                      )     SS:  
COUNTY OF                )

I HEREBY CERTIFY that a meeting of the Partners of the \_\_\_\_\_

\_\_\_\_\_

a partnership existing under the laws of the State of \_\_\_\_\_, held  
on \_\_\_\_\_, 20 \_\_\_\_\_, the following resolution was duly passed and adopted:

“RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of the  
Partnership, be and is hereby authorized to execute the Bid dated \_\_\_\_\_, 20\_\_\_\_,  
to the South Valley Water Reclamation Facility by this Partnership and that his/her execution  
thereof, attested by the \_\_\_\_\_ shall be the official act and deed  
of this Partnership.”

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of  
\_\_\_\_\_, 20\_\_\_\_.

**BID CERTIFICATE**

**(if Joint Venture)**

STATE OF                    )  
                                  )     SS:  
COUNTY OF                )

I HEREBY CERTIFY that a meeting of the Principals of the \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

a joint venture existing under the laws of the State of \_\_\_\_\_, held  
on \_\_\_\_\_, 20 \_\_\_\_\_, the following resolution was duly passed and adopted:

“RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of the Joint  
Venture, be and is hereby authorized to execute the Bid dated \_\_\_\_\_, 20\_\_\_\_, to  
the “South Valley Water Reclamation Facility by this Joint Venture and that his/her execution  
thereof, attested by the \_\_\_\_\_ shall be the official act and deed of this  
Joint Venture.”

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the  
corporation this \_\_\_\_\_, day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_

## LIST OF SUBCONTRACTORS

The Bidder shall list below the name and the location of the place of business of each Subcontractor who will perform work or labor or render service to the prime contractor in or about the construction of the work or improvement, or a Subcontractor who, under subcontract to the prime contractor, specially fabricates and installs a portion of the work or improvement according to detailed drawings contained in the plans and specifications, in an amount in excess of one-half of 1 percent of the prime contractor's total bid or ten thousand dollars (\$10,000), whichever is greater. The Bidder shall also list below the portion of the WORK which will be performed by each Subcontractor under its contract. The prime contractor shall list only one Subcontractor for each portion as is defined by the prime contractor in its bid. The prime contractor shall submit information (see next page) required of specialty subcontractors which are proposed to do Sheet Metal (HVAC) Work, Mechanical Work or Electrical Work, if any.

The Bidder's attention is directed to the provisions of Paragraph entitled "Subcontract Limitations," of the Supplementary General Conditions which stipulates the percent of the WORK to be performed with the Bidder's own forces. Failure to comply with this requirement will render the Bid non-responsive and may cause its rejection.

<u>Work to be Performed</u>	<u>Subcontr. License Number</u>	<u>Percent of Total Bid</u>	<u>Subcontractor's Name and Address</u>
1. _____	_____	_____	_____ _____ _____ _____
2. _____	_____	_____	_____ _____ _____ _____ _____
3. _____	_____	_____	_____ _____ _____ _____
4. _____	_____	_____	_____ _____ _____ _____

Note: Attach additional sheets if required.

## INFORMATION REQUIRED OF SPECIALTY SUBCONTRACTORS

The Bidder shall furnish the following information for each specialty subcontractor. Additional sheets shall be attached as required. Failure to complete Item Nos. 1, 2, and 3, will cause the Bid to be non-responsive and may cause its rejection.

(1) SPECIALTY SUBCONTRACTOR's name and address:

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---

---

(2) SPECIALTY SUBCONTRACTOR's license:

Primary Classification \_\_\_\_\_

State License No. and Expiration Date \_\_\_\_\_

Specialty classifications held, if any: \_\_\_\_\_

Name of Licensee, if different from (1) above:

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(3) ATTACH TO THIS BID a list of the 5 most recent construction contracts or subcontracts completed by the SPECIALTY SUBCONTRACTOR involving HVAC, Mechanical or Electrical Work of similar type and comparable value at Municipal Water Treatment Plants or Municipal Wastewater Treatment Plants.

The list shall include the following information as a minimum:

- Names, address, and telephone number of owner.
- Name of Project.
- Location of Project.
- Brief description of the work involved.
- Contract amount.
- Date of completion of the contract.
- Name, address, and telephone number of architect or engineer.
- Name of owner's project engineer.

## INFORMATION REQUIRED OF BIDDER

The Bidder shall furnish the following information. Additional sheets shall be attached as required. Failure to complete Item Nos. 1, 3, and 6, will cause the Bid to be non-responsive and may cause its rejection.

- (1) CONTRACTOR's name and address:

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- (2) CONTRACTOR'S telephone number: \_\_\_\_\_

- (3) CONTRACTOR's fax number: \_\_\_\_\_

- (4) CONTRACTOR's license: Primary Classification \_\_\_\_\_

State License No. and Expiration Date \_\_\_\_\_

Specialty classifications held, if any: \_\_\_\_\_

Name of Licensee, if different from (1) above: \_\_\_\_\_

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- (5) Name, address, and telephone number of surety company and agent who will provide the required bonds on this contract:

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- (6) ATTACH TO THIS BID a financial statement, references, and other information, sufficiently comprehensive to permit an appraisal of CONTRACTOR's current financial condition.

- (7) ATTACH TO THIS BID a list of the 5 most recent construction contracts completed by the CONTRACTOR involving Work of similar type and comparable value at Municipal Water Treatment Plants or Municipal Wastewater Treatment Plants. The list shall include the following information as a minimum:

- Names, address, and telephone number of owner.
- Name of Project.
- Location of Project.
- Brief description of the work involved.
- Contract amount.
- Date of completion of the contract.
- Name, address, and telephone number of architect or engineer.
- Name of owner's project engineer.

**NONCOLLUSION AFFIDAVIT TO BE EXECUTED BY BIDDER  
AND SUBMITTED WITH BID**

STATE OF                    )  
                                  )     SS:  
COUNTY OF                )

\_\_\_\_\_, being first duly sworn, deposes and says that he or she is \_\_\_\_\_ of \_\_\_\_\_ the party making the foregoing bid that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or sham; that the bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit or cost element of awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and further, that the bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

Signed: \_\_\_\_\_

Subscribed and sworn to before me  
this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_

\_\_\_\_\_  
Notary Public in and for the  
County of \_\_\_\_\_  
State of \_\_\_\_\_

(SEAL)

**BID BOND**

KNOW ALL MEN BY THESE PRESENTS,

That \_\_\_\_\_ as Principal, and  
\_\_\_\_\_ as Surety, are held  
and firmly bound unto the South Valley Water Reclamation Facility hereinafter called "OWNER,"  
in the sum of \_\_\_\_\_ dollars, for  
the payment of which sum, well and truly to be made, we jointly and severally bind ourselves,  
our heirs, executors, administrators, successors, and assigns firmly by these presents.

WHEREAS, said Principal has submitted a Bid to said OWNER to perform the WORK required  
under the bidding schedule(s) of the OWNER's Contract Documents entitled "South Valley  
Water Reclamation Facility - Generator Replacement Project."

NOW THEREFORE, if said Principal is awarded a contract by said OWNER and, within the time  
and in the manner required in the "Notice Inviting Bids" and the "Instruction to Bidder" enters  
into a written Agreement on the form of agreement bound with said Contract documents,  
furnishes the required certificates of insurance, and furnishes the required Performance Bond  
and Payment Bond, and performs in all other respects the agreement created by this bid, then  
this obligation shall be null and void, otherwise it shall remain in full force and effect. The Surety  
stipulates and agrees that the obligation of said Surety shall in no way be impaired or affected  
by an extension of the time within which the OWNER may accept such bid and Surety further  
waives notice of any such extension. In the event suit is brought upon this bond by said  
OWNER and OWNER prevails, said Principal and Surety shall pay all costs incurred by said  
OWNER in such suit, including reasonable attorney's fees and costs to be fixed by the court.

SIGNED AND SEALED, this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_  
\_\_\_\_\_  
(Principal) (SEAL) \_\_\_\_\_ (SEAL)  
(Surety)  
By: \_\_\_\_\_ By: \_\_\_\_\_  
(Signature) (Signature)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

- END OF BID FORMS -





## **BID SCHEDULES**

### **PART 1 - GENERAL**

#### **1.01 CONSTRUCTION CONTRACT**

- A. This Bid is submitted to:
- South Valley Water Reclamation Facility (Owner)  
7495 South 1300 West  
West Jordan, Utah 84084
- B. Name of Project: SOUTH VALLEY WATER RECLAMATION FACILITY - GENERATOR REPLACEMENT.

#### **1.02 SCHEDULES TO BE ADDED TO THE AGREEMENT**

- A. This Bid Schedules contain the schedules of prices which will be incorporated into the Agreement by reference.

#### **1.03 TAXES**

- A. The Bidder agrees that all sales, consumer, use, and other similar taxes are included in the stated bid prices for the Work, unless provision is made herein for the Bidder to separately itemize the estimated amount of tax.

#### **1.04 SCHEDULES OF PRICES**

- A. Lump Sum Bid & Basis of Award: Schedule of Prices for South Valley Water Reclamation Facility - Generator Replacement as specified and shown on the Drawings. Bidder shall complete Schedule A in its entirety. Award of the contract shall be based on the total combined amount of the bid that is within available funds. Bids shall be evaluated in the following manner for determination of the lowest, responsible, responsive bidder:

- a. Schedule A

However, the OWNER reserves the right to award Schedule A or Schedule A plus Schedule B with any combination of Line Items from Additive Schedule C which results in a sum total within available funds, which in the OWNER's sole discretion, is in the OWNER's best interest. An award is anticipated to be made to a single Bidder. If bids exceed available funds, the OWNER reserves the right to reject all bids.

- B. Schedule A contains prices for the WORK to replace existing diesel standby generator related to the improvements shown in South Valley Water Reclamation Facility Generator Replacement Contract Documents including, providing temporary generators, demolition and removal of the existing generator and switchboard, installation of the new generator and switchboard, and connection of BB-TR-2 in Blower Building 3 to the motor control center in the Grit Removal Building.

C. Bid Prices: Bidder will complete the WORK in accordance with the Contract Documents for the Lump Sum Bid Prices indicated in the Bid Schedules hereafter.

D. BID SCHEDULES

**SCHEDULE A - GENERATOR REPLACEMENT**

<b>Line Item No.</b>	<b>Description</b>	<b>Amount</b>
1.	Contractor Administration	
2.	Mobilization and Demobilization	
3.	Provision of temporary generators to provide standby power at the South Valley Water Reclamation Facility.	
4.	Demolition and removal of the existing generator and switchboard	
5.	New diesel generator EGU-3510	
6	New PLC Control Panel PCM-3500	
7.	LUMP SUM PRICE - WORK for construction of South Valley Water Reclamation Facility Generator Replacement Project,	
Schedule A TOTAL for all Line Items		
(Schedule A Total in Words)		

1. See 00100, Item 7.

E. ATTACHMENTS TO THIS BID

- a. The following documents are attached to and made a condition of this Bid:
  - i. Required Bid security in the form of a certified or cashier's check, or a Bid Bond as specified in Document 00300 - Bid Forms.
  - ii. Document 00300 - Bid Forms, and other individuals and entities required to be identified in this Bid.
  - iii. Document 00436 - List of Equipment Manufacturers.
  - iv. Document 00444 - Experience Modification Rate.
  - v. Document 00453 - Bid Preference.
  - vi. Document 00454 - Bid Certification of the Payment of State and Local Taxes.
  - vii. Document 00458 - Certification of Drug-Free Workplace Requirements

- END OF BID SCHEDULES -



**DOCUMENT 00436**

**LIST OF EQUIPMENT MANUFACTURERS**

**ARTICLE 1 - SELECTED MANUFACTURER/SUPPLIER**

- 1.01 Bidder shall edit Table 1 List of Selected Equipment Manufacturers by adding the manufacturer or supplier that will furnish the respective item of equipment for the Work.
- 1.02 Manufactures that are already listed (if any) are for Owner pre-selected equipment. Existing Contracts between Owner and Supplier for Owner pre-selected equipment will be assigned to the CONTRACTOR.
- 1.03 Acceptance of a manufacturer or supplier listed by the Bidder shall not constitute a waiver of any provision of the Contract Documents.

Table 1. List of Selected Equipment Manufacturers

<b>Section</b>	<b>Equipment</b>	<b>Manufacturer/Supplier</b>
16232	Generator	

BIDDER

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(Signature)

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(Date)

END OF DOCUMENT

**DOCUMENT 00444**

**EXPERIENCE MODIFICATION RATE**

**ARTICLE 1 - CONTRACTOR'S SAFETY PERFORMANCE AND PROGRAM**

**1.01 WORKERS' COMPENSATION INSURANCE - EXPERIENCE MODIFICATION RATE (EMR)**

A. Provide the following data:

	<u>Policy Year</u>	<u>Modification Rate</u>
Most Recent Policy Year	_____	_____
1 year previously	_____	_____
2 years previously	_____	_____

B. Answer the following questions.

1. Are the above rates interstate or intrastate? \_\_\_\_\_.
2. If intrastate, which state? \_\_\_\_\_.
3. If your EMR is exactly 1.0 for any policy year, it is because your firm is (or was) too new or too small to have an EMR calculated?

Yes \_\_\_\_\_ No \_\_\_\_\_

C. Provide documentation by one of the following methods:

1. Furnish a letter from your insurance agent, insurance carrier, or state fund (on their letterhead) verifying the EMR data for the last 3 rating periods.
  - a. If you do not have an interstate rating, obtain your intrastate EMR's.
2. Furnish a copy of the last 3 years' Experience Rating Calculation Sheets from your insurance carrier.
3. If you are in a "state fund", such as Ohio or West Virginia, furnish a copy of the state's last 3 years annual statement page that shows the modification rate and the coverage period.

**END OF DOCUMENT**





**DOCUMENT 00453**

**BID PREFERENCES**

1. Did you claim a bid preference under Utah Procurement Code 63G-6-404 - Preference for Providers of State Products?

☐ Yes ☐ No

If so, are you submitting proof that the goods, supplies, equipment, materials, or printing offered are produced, manufactured, mined, grown or performed in Utah?

☐ Yes ☐ No

2. Did you claim a bid preference under Utah Procurement Code 63G-6-405 - Preference for Resident Contractors?

☐ Yes ☐ No

If so, are you submitting proof of qualifications as a Resident Contractor?

☐ Yes ☐ No

3. Did you claim a bid preference under Utah Procurement Code 63G-6-406 - Preference for Recycled Paper and Paper Products?

☐ Yes ☐ No

If so, are you submitting proof of entitlement under this Code section?

☐ Yes ☐ No

**BIDDER**

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Date)

**END OF DOCUMENT**



**DOCUMENT 00454**

**BID CERTIFICATION FOR THE PAYMENT OF UTAH STATE AND LOCAL TAXES**

KNOW ALL MEN BY THESE PRESENTS, THAT the Bidder does hereby stipulate and certify that the Bidder has paid Utah state and local taxes for 5 successive years before submitting this Bid to Owner.

☐ Yes

☐ No

BIDDER

---

(Signature)

---

(Date)

END OF DOCUMENT



## **DOCUMENT 00458**

### **CERTIFICATION OF DRUG-FREE WORKPLACE REQUIREMENTS**

#### **ARTICLE 1 - BIDDER CERTIFICATIONS**

1.01 The Bidder certifies that it will or will continue to provide a drug-free work place by:

- A. Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the Bidder's work place and specifying the actions that will be taken against employees for violation of such prohibition.
  - 1. Making it a requirement that each employee to be engaged in the performance of the contract be given a copy of the statement.
  - 2. Notifying the employee in the statement that, as a condition of employment under the Contract, the employee will:
    - a. Abide by the terms of the statement.
    - b. Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the work place no later than 5 calendar days after such conviction.
      - 1) Notifying the Owner in writing within 10 calendar days after receiving notice from an employee or otherwise receiving actual notice of such conviction.
      - 2) Taking 1 of the following actions, within 30 calendar days of receiving notice, with respect to any employee who is so convicted:
        - a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of Federal and State law.
        - b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purpose by a Federal, State or local health, law enforcement, or other appropriate agency.
      - c. Notify the employee that in the event of a major accident/incident resulting in loss of life, injury or damage to the facility, or equipment, all personnel involved shall be required to submit to substance testing as soon as possible after the incident, but not more than 4 hours after the incident.
- B. Establishing an ongoing drug-free awareness program to inform employees about:
  - 1. The dangers of drug abuse in the work place.
  - 2. The Bidder's policy of maintaining a drug-free work place.
  - 3. Any available drug counseling, rehabilitation, and employee assistance programs.
  - 4. The penalties that may be imposed upon employees for drug abuse violations occurring in the work place.
- C. Making a good faith effort to continue to maintain a drug-free work place through implementation of the requirements stated in this Document.

## ARTICLE 2 - WORK LOCATIONS

2.01 The Bidder may insert in the space provided below the site(s) for the performance of work done in connection with this Contract:

A. Place(s) of Performance: (Street address, city, county, state, zip code):

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BIDDER

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(Signature)

---

(Date)

END OF DOCUMENT

## SECTION 00500

### AGREEMENT

THIS AGREEMENT is dated as of the \_\_\_\_\_ day of \_\_\_\_\_ in the year 2021 by and between South Valley Water Reclamation Facility (hereinafter called OWNER) and \_\_\_\_\_ (Hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

#### ARTICLE 1. WORK.

CONTRACTOR shall complete the WORK as specified or indicated in the OWNER's Contract Documents entitled "South Valley Water Reclamation Facility Generator Replacement Project". The WORK is generally described in Specification Section 01110 - Summary of Work.

#### ARTICLE 2. CONTRACT TIMES

COMPLETION OF WORK: The WORK shall be completed as follows:

1. Contractor shall begin WORK as soon as the Notice to Proceed is issued following award of WORK. Notice to Proceed is planned for May 6, 2021. Work shall be substantially complete by October 29, 2021.

#### ARTICLE 3. LIQUIDATED DAMAGES

OWNER and the CONTRACTOR recognize that time is of the essence of this Agreement and that the OWNER will suffer financial loss if the WORK is not completed within the time specified in Article 2 herein, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense, and difficulties involved in proving in a legal proceeding the actual loss suffered by the OWNER if the WORK is not completed on time. Accordingly, instead of requiring any such proof, the OWNER and the CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) the CONTRACTOR shall pay the OWNER \$2,500.00, or as otherwise specified in the Supplementary General Conditions for each day that expires after the deadlines specified in Article 2 herein.

#### ARTICLE 4. CONTRACT PRICE

OWNER shall pay CONTRACTOR for completion of the WORK in accordance with the Contract Documents in current funds the amount set forth in the Bid Schedule(s).

## ARTICLE 5. PAYMENT PROCEDURES

CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by OWNER as provided in the General Conditions.

## ARTICLE 6. CONTRACT DOCUMENTS

The Contract Documents which comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK consist of this Agreement (pages 00500-1 to 00500-6, inclusive) and the following attachments to this Agreement:

- Notice Inviting Bids (pages 00030-1 to 00030-2, inclusive).
- Instructions to Bidders (pages 00100-1 to 00100-5, inclusive).
- Bid Forms including the Bid, Bid Schedule(s), information required of Bidder, Bid Bond, and all required certificates and affidavits (pages 00300-1 to 00300-9 and 00310-1 to 00310-2, inclusive).
- Performance Bond (pages 00610-1 to 00610-1, inclusive).
- Payment Bond (pages 00620-1 to 00620-1, inclusive).
- General Conditions (pages 00700-1 to 00700-36, inclusive).
- Supplementary General Conditions (pages 00800-1 to 00800-7, inclusive).
- Supplementary General Conditions (Utah) (pages 00810-1 to 00810-4, inclusive).
- Technical Specifications consisting of Divisions and pages, as listed in the Table of Contents.
- Drawings, as listed in the Table of Contents/List of Drawings.
- Any such Addenda issued during the bidding process.
- Notice to Proceed.
- Change Orders which may be delivered or issued after Effective Date of this Agreement and are not attached hereto.

There are no Contract Documents other than those listed in this Article 6. The Contract Documents may only be amended by Change Order as provided in Paragraph 3.03 of the General Conditions.

## ARTICLE 7. ASSIGNMENTS

No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation monies that may become due and monies that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

OWNER and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect of all covenants, agreements and obligations contained in the Contract Documents.



IN WITNESS WHEREOF, OWNER and CONTRACTOR have caused this Agreement to be executed the day and year first above written.

OWNER:

South Valley Water Reclamation Facility

By \_\_\_\_\_  
(Jerry Knight, Board Chairman)

Attest \_\_\_\_\_

Address for giving notices:

South Valley Water Reclamation Facility  
7495 South 1300 West  
West Jordan, Utah 84084

Approved as to Form:

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Facility Attorney)

CONTRACTOR:

\_\_\_\_\_  
By \_\_\_\_\_

[CORPORATE SEAL]

Attest \_\_\_\_\_

Address for giving notices:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Agent for service of process: \_\_\_\_\_

\_\_\_\_\_

Telephone No. for Agent

\_\_\_\_\_

**AGREEMENT CERTIFICATE**

**(if Corporation)**

STATE OF                    )  
                                  )     SS:  
COUNTY OF                )

I HEREBY CERTIFY that a meeting of the Board of Directors of the \_\_\_\_\_

\_\_\_\_\_

a corporation existing under the laws of the State of \_\_\_\_\_, held  
on \_\_\_\_\_, 20 \_\_\_\_\_, the following resolution was duly passed and  
adopted:

“RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of this  
Corporation, be and is hereby authorized to execute the Agreement dated  
\_\_\_\_\_, 20\_\_\_\_, to the South Valley Water Reclamation Facility by this  
Corporation and that his/her execution thereof, attested by the Secretary of this Corporation,  
and with the Corporate Seal affixed, shall be the official act and deed of this Corporation.”

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the  
corporation this \_\_\_\_\_, day of \_\_\_\_\_, 20\_\_\_\_.

\_\_\_\_\_  
Secretary

(SEAL)

**AGREEMENT CERTIFICATE**

**(if Partnership)**

STATE OF                    )  
                                  )     SS:  
COUNTY OF                )

I HEREBY CERTIFY that a meeting of the Partners of the \_\_\_\_\_

\_\_\_\_\_

a partnership existing under the laws of the State of \_\_\_\_\_, held  
on \_\_\_\_\_, 20 \_\_\_\_\_, the following resolution was duly passed and adopted:

“RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of the  
Partnership, be and is hereby authorized to execute the Agreement dated \_\_\_\_\_,  
20\_\_\_\_, by and between this Partnership and South Valley Water Reclamation Facility by this  
Partnership and that his/her execution thereof, attested by the \_\_\_\_\_ shall be  
the official act and deed of this Partnership.”

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of  
\_\_\_\_\_, 20\_\_\_\_.

**AGREEMENT CERTIFICATE**

**(if Joint Venture)**

STATE OF                    )  
                                  )       SS:  
COUNTY OF                )

I HEREBY CERTIFY that a meeting of the Principals of the \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

a joint venture existing under the laws of the State of \_\_\_\_\_, held  
on \_\_\_\_\_, 20 \_\_\_\_\_, the following resolution was duly passed and adopted:

“RESOLVED, that \_\_\_\_\_, as  
\_\_\_\_\_ of the Joint  
Venture, be and is hereby authorized to execute the Agreement dated \_\_\_\_\_,  
20\_\_\_\_, by and between this Joint Venture and South Valley Water Reclamation Facility and  
that his/her execution thereof, attested by the \_\_\_\_\_ shall be the official  
act and deed of this Joint Venture.”

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this \_\_\_\_\_, day of  
\_\_\_\_\_, 20\_\_\_\_.

## DOCUMENT 00510

### NOTICE OF AWARD

<b>Issue Date:</b>	<u>MM/DD/YYYY</u>	<b>Owner's Contract No.:</b>	<u>Enter Contract No.</u>
<b>Owner:</b>	<u>South Valley Water Reclamation Facility</u>	<b>Contractor's Project No.:</b>	<u>Enter ##</u>
<b>Engineer:</b>	<u>Carollo Engineers, Inc.</u>		
<b>Project:</b>	<u>South Valley Water Reclamation Facility's Generator Replacement Project</u>		
<b>Bidder:</b>	<u>Click here to enter text.</u>		
<b>Bidder's Address:</b>	<u>Click here to enter text.</u>		

#### Notice of Award To Bidder

You are notified that Owner has accepted your Bid dated \_\_\_\_\_, 2021, for the above Contract, and that you are the Successful Bidder and are awarded a contract for:

\_\_\_\_\_  
(describe Work awarded)

The Contract Price of the awarded Contract is: \$\_\_\_\_\_

Two unexecuted counterparts of the Document 00500 - Agreement accompany this Notice of Award, and the Contract Documents have been made available to Bidder electronically.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner two counterparts of the Agreement, fully executed by Bidder.
2. Deliver with the executed Agreement(s) the Contract security and insurance documentation as specified in the Instructions to Bidders and General Conditions, Articles 2 and 6.
3. Other conditions precedent (if any):

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner: \_\_\_\_\_  
Authorized Signature: \_\_\_\_\_  
By: \_\_\_\_\_ Title: \_\_\_\_\_

Copy: Engineer

END OF DOCUMENT

**DOCUMENT 00550**

**NOTICE TO PROCEED**

**Owner:** South Valley Water Reclamation Facility

**Owner's Contract No.:** Click here to enter text. **Effective Date of Contract:** Click here to enter a date.

**Contractor:** Click here to enter text. **Contractor's Project No.:** Click here to enter text.

**Project Name:** South Valley Water Reclamation Facility's Generator Replacement Project

**Contract Name:** Click here to enter text.

**Engineer:** Carollo Engineers, Inc. **Engineer's Project No.:** 10548A.10

To Contractor	
<p>Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on Enter Notice To Proceed Date.</p> <p>On that date, Contractor shall start performing its obligations under the Contract Documents. No Work shall be done at the Site prior to such date. In accordance with the Contract, the date of Substantial Completion is _____, and the date of readiness for final payment is _____ or the number of days to achieve Substantial Completion is _____, and the number of days to achieve readiness for final payment is _____.</p>	
<p>Before starting any Work at the Site, Contractor must comply with the following:</p> <ul style="list-style-type: none"><li>- A Preconstruction conference to be held at <b>( )</b> on _____ at South Valley Water Reclamation Facility. Representatives of Owner and Engineer will be present to discuss project. Contractor is required to attend and participate in the conference.</li></ul>	
Owner Authorized Signature:	_____
Printed Name:	_____
Title:	_____
Date Issued:	_____

Copy: Engineer

END OF SECTION





**DOCUMENT 00602**

**ESCROW AGREEMENT FOR SECURITY DEPOSITS IN LIEU OF RETENTION**

This escrow agreement is made and entered into by and between

\_\_\_\_\_  
whose address is \_\_\_\_\_ hereinafter called "Owner,"

\_\_\_\_\_  
whose address is \_\_\_\_\_ hereinafter called "Contractor," and

\_\_\_\_\_  
whose address is \_\_\_\_\_ hereinafter called "Escrow Agent."

For the consideration hereinafter set forth, the Owner, Contractor, and Escrow Agent agree as follows:

1. Pursuant to Section 13-8-5 of Utah Code Annotated, the Contractor has the option to deposit securities with the Escrow Agent as a substitute for retention earnings required to be withheld by the Owner pursuant to the construction contract entered into between the Owner and Contractor for South Valley Water Reclamation Facility's Generator Replacement Project in the amount of \$ \_\_\_\_\_ dated \_\_\_\_\_ (hereafter referred to as the "contract"). Alternatively, on written request of the Contractor, the Owner shall make payments of the retention earnings directly to the Escrow Agent. When the Contractor deposits the securities as a substitute for the contract earnings, the Escrow Agent shall notify the Owner within ten days of the deposit. The market value of the securities at the time of the substitution shall be at least equal to the cash amount then required to be withheld as retention under the terms of the contract between the Owner and Contractor. Securities shall be held in the name of the \_\_\_\_\_ and shall designate the Contractor as the beneficial owner.
2. The Owner shall make progress payments to the Contractor for those funds which otherwise would be withheld from progress payments pursuant to the contract provision, provided that the Escrow Agent holds securities in the form and amount specified above.
3. When the Owner makes payment of retentions earned directly to the Escrow Agent, the Escrow Agent shall hold them for the benefit of the Contractor until such time as the escrow created under this contract is terminated. The Contractor may direct the investment of the payments into securities. All terms and conditions of this Agreement and the rights and responsibilities of the parties shall be equally applicable and binding when the Owner pays the Escrow Agent directly.
4. The Contractor shall be responsible for paying all fees for the expenses incurred by the Escrow Agent in administering the escrow account. These expenses and payment terms shall be determined by the Contractor and Escrow Agent.

5. The interest earned on the securities or the money market accounts held in escrow and all interest earned on the interest shall be for the sole account of Contractor and shall be subject to withdrawal by Contractor at any time and from time to time without notice to the Owner.
6. The Contractor shall have the right to withdraw all or any part of the principal in the escrow account only by written notice to the Escrow Agent accompanied by written authorization from the Owner to the Escrow Agent that the Owner consents to the withdrawal of the amount sought to be withdrawn by Contractor.
7. The Owner shall have a right to draw upon the securities in the event of default by the Contractor. Upon seven days' written notice to the Escrow Agent from the Owner of the default, the Escrow Agent shall immediately convert the securities to cash and shall distribute the cash as instructed by the Owner.
8. Upon receipt of written notification from the Owner certifying that the contract is final and complete, and that the Contractor has complied with all requirements and procedures applicable to the contract, the Escrow Agent shall release to the Contractor all securities and interest on deposit less escrow fees and charges of the escrow account. The escrow shall be closed immediately upon disbursement of all moneys and securities on deposit and payments of fees and charges.
9. The Escrow Agent shall rely on the written notifications from the Owner and the Contractor pursuant to Sections above, inclusive, of this Agreement and the Owner and Contractor shall hold the Escrow Agent harmless from the Escrow Agent's release, conversion, and disbursement of the securities and interest as set forth above.
10. The names of the persons who are authorized to give written notice or to receive written notice on behalf of the Owner and on behalf of the Contractor in connection with the foregoing, and exemplars of their respective signatures are as follows:

On behalf of the Owner:

On behalf of the Contractor:

---

Title

---

Title

---

Name

---

Name

---

Signature

---

Signature

---

Address

---

Address

---

On behalf of the Escrow Agent:

\_\_\_\_\_  
Title

\_\_\_\_\_  
Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Address

At the time the escrow account is opened, the Owner and Contractor shall deliver to the Escrow Agent a fully executed counterpart of this Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement by their proper officers on the date first set forth above.

Owner

Contractor

\_\_\_\_\_  
Title

\_\_\_\_\_  
Title

\_\_\_\_\_  
Name

\_\_\_\_\_  
Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Signature

END OF DOCUMENT



**DOCUMENT 00610**

**SURETY'S AGREEMENT TO ASSIGNMENT**

Surety hereby acknowledges and agrees the Assignment of Procurement Contract dated \_\_\_\_\_ by and between \_\_\_\_\_

(Supplier) and \_\_\_\_\_ (Owner) assigning and transferring to \_\_\_\_\_, the Contractor for General Construction Work, in accordance with the Contract Documents.

Surety further agrees that, upon assignment of the Procurement Contract, the Contractor for General Construction Work shall have all the rights previously conferred upon the Owner under the Procurement Performance Bond and Warranties therein contained.

(Corporate Seal)

Surety

Company: \_\_\_\_\_

Signature: \_\_\_\_\_

Name/Title: \_\_\_\_\_

END OF DOCUMENT



**SECTION 00620**

**PAYMENT BOND**

KNOW ALL MEN BY THESE PRESENTS,

That \_\_\_\_\_ as

GENERAL CONTRACTOR,

and \_\_\_\_\_ as Surety,

are held and firmly bound unto South Valley Water Reclamation Facility hereinafter called "OWNER," in the sum of \_\_\_\_\_ dollars, for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH that said GENERAL CONTRACTOR has been awarded and is about to enter into the annexed Agreement with said OWNER to perform the WORK as specified or indicated in the Contract Documents entitled "South Valley Water Reclamation Facility Generator Replacement Project".

NOW THEREFORE, if said GENERAL CONTRACTOR, or subcontractor, fails to pay for any materials, equipment, or other supplies, or for rental of same, used in connection with the performance of work contracted to be done, or for amounts due under applicable State law for any work or labor thereon, said Surety will pay for the same in an amount not exceeding the sum specified above, and, in the event suit is brought upon this bond, reasonable attorney's fees to be fixed by the court. This bond shall inure to the benefit of any persons, companies, or corporations entitled to file claims under applicable State law so as to give a right of action to them or their assigns in any suit brought upon this bond.

PROVIDED, that any alterations in the WORK to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of said Contract Documents, shall not in any way release said GENERAL CONTRACTOR or said Surety thereunder, nor shall any extensions of time granted under the provisions of said Contract Documents release either said GENERAL CONTRACTOR or said Surety, and notice of such alterations or extensions of the Agreement is hereby waived by said Surety.

IN WITNESS WHEREOF, we have hereunto set our hands and seals this\_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

\_\_\_\_\_(SEAL) \_\_\_\_\_(SEAL)  
(DESIGN-BUILDER) (Surety)

By: \_\_\_\_\_ By: \_\_\_\_\_  
(Signature) (Signature and SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

- END OF BID FORMS -



**DOCUMENT 00632**

**REQUEST FOR INFORMATION OR INTERPRETATION (RFI)**

<b>Owner:</b>	<u>Click here to enter text.</u>	<b>Date:</b>	<u>XX/XX/XXXX</u>
<b>Contractor:</b>	<u>Click here to enter text.</u>	<b>Project No.:</b>	<u>00000.00</u>
<b>Project Name:</b>	<u>Click here to enter text.</u>	<b>RFI No.:</b>	<u>000</u>
<b>RFI Title:</b>	<u>Click here to enter text.</u>	<b>Spec/Dwg. Reference:</b>	<u>00000</u>

Information or Interpretation and Reason Requested	
<u>Click here to enter text.</u>	
<b>Authored By:</b>	<b>Date Submitted:</b>
<u>Click here to enter text.</u>	<u>XX/XX/XXXX</u>

Response to Request:	
<u>Click here to enter text.</u>	
In the event, Contractor believes the RFI response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.	
<b>Firm Name:</b>	<b>Date Returned:</b>
<u>Click here to enter text.</u>	<u>XX/XX/XXXX</u>
<b>Signature:</b>	<b>Printed Name:</b>
<u></u>	<u></u>

END OF DOCUMENT



## SECTION 00700

### GENERAL CONDITIONS

#### ARTICLE 1 - DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents and printed with initial or all capital letters, the following terms have the meanings indicated:

Addenda - Written or graphic instruments issued prior to the opening of Bids which make additions, deletions, or revisions to the Contract Documents.

Agreement - The written contract between the OWNER and the CONTRACTOR for the performance of the WORK pursuant to the Contract Documents. Documents incorporated into the contract by reference become part of the contract and of the Agreement.

Application for Payment - The form furnished by the ENGINEER and completed by the CONTRACTOR to request progress or final payment including supporting documentation to substantiate the amounts for which payment is requested.

Bid - The offer or proposal of a Bidder, submitted on the prescribed form, setting forth the price or prices for the WORK to be performed.

Bidder - Any person, firm or corporation submitting a Bid for the WORK.

Bonds - Bid, Performance and Payment Bonds and other instruments which protect the OWNER against loss due to inability or refusal of the CONTRACTOR to perform pursuant to the Contract Documents.

Change Order - A document recommended by the OWNER'S REPRESENTATIVE, which is signed by the CONTRACTOR and the OWNER and authorizes an addition, deletion, or revision in the WORK, or an adjustment in the Contract Price or the Contract Time, issued on or after the Effective Date of the Agreement.

Contract Documents - The documents which comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK, consisting of the Drawings, Technical Specifications, General Conditions, Supplementary General Conditions, Notice Inviting Bids, Instructions to Bidders, Addenda, CONTRACTOR's Bid, Information Required of Bidder, Agreement, Performance Bond, Payment Bond, Notice To Proceed and Change Orders. Only printed or hard copies of the documents listed above are Contract Documents.

Contract Price - The total monies payable by the OWNER to the CONTRACTOR for completion of the WORK under the terms and conditions of the Contract Documents.

Contract Time - The number of successive Days or the date stated in the Contract Documents for Substantial Completion of the WORK. The Contract Time begins to run on the date specified in the Notice to Proceed.

CONTRACTOR - The person, firm, or corporation with whom the OWNER has executed the Agreement.

Day - A calendar day of 24 hours measured from midnight to the next midnight.

Defective Work - Work that: is unsatisfactory, faulty, or deficient; does not conform to the Contract Documents; does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents; has been damaged prior to the ENGINEER's recommendation of final payment.

Drawings - The drawings, plans, maps, profiles, diagrams, and other graphic representations which show the character, location, nature, extent, and scope of the WORK.

Effective Date of the Agreement - The date indicated in the Agreement on which it was executed.

ENGINEER - The person, firm or corporation named as such in the Contract Documents.

Field Order - A written order issued by the OWNER which requires minor changes in the WORK, but which does not involve a change in the Contract Price or Contract Time.

General Requirements - Division 1 of the Technical Specifications.

Laws and Regulations; Laws or Regulations - Includes any and all applicable state, federal and local statutes, common law, rules, regulations, ordinances, codes, and/or orders.

Notice of Award - The OWNER's written notice to the apparent successful Bidder stating that upon compliance with the conditions precedent enumerated therein by the apparent successful Bidder within the time specified, the OWNER will enter into the Agreement.

Notice to Proceed - The OWNER's written notice to the CONTRACTOR authorizing the CONTRACTOR to proceed with the work and establishing the date of commencement of the Contract Time.

OWNER - SOUTH VALLEY WATER RECLAMATION FACILITY.

OWNER'S REPRESENTATIVE - The authorized representative of the OWNER who is assigned to the site or any part thereof.

Partial Utilization - Placing a portion of the WORK in service for the purpose for which it is intended (or a related purpose) before reaching Substantial Completion of the WORK.

Project - A unit of total construction of which the WORK to be provided under the Contract Documents, may be the whole, or a part thereof.

Shop Drawings - All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the CONTRACTOR to illustrate some portion of WORK and all illustrations, brochures, standard schedules, performance charts, instruction, and diagrams to illustrate material or equipment for some portion of the WORK.

Specifications - (Same definition as for Technical Specifications hereinafter).

Subcontractor - An individual, firm, or corporation having a direct contract with the CONTRACTOR or with any other Subcontractor for the performance of a part of the WORK.

Substantial Completion - That state of construction when the WORK has progressed to the point where, in the opinion of the OWNER as evidenced by the Notice of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the WORK can be

utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to any work refer to substantial completion thereof.

Supplementary General Conditions - The part of the Contract Documents which makes additions, deletions, or revisions to these General Conditions.

Supplier - A manufacturer, fabricator, supplier, distributor, materialman, or vendor.

Technical Data - The factual information contained in reports describing physical conditions, including: exploration method, plans, logs, laboratory test methods and factual data. Technical Data does not include conclusions, interpretations, interpolations, extrapolations or opinions contained in reports or reached by the CONTRACTOR.

Technical Specifications - Those portions of the Contract Documents consisting of the General Requirements and written technical descriptions of products and execution of the WORK.

Underground Utilities - All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: water, sewage and drainage removal, electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, traffic, or other control systems.

WORK - The entire construction required to be furnished under the Contract Documents. WORK is the result of performing services, furnishing labor and supervision, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

## **ARTICLE 2 - PRELIMINARY MATTERS**

### **2.01 DELIVERY OF BONDS/INSURANCE CERTIFICATES**

- A. The CONTRACTOR shall deliver to the OWNER the Bonds and insurance certificates required by the Contract Documents within ten (10) days after receiving the Notice of Award from the OWNER.

### **2.02 COPIES OF DOCUMENTS**

- A. The OWNER shall furnish the CONTRACTOR five copies of the Contract Documents (Specifications and reduced Drawings), together with two sets of full-scale Drawings. Additional quantities of the Contract Documents will be furnished at reproduction cost.

### **2.03 STARTING THE PROJECT**

- A. The CONTRACTOR shall begin construction of the WORK within 10 days after the commencement date stated in the Notice to Proceed, but shall not commence construction prior to the commencement date.

### **2.04 BEFORE STARTING CONSTRUCTION**

- A. Before undertaking each part of the WORK, the CONTRACTOR shall carefully study and compare the Contract Documents to check and verify pertinent figures and dimensions shown thereon with all applicable field measurements. The CONTRACTOR shall promptly report in writing to the OWNER any conflict, error, or discrepancy which

- the CONTRACTOR may discover and shall obtain a written interpretation or clarification from the OWNER before proceeding with any work affected thereby.
- B. The CONTRACTOR shall submit to the OWNER for review those documents called for under the Section entitled "Contractor Submittals" in the General Requirements.
- 2.05 PRECONSTRUCTION CONFERENCE
- A. The CONTRACTOR shall attend a preconstruction conference with the OWNER, the ENGINEER and others as appropriate to discuss the construction of the WORK in accordance with the Contract Documents.
- 2.06 FINALIZING SCHEDULES
- A. At least 7 days before the CONTRACTOR's submittal of its first Application for Payment, the CONTRACTOR, the OWNER, and others as appropriate will meet to finalize the schedules submitted in accordance with the General Requirements.

### **ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE**

#### **3.01 INTENT**

- A. The Contract Documents comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK. The Contract Documents are complementary, what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the place of the Project.
- B. It is the intent of the Contract Documents to describe the WORK, as completely as possible and in a functional manner. The WORK is intended to be constructed in accordance with the Contract Documents. All work, materials, or equipment that may be reasonably inferred from the Contract Documents as being required to produce the completed work shall be supplied whether or not specifically called for. When words which have a well-known technical or trade meaning are used to describe work, materials, or equipment such words shall be interpreted in accordance with that meaning. Reference to standard specifications, manuals, or codes or any technical society, organization, or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual, or code (whether or not specifically incorporated by reference in the Contract Documents) shall be effective to change the duties and responsibilities of the OWNER, the CONTRACTOR, or the ENGINEER or any of their consultants, agents, or employees from those set forth in the Contract Documents.
- C. If, during the performance of the WORK, the CONTRACTOR finds a conflict, error or discrepancy in the Contract Documents, the CONTRACTOR shall immediately report it to the OWNER in writing and before proceeding with the work affected thereby. The OWNER shall then make a written interpretation, clarification, or correction.

### 3.02 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

- A. In resolving issues resulting from conflicts, errors, or discrepancies in any of the Contract Documents, or the order of precedence shall be as follows:
1. Change Orders
  2. Agreement
  3. Addenda
  4. Supplementary General Conditions
  5. General Conditions
  6. Technical Specifications
  7. Referenced Standard Specifications
  8. Drawings
  9. Contractor's Bid (Bid Form).
- B. With reference to the Drawings the order of precedence is as follows:
1. Figures govern over scaled dimensions
  2. Detail drawings govern over general drawings
  3. Addenda/change order drawings govern over general drawings
  4. Contract Drawings govern over standard drawings.

### 3.03 AMENDING AND SUPPLEMENTING CONTRACT DOCUMENTS

- A. The Contract Documents may be amended by a Change Order (pursuant to Article 10) to provide for additions, deletions or revisions in the WORK or to modify terms and conditions.

### 3.04 REUSE OF DOCUMENTS

- A. Neither the CONTRACTOR, Subcontractor, Supplier, nor any other person or organization performing any of the WORK under a contract with the OWNER shall have or acquire any title to or ownership rights in any of the Drawings, Technical Specifications, or other documents used on the WORK, and they shall not reuse any of them on the extensions of the Project or any other project without the written consent of the OWNER and the ENGINEER.

## **ARTICLE 4 - AVAILABILITY OF LANDS: PHYSICAL CONDITIONS, REFERENCE POINTS**

### 4.01 AVAILABILITY OF LANDS

- A. The OWNER shall furnish the lands, rights-of-way and easements upon which the

WORK is to be performed and for access thereto, together with other lands designated for the use of the CONTRACTOR in the Contract Documents. Easements for permanent structures or permanent changes in existing major facilities will be obtained and paid for by the OWNER, unless otherwise provided in the Contract Documents. Nothing contained in the Contract Documents shall be interpreted as giving the CONTRACTOR exclusive occupancy of the lands or rights-of-way provided. The CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment. The CONTRACTOR shall not enter upon nor use any property not under the control of the OWNER until a written temporary construction easement agreement has been executed by the CONTRACTOR and the property owner, and a copy of the easement furnished to the ENGINEER prior to its use. Neither the OWNER nor the ENGINEER shall be liable for any claims or damages resulting from the CONTRACTOR's unauthorized trespass or use of any properties.

#### 4.02 PHYSICAL CONDITIONS - SUBSURFACE AND EXISTING STRUCTURES

- A. Explorations and Reports: The Supplementary General Conditions may identify exploration reports and subsurface conditions tests at the site that have been utilized by the OWNER in the preparation of the Contract Documents. The CONTRACTOR may rely upon the accuracy of the Technical Data contained in these reports. The CONTRACTOR is responsible for the interpretation, extrapolation or interpolation of all technical as well as nontechnical data and its reliance on the completeness, opinions and interpretation of the reports.
- B. Existing Structures: The Supplementary General Conditions identify the drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Utilities referred to in Paragraph 4.04 herein) which are at or contiguous to the site that have been utilized by the OWNER in the preparation of the Contract Documents. The CONTRACTOR is responsible for the interpretation, extrapolation or interpolation of all technical as well as nontechnical data and its reliance on the completeness, opinions and interpretation of the reports.

#### 4.03 DIFFERING SITE CONDITIONS

- A. The CONTRACTOR shall notify the OWNER upon encountering any of the following unforeseen conditions, hereinafter called "differing site conditions," during the prosecution of the WORK. The CONTRACTOR's notice to the OWNER shall be in writing and delivered before the differing site conditions are disturbed, but in no event later than 14 days after their discovery.
  - 1. Subsurface or latent physical conditions at the site of the WORK which could not reasonably have been discovered through diligent inspection by CONTRACTOR before his Bid was submitted which differs materially from those indicated, described, or delineated in the Contract Documents including those reports and documents discussed in Paragraph 4.02; and
  - 2. Physical conditions at the site of the WORK of an unusual nature which could not reasonably have been discovered through diligent inspection by CONTRACTOR before his Bid was submitted and which differ materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents including those reports and documents discussed in Paragraph 4.02.



- B. The OWNER will review the alleged differing site conditions; determine the necessity of obtaining additional explorations or tests with respect to verifying their existence and extent.
- C. If the OWNER concludes that because of newly discovered conditions a change in the Contract Documents is required, a Change Order will be issued as provided in Article 10 to reflect and document the consequences of the differing site conditions.
- D. In each such case, an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, or any combination thereof, will be allowable to the extent that they are attributable to the differing site conditions. If the OWNER and the CONTRACTOR are unable to agree as to the amount or length of the Change Order, a claim may be made as provided in Articles 11 and 12.
- E. The CONTRACTOR's failure to give written notice of differing site conditions within 14 days of their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith, whether direct or consequential in nature.

#### 4.04 PHYSICAL CONDITIONS - UNDERGROUND UTILITIES

- A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Utilities at or contiguous to the site are based on information and data furnished to the OWNER by the owners of Underground Utilities or by others. Unless it is expressly provided in the Supplementary General Conditions, the OWNER and the ENGINEER shall not be responsible for the accuracy or completeness of any Underground Utilities information or data. The CONTRACTOR's responsibility relating to underground utilities are: review and check all information and data, locate all Underground Utilities shown or indicated in the Contract Documents, coordinate the WORK with the owners of Underground Utilities during construction, safeguard and protect the Underground Utilities, and repair any damage to Underground Utilities resulting from the WORK. The cost of all these activities will be considered as having been included in the Contract Price.
- B. Not Shown or Indicated: If an Underground Utility not shown or indicated in the Contract Documents is uncovered or revealed at or contiguous to the site and which the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall identify the owner of the Underground Utility, give written notice of the location to that owner and notify the OWNER.

#### 4.05 REFERENCE POINTS

- A. The OWNER will provide one benchmark, near or on the site of the WORK, and will provide two points near or on the site to establish a base line for use by the CONTRACTOR in laying out the WORK. Unless otherwise specified in the General Requirements, the CONTRACTOR shall furnish all other lines, grades, and benchmarks required for proper execution of the WORK.
- B. The CONTRACTOR shall preserve all benchmarks, stakes, and other survey marks. In case of their removal or destruction by its own employees or by its subcontractor's employees, the CONTRACTOR shall be responsible for the accurate replacement of reference points by professionally qualified personnel at no additional cost to the OWNER.

## ARTICLE 5 - BONDS AND INSURANCE

### 5.01 PERFORMANCE, PAYMENT AND OTHER BONDS

- A. The CONTRACTOR shall furnish Performance and Payment Bonds, each in the amount of 100% of the Contract Price as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents. The Performance Bond shall remain in effect at least until one year after the date of Notice of Completion, except as otherwise provided by Law or Regulation or by the Contract Documents. After the OWNER issues the Notice of Completion, the amount of the Performance Bond may be reduced to 10 percent of the Contract Price, or \$1,000, whichever is greater. The CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary General Conditions.
- B. If the surety on any Bond furnished by the CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the WORK is located, the CONTRACTOR shall within 7 days after written approval by the OWNER of a substitute Bond and Surety substitute the approved Bond and Surety.

### 5.02 INSURANCE

- A. The CONTRACTOR shall purchase and maintain the insurance required under this paragraph. This insurance shall include the specific coverages set out herein and be written for not less than the limits of liability and coverages provided in the Supplementary General Conditions, or required by law, whichever is greater. The CONTRACTOR's liabilities under the Agreement shall not be deemed limited in any way to the insurance coverage required.
- B. The CONTRACTOR shall furnish the OWNER with certificates indicating the type, amount, class of operations covered, effective dates and expiration dates of all policies. All insurance policies purchased and maintained (or the certificates or other evidence thereof) shall contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 30 days' prior written notice has been given to the OWNER by certified mail. Contract or certificate terms which state that reasonable efforts will be made to notify the OWNER prior to cancellation, change or renewal of the policy are not acceptable. All insurance shall remain in effect until the OWNER issues the Notice of Final Completion and at all times thereafter when the CONTRACTOR may be correcting, removing, or replacing defective work in accordance with Paragraph 13.01B or completing punch list items required by the Notice of Substantial Completion. In addition, the insurance required herein (except for Worker's Compensation and Employer's Liability) shall name the OWNER, the ENGINEER, and their officers, agents, and employees as "additional insured" under the policies. All liability insurance policies shall be occurrence and not claims made policies.
  - 1. Workers' Compensation and Employer's Liability: This insurance shall protect the CONTRACTOR against all claims under applicable state workers' compensation laws. The CONTRACTOR shall also be protected against claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workers' compensation law. This policy shall include an "all states" endorsement. The CONTRACTOR shall require each subcontractor similarly to provide Workers' Compensation Insurance for all of the latter's employees to be engaged in the WORK unless its employees are covered by the protection afforded by the CONTRACTOR's Workers' Compensation Insurance.

In the event a class of employees is not protected under the Workers' Compensation Statute, the CONTRACTOR or Subcontractor, as the case may be, shall provide adequate employer's liability insurance for the protection of its employees not protected under the statute.

2. Comprehensive General Liability: This insurance shall be written in comprehensive form and shall protect the CONTRACTOR against all claims arising from injuries to persons other than its employees and damage to property of the OWNER or others arising out of any act or omission of the CONTRACTOR or its agents, employees or subcontractors. The policy shall include the following endorsements: (1) Protective Liability endorsement to insure the contractual liability assumed by the CONTRACTOR under the indemnification provisions in these General Conditions; (2) Broad Form Property Damage endorsement; (3) Personal Injury endorsement to cover personal injury liability for intangible harm. The Comprehensive General Liability coverage shall contain no exclusion relative to blasting, explosion, collapse of building, or damage to underground structures.
3. Comprehensive Automobile Liability: This insurance shall be written in comprehensive form. The policy shall protect the CONTRACTOR against all claims for injuries to employees, members of the public and damage to property of others arising from the use of CONTRACTOR's motor vehicles, whether they are owned, non-owned, or hired, and whether used or operated on or off the site. The motor vehicle insurance required under this paragraph shall include: (a) motor vehicle liability coverage; (b) personal injury protection coverage and benefits; (c) uninsured motor vehicle coverage; and (d) underinsured motor vehicle coverage.
4. Subcontractor's Insurance: The CONTRACTOR shall require each of its subcontractors to procure and to maintain Comprehensive General Liability Insurance and Comprehensive Automobile Liability Insurance of the type and in the amounts specified in the Supplementary General Conditions or insure the activities of its subcontractors in the CONTRACTOR's own policy, in like amount.
5. Builder's Risk: This insurance shall be of the "all risk" type, shall be written in completed value form, and shall protect the CONTRACTOR, the OWNER, and the ENGINEER against damage to buildings, structures, materials and equipment. The amount of this insurance shall not be less than the insurable value of the WORK at completion. Builder's risk insurance shall provide for losses to be payable to the CONTRACTOR, the OWNER, and the ENGINEER as their interests may appear. The policy shall contain a provision that in the event of payment for any loss under the coverage provided, the insurance company shall have no rights of recovery against the CONTRACTOR, the OWNER, or the ENGINEER. The Builder's Risk policy shall insure against all risks of direct physical loss or damage to property from any external cause including flood and earthquake. Allowable exclusions, if any, shall be as specified in the Supplementary General Conditions.

## **ARTICLE 6 - CONTRACTOR RESPONSIBILITIES**

### **6.01 SUPERVISION AND SUPERINTENDENCE**

- A. The CONTRACTOR shall supervise and direct the WORK competently and efficiently, devoting the attention and applying the skills and expertise necessary to perform the WORK in accordance with the Contract Documents. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction and safety precautions and programs incidental thereto. The CONTRACTOR shall be responsible to see that the finished WORK complies accurately with the Contract Documents.
- B. The CONTRACTOR shall employ the superintendent named in "Information Required of Bidder" on the work site at all times during the progress of the WORK. The superintendent shall not be replaced without the OWNER's written consent. The superintendent will be the CONTRACTOR's representative at the site and shall have authority to act on behalf of the CONTRACTOR. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR. The CONTRACTOR shall issue all its communications to the OWNER.
- C. The CONTRACTOR's superintendent, or OWNER approved representative shall be present at the site of the WORK at all times while work is in progress. Failure to observe this requirement shall be considered suspension of the WORK by the CONTRACTOR until the superintendent is again present at the site.

### **6.02 LABOR, MATERIALS, AND EQUIPMENT**

- A. The CONTRACTOR shall provide skilled, competent and suitably qualified personnel to survey and lay out the WORK and perform construction as required by the Contract Documents. The CONTRACTOR shall at all times maintain good discipline and order at the site.
- B. Except in connection with the safety or protection of persons at the WORK, or property at the site or adjacent thereto, all work at the site shall be performed during regular working hours (7:00 a.m. - 6:00 p.m., Monday through Friday), and the CONTRACTOR will not permit overtime work or the performance of work on Saturday, Sunday or any legal holiday observed by the OWNER without the OWNER's written consent given after prior written notice to the OWNER. Except as otherwise provided in this Paragraph, the CONTRACTOR shall receive no additional compensation for overtime work, i.e., work in excess of 8 hours in any one calendar day or 40 hours in any one calendar week, even though such overtime work may be required under emergency conditions and may be ordered by the OWNER in writing. Additional compensation will be paid the CONTRACTOR for overtime work in the event extra work is ordered by the OWNER and the Change Order specifically authorizes the use of overtime work, but only to the extent that the CONTRACTOR pays overtime wages on a regular basis being paid (>40 hours per week) for overtime work of a similar nature in the same locality.
- C. All costs of inspection and testing performed during overtime work approved solely for the convenience of the CONTRACTOR shall be borne by the CONTRACTOR. The OWNER shall have the authority to deduct the costs of all inspection and testing from any partial payments otherwise due to the CONTRACTOR.

- D. Unless otherwise specified in the Contract Documents, the CONTRACTOR shall furnish, erect, maintain and remove the construction plant, and temporary works and assume full responsibility for all materials, equipment, labor, transportation, construction equipment, machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities and all other facilities and incidentals necessary for the furnishing, performance testing, start-up and completion of the WORK.
- E. All materials and equipment incorporated into the WORK shall be of new and good quality, except as otherwise provided in the Contract Documents. If required by the OWNER, the CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. The CONTRACTOR shall apply, install, connect, erect, use, clean, and condition all material and equipment in accordance with the instructions of the manufacturer and Supplier except as otherwise provided in the Contract Documents.

#### 6.03 ADJUSTING PROGRESS SCHEDULE

- A. The CONTRACTOR shall submit any adjustments in the progress schedule to the OWNER for acceptance in accordance with the provisions for "Contractor Submittals" in the General Requirements.

#### 6.04 SUBSTITUTES AND "OR-EQUAL" ITEMS

- A. The CONTRACTOR shall submit proposed substitutes and "or-equal" items in accordance with the provisions for "Contractor Submittals" in the General Requirements.

#### 6.05 SUBCONTRACTORS, SUPPLIERS, AND OTHERS

- A. The CONTRACTOR shall be responsible to the OWNER and the ENGINEER for the acts and omissions of its subcontractors and their employees to the same extent as the CONTRACTOR is responsible for the acts and omissions of its own employees. Nothing contained in this paragraph shall create any contractual relationship between any subcontractor and the OWNER or the ENGINEER nor relieve the CONTRACTOR of any liability or obligation under the Agreement.

#### 6.06 PERMITS

- A. Unless otherwise provided in the Supplementary General Conditions, the CONTRACTOR shall obtain and pay for all construction permits and licenses from the agencies having jurisdiction, including furnishing the insurance and bonds required by such agencies. The costs incurred by the CONTRACTOR in compliance with this paragraph shall not be made the basis for claims for additional compensation. The OWNER shall assist the CONTRACTOR, when necessary, in obtaining such permits and licenses. The CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the WORK, which are applicable at the time of opening of Bids, including all utility connection charges for utilities required by the WORK.
- B. The CONTRACTOR shall pay all license fees and royalties and assume all costs when any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others when issued in the construction of the WORK or incorporated into the WORK. If a particular invention, design, process, product, or device is specified in the Contract Documents for incorporation into or use in the construction of the WORK

and if to the actual knowledge of the OWNER or the ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of these rights shall be disclosed by the OWNER in the Contract Documents. The CONTRACTOR shall indemnify, defend and hold harmless the OWNER and the ENGINEER and anyone directly or indirectly employed by either of them from and against all claims, damages, losses, and expenses (including attorneys' fees and court costs) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the WORK or resulting from the incorporation in the WORK of any invention, design, process, product, or device not specified in the Contract Documents.

#### 6.07 LAWS AND REGULATIONS

- A. The CONTRACTOR shall observe and comply with all Laws and Regulations which in any manner affect those engaged or employed on the WORK, the materials used in the WORK, or the conduct of the WORK. If any discrepancy or inconsistency should be discovered in the Contract Documents in relation to any Laws or Regulations, the CONTRACTOR shall report the same in writing to the OWNER. Notwithstanding any immunity otherwise provided by applicable workers' compensation statutes, the CONTRACTOR shall indemnify, defend and hold harmless the OWNER, the ENGINEER and their officers, agents, and employees against all claims arising from violation of any Laws or Regulations, by CONTRACTOR or by its employees or subcontractors. This indemnity provision is intended to provide the greatest protection of the OWNER and ENGINEER allowed by law. Any particular law or regulation specified or referred to elsewhere in the Contract Documents shall not in any way limit the obligation of the CONTRACTOR to comply with all other provisions of federal, state, and local laws and regulations.

#### 6.08 EQUAL OPPORTUNITY

- A. The CONTRACTOR agrees not to discriminate against anyone because of race, national origin, ancestry, color, religion, sex, age, or disability. The CONTRACTOR agrees to abide by all applicable civil rights Laws and Regulations.

#### 6.09 TAXES

- A. The CONTRACTOR shall pay all sales, consumer, use, and other similar taxes required to be paid by the CONTRACTOR in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the WORK.

#### 6.10 USE OF PREMISES

- A. The CONTRACTOR shall confine construction equipment, stored materials and equipment, and other operations of workers to (1) the Project site, (2) the land and areas identified for the CONTRACTOR's use in the Contract Documents, and (3) other lands whose use is acquired by Laws and Regulations, rights-of-way, permits, and easements. The CONTRACTOR shall be fully responsible to the owner and occupant of such lands for any damage to the lands or areas contiguous thereto, resulting from the performance of the WORK or otherwise. Should any claim be made against the OWNER or the ENGINEER by owner or occupant of lands because of the performance of the WORK, the CONTRACTOR shall promptly settle the claim by agreement, or resolve the claim through litigation. The CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify, defend, and hold the OWNER and the ENGINEER harmless

from and against all claims, damages, losses, and expenses (including, but not limited to, fees of engineers, architects, attorneys, and other professionals and court costs) arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any owner or occupant of land against the OWNER or the ENGINEER to the extent the claim is based or arises out of the CONTRACTOR's performance of the WORK.

#### 6.11 SAFETY AND PROTECTION

- A. The CONTRACTOR shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
  - 1. All persons on or near the work site and other persons and organizations who may be affected by activities on or near the work site.
  - 2. All the WORK and materials and equipment to be incorporated therein, whether in storage on or off the site; and
  - 3. Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.
- B. The CONTRACTOR shall comply with all applicable Laws and Regulations (whether referred to herein or not) of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury, or loss and shall erect and maintain all necessary safeguards for such safety and protection. The CONTRACTOR shall notify owners of adjacent property and utilities when prosecution of the WORK may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.
- C. Unless the CONTRACTOR otherwise designates in writing a different individual as the responsible individual, the CONTRACTOR's superintendent shall be CONTRACTOR's representative at the site whose duties shall include providing all persons on the work site with a reasonably safe environment and the prevention of accidents.

#### 6.12 SHOP DRAWINGS AND SAMPLES

- A. After checking and verifying all field measurements and after complying with the applicable procedures specified in the General Requirements, the CONTRACTOR shall submit all shop drawings to the OWNER for review and approval in accordance with the approved schedule for shop drawing submittals specified in the General Requirements.
- B. The CONTRACTOR shall also submit to the OWNER for review and approval all samples in accordance with the approved schedule of sample submittals specified in the General Requirements.
- C. Before submitting shop drawings or samples, the CONTRACTOR shall determine and verify all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto and review or coordinate each shop drawing or sample with other shop drawings and samples and with the requirements of the WORK and the Contract Documents. The CONTRACTOR shall stamp each shop drawing, certifying his review. If the same shop drawings require

re-submittal more than two times, the CONTRACTOR shall pay for the costs of ENGINEER's and OWNER's subsequent review(s).

#### 6.13 CONTINUING THE WORK

- A. The CONTRACTOR shall carry on the WORK and adhere to the progress schedule during all disputes or disagreements with the OWNER. No work shall be delayed or postponed pending resolution of any dispute or disagreement, except as the CONTRACTOR and the OWNER may otherwise mutually agree in writing.

#### 6.14 INDEMNIFICATION

- A. To the fullest extent permitted by Laws and Regulations, and notwithstanding any immunity the CONTRACTOR might otherwise have under applicable workers' compensation statutes, the CONTRACTOR shall indemnify, defend, and hold harmless the OWNER, the ENGINEER, and their officers, agents, and employees, against and from all claims and liability arising under or by reason of, or claimed by others to arise under or by reason of, the Agreement or any performance of the WORK, but not from the sole negligence or willful misconduct of the OWNER and/or the ENGINEER. Such indemnification by the CONTRACTOR shall include but not be limited to the following:
1. Liability or claims resulting in whole or in part, directly or indirectly from, or claimed by others to result in whole or in part, directly or indirectly from, the negligence, carelessness or other fault of the CONTRACTOR or its employees, Subcontractors, Suppliers or agents in the performance of the WORK, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction;
  2. Liability or claims arising in whole or in part, directly or indirectly, from or based on, or claimed by others to arise in whole or in part, directly or indirectly, from or based on, the violation of any Laws or Regulations by the CONTRACTOR or its employees, Subcontractors, Suppliers or agents;
  3. Liability or claims arising in whole or in part, directly or indirectly, from, or claimed by others to arise in whole or in part, directly or indirectly from, the use or manufacture by the CONTRACTOR, or its Subcontractors, Suppliers or agents in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specifically stipulated in this Agreement.
  4. Liability or claims arising in whole or in part, directly or indirectly, from, or claimed by others to arise in whole or in part, directly or indirectly from, the breach of any warranties, whether express or implied, made by the CONTRACTOR or its Subcontractors, Suppliers or agents;
  5. Liabilities or claims arising in whole or in part, directly or indirectly, from, or claimed by others to arise in whole or in part, directly or indirectly from, the willful misconduct of the CONTRACTOR or its Subcontractors, Suppliers or agents; and,
  6. Liabilities or claims arising in whole or in part, directly or indirectly, from, or claimed by others to arise in whole or in part, directly or indirectly from, any



breach of the obligations assumed herein by the CONTRACTOR or its Subcontractors, Suppliers or agents.

7. If for any reason the OWNER is required to pay damages in proportion to the fault of the OWNER notwithstanding the above indemnity provisions, CONTRACTOR shall, notwithstanding any workers' compensation immunity, indemnify and hold OWNER harmless from the payment of any increased damages OWNER is required to pay which result from a reapportionment of the fault of the CONTRACTOR, or any of its employees, Subcontractors or Suppliers pursuant to Utah Code Annotated section 78b-5-818, Comparative negligence.
- B. The CONTRACTOR shall reimburse the OWNER, and the ENGINEER for all costs and expense, (including but not limited to fees and charges of engineers, architects, attorneys, and other professional and court costs) incurred by the OWNER, and the ENGINEER in enforcing the provisions of this Paragraph.
- C. The indemnification obligation under this Paragraph shall not be limited in any way by any limitation of the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any such subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.

#### 6.15 CONTRACTOR'S DAILY REPORTS

- A. The CONTRACTOR shall complete a daily report indicating manpower, major equipment, subcontractors, weather conditions, etc., involved in the performance of the WORK. The daily report shall be completed on forms prepared by the CONTRACTOR and acceptable to the OWNER, and shall be submitted to the OWNER at the conclusion of each workday.

#### 6.16 ASSIGNMENT OF CONTRACT

- A. The CONTRACTOR shall not assign, sublet, sell, transfer, or otherwise dispose of the Agreement or any portion thereof, or its right, title, or interest therein, or obligations thereunder, without the written consent of the OWNER except as imposed by law. If the CONTRACTOR violates this provision, the Agreement may be terminated at the option of the OWNER. In such event, the OWNER shall be relieved of all liability and obligations to the CONTRACTOR and to its assignee or transferee, growing out of such termination.

### ARTICLE 7 - OTHER WORK

#### 7.01 RELATED WORK

- A. The OWNER may perform other work related to the Project at the site by the OWNER's own forces, have other work performed by utility owners, or let other direct contracts for the performance of the other work which may contain General Conditions similar to these. If the fact that such other work is to be performed was not noted in the Contract Documents written notice thereof will be given to the CONTRACTOR prior to commencing any other work.
- B. The CONTRACTOR shall afford each utility owner and other contractor who is a party to a direct contract (or the OWNER, if the OWNER is performing the additional work with the OWNER's employees) proper and safe access to the site and a reasonable

opportunity for the introduction and storage of materials and equipment and the execution of the other work. The CONTRACTOR shall properly connect and coordinate the WORK with the other work. The CONTRACTOR shall do all cutting, fitting, and patching of the WORK that may be required to make its several parts come together properly and integrate with the other work. The CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and shall only cut or alter their work with the written consent of the OWNER and the others whose work will be affected.

- C. If the proper execution or results of any part of the CONTRACTOR's work depends upon the integration of work with the completion of other work by any other contractor or utility owner (or the OWNER), the CONTRACTOR shall inspect and report to the OWNER in writing all delays, defects, or deficiencies in the other work that renders it unavailable or unsuitable for proper integration with the CONTRACTOR's work. Except for the results or effects of material latent defects and deficiencies in the other work which could not reasonably have been discovered by the CONTRACTOR, the CONTRACTOR's failure to report will constitute an acceptance of the other work as fit and proper for integration with the CONTRACTOR's work and as a waiver of any claim for additional time or compensation associated with the integration of the CONTRACTOR's work with the other work.

## 7.02 COORDINATION

- A. If the OWNER contracts with others for the performance of other work on the Project at the site, a coordinator will be identified to the extent that the coordinator can be identified at this time, in the Supplementary General Conditions and delegated the authority and responsibility for coordination of the activities among the various contractors. The specific matters over which the coordinator has authority and the extent of the coordinator's authority and responsibility will be itemized in the Supplementary General Conditions or in a notice to the CONTRACTOR at such time as the identity of the coordinator is determined.

## ARTICLE 8 - OWNER'S RESPONSIBILITIES

### 8.01 COMMUNICATIONS

- A. The OWNER shall issue all its communications directly to the CONTRACTOR.

### 8.02 PAYMENTS

- A. The OWNER shall make payments to the CONTRACTOR as provided in Article 14.

### 8.03 LANDS, EASEMENTS, AND SURVEYS

- A. The OWNER's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. The OWNER shall identify and make available to the CONTRACTOR copies of exploration reports and subsurface conditions tests at the site and in existing structures which have been utilized in preparing the Drawings and Technical Specifications as set forth in Paragraph 4.02.

#### 8.04 CHANGE ORDERS

- A. The OWNER shall execute approved Change Orders for the conditions described in Paragraph 10.01D.
- B. When funds are not budgeted to support continuation of performance in a subsequent fiscal period, the contract shall be canceled and the contractor shall be reimbursed for the reasonable value of any non-recurring costs incurred but not amortized in the price of the supplies or services delivered under the contract.

#### 8.05 INSPECTIONS AND TESTS

- A. The OWNER's responsibility with respect to inspection, tests, and approvals is set forth in Paragraph 13.03B.

#### 8.06 SUSPENSION OF WORK

- A. In connection with the OWNER's right to stop work or suspend work, see Paragraphs 13.04 and 15.01, Paragraphs 15.02 and 15.03 deal with the OWNER's right to terminate services of the CONTRACTOR under certain circumstances.

### **ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION**

#### 9.01 OWNER'S REPRESENTATIVE

- A. The OWNER will designate a representative during the construction period. The duties, responsibilities and the limitations of authority of the OWNER's representative during construction are summarized hereafter.

#### 9.02 VISITS TO SITE

- A. The ENGINEER will make visits to the site during construction to observe and inspect the progress and quality of the WORK and to determine, in general if the WORK is proceeding in accordance with the Contract Documents.

#### 9.03 PROJECT REPRESENTATIVE

- A. The OWNER'S Representative will observe and inspect the performance of the WORK. The Owner's Representative and/or other authorized agents of the OWNER shall serve as the primary contact(s) with the Contractor during the construction phase. All submittals shall be delivered to, and communications between the OWNER and the CONTRACTOR shall be handled by, the Owner's Representative and/or other authorized agents. The Owner's Representative shall be the primary authorized representative of the OWNER in all on-site relations with the CONTRACTOR.

#### 9.04 CLARIFICATIONS AND INTERPRETATIONS

- A. The OWNER will issue, with reasonable promptness written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as the OWNER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

#### 9.05 AUTHORIZED VARIATIONS IN WORK

- A. The OWNER may authorize minor variations in the WORK as described in the Contract Documents when such variations do not involve an adjustment in the Contract Price or the Contract Time and are consistent with the overall intent of the Contract Documents. These variations shall be accomplished by issuing a Field Order. The issuance of a Field Order requires the CONTRACTOR to perform the work described in the order promptly. If the CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Time and the parties are unable to agree as to the amount or extent thereof, the CONTRACTOR may make a claim therefor as provided in Article 11 and 12.

#### 9.06 REJECTION OF DEFECTIVE WORK

- A. The OWNER is authorized to reject work which the OWNER believes to be defective and require special inspection or testing of the WORK as provided in Paragraph 13.03G, whether or not the WORK is fabricated, installed, or completed.

#### 9.07 CONTRACTOR SUBMITTALS, CHANGE ORDERS, AND PAYMENTS

- A. The OWNER will review for approval all CONTRACTOR submittals, including shop drawings, samples, substitutes, and "or equal" items, etc., in accordance with the procedures set forth in the General Requirements.
- B. In connection with the OWNER's REPRESENTATIVE responsibilities as to Change Orders, see Articles 10, 11, and 12.
- C. In connection with the OWNER responsibilities as to Applications for Payment, see Article 14.

#### 9.08 DISPUTES, CLAIMS AND OTHER MATTERS

- A. All claims, disputes, and other matters concerning the acceptability of the WORK, the interpretation of the requirements of the Contract Documents pertaining to the performance of the WORK, and claims for changes in the Contract Price or Contract Time under Articles 11 and 12 will be referred to the OWNER in writing with a request for formal decision in accordance with this paragraph. The OWNER will render a decision in writing within 30 days of receipt of the request. Written notice of each claim, dispute, or other matter will be delivered by the CONTRACTOR to the OWNER promptly (but in no event later than 30 days) after the occurrence of the event. Written supporting data will be submitted to the OWNER with the written claim unless the OWNER allows an additional period of time to ascertain more accurate data in support of the claim.
- B. When reviewing the claim or dispute, the OWNER'S REPRESENTATIVE will not show partiality to the OWNER or the CONTRACTOR and will incur no liability in connection with any interpretation or decision rendered in good faith. The OWNER'S REPRESENTATIVE rendering of a decision with respect to any claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment as provided in Paragraph 14.12) shall be a condition precedent to the OWNER's or the CONTRACTOR's exercise of their rights or remedies under the Contract Documents or by Law or Regulations with respect to the claim, dispute, or other matter.

## 9.09 LIMITATION ON ENGINEER'S RESPONSIBILITIES

- A. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as reviewed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review, or judgment of the OWNER as to the WORK, it is intended that such requirement, direction, review, or judgment will be solely to evaluate the WORK for compliance with the Contract Documents, unless there is a specific statement indicating otherwise. The use of any such term or adjective shall not be effective to assign to the OWNER any duty or authority to supervise or direct the performance of the WORK.
- B. Neither the OWNER nor the ENGINEER will be responsible for the CONTRACTOR's means, methods, techniques, sequences, or procedures of construction not specified in the Contract Documents. Neither the OWNER nor the ENGINEER shall have any responsibility for safety precautions or programs on site or for the safety of CONTRACTOR'S employees, Subcontractors, employees of Subcontractors, Suppliers, employees of Suppliers or others on site.
- C. Neither the OWNER nor the ENGINEER will be responsible for the acts or omissions of the CONTRACTOR nor of any Subcontractor, Supplier, or any other person or organization performing any of the WORK to the extent that such acts or omissions are not reasonably discoverable considering the level of observation and inspection required by the ENGINEER's agreement with the OWNER.

## ARTICLE 10 - CHANGES IN THE WORK

### 10.01 GENERAL

- A. Without invalidating the Agreement and without notice to any surety, the OWNER may at any time or from time to time, order additions, deletions, or revisions in the WORK; these will be authorized by a written Field Order and/or a Change Order issued by the OWNER. Upon receipt of any of these documents, the CONTRACTOR shall promptly proceed with the work involved pursuant to the applicable conditions of the Contract Documents.
- B. If the OWNER and the CONTRACTOR are unable to agree upon the increase or decrease in the Contract Price or an extension or shortening of the Contract Time, if any, that should be allowed as a result of a Field Order, a claim may be made therefor as provided in Articles 11 and 12.
- C. The CONTRACTOR shall not be entitled to an increase in the Contract Price nor an extension of the Contract Time with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented by Change Order, except in the case of an emergency and except in the case of uncovering work provided in the Paragraph 13.03G.
- D. The OWNER and the CONTRACTOR shall execute appropriate Change Orders covering:
  - 1. Changes in the WORK which are ordered by the OWNER pursuant to Paragraph 10.01A;

2. Changes required because of acceptance of defective work under Paragraph 13.06;
  3. Changes in the Contract Price or Contract Time which are agreed to by the parties; or
  4. Any other changes agreed to by the parties.
  5. Any construction contract change order which increases the contract amount shall have the prior written certification of the District's controller that the expenditure of the change order amount is properly authorized by the District's board of trustees consistent with the District's budget and financial management policies and the instructions of the board of trustees.
- E. If the provisions of any Bond require notice of any change to be given to a surety, the giving of these notices will be the CONTRACTOR's responsibility. The CONTRACTOR shall provide for the amount of each applicable Bond to be adjusted accordingly.

#### 10.02 ALLOWABLE QUANTITY VARIATIONS

- A. Whenever a unit price and quantity have been established for a bid item in the Contract Documents, the quantity stated may be increased or decreased to a maximum of 25 percent with no change in the unit price. An adjustment in the quantity in excess of 25 percent will be sufficient to justify a change in the unit price. All changes in the quantities of bid items shall be documented by Change Order.
- B. In the event a part of the WORK is to be entirely eliminated and no lump sum or unit price is named in the Contract Documents to cover the eliminated work, the price of the eliminated work shall be agreed upon in writing by the OWNER and the CONTRACTOR. If the OWNER and the CONTRACTOR fail to agree upon the price of the eliminated work, the price shall be determined in accordance with the provisions of Article 11.

### ARTICLE 11 - CHANGE OF CONTRACT PRICE

#### 11.01 GENERAL

- A. The Contract Price constitutes the total compensation payable to the CONTRACTOR for performing the WORK. Except as directed by Change Orders, all duties, responsibilities, and obligations assigned to or undertaken by the CONTRACTOR shall be at its expense without change in the Contract Price.
- B. The Contract Price may only be changed by a Change Order. Any claim for an increase in the Contract Price shall be based on written notice delivered by the CONTRACTOR to the OWNER promptly (but in no event later than 30 days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered with the claim, unless the OWNER allows an additional period of time to ascertain more accurate data in support of the claim, and shall be accompanied by the CONTRACTOR's written statement that the amount claimed covers all known amounts (direct, indirect, and consequential) to which the CONTRACTOR is entitled as a result of the occurrence of the event. If the OWNER and the CONTRACTOR cannot otherwise agree on the amount involved, all claims for adjustment in the Contract Price shall be determined by the OWNER in

accordance with Paragraph 9.08A. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this paragraph.

- C. The value of any work covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined in one of the following ways:
1. Where the work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.
  2. Mutual acceptance of a lump sum, which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.
  3. On the basis of the cost of work (determined as provided in Paragraphs 11.02 and 11.03) plus a CONTRACTOR's fee for overhead and profit (determined as provided in Paragraph 11.04).

#### 11.02 COST OF WORK (BASED ON TIME AND MATERIALS)

- A. General: The term "cost of work" means the sum of all costs necessarily incurred and paid by the CONTRACTOR for labor, materials, and equipment in the proper performance of work. Except as otherwise may be agreed to in writing by the OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project.
- B. Labor: The cost of labor used in performing work by the CONTRACTOR, a Subcontractor, or other forces will be the sum of the following:
1. The actual wages paid plus any employer payments to, or on behalf of workers for fringe benefits including health and welfare, pension, vacation, and similar purposes. The cost of labor may include the rates paid to foremen when determined by the OWNER that the services of foremen do not constitute a part of the overhead allowance.
  2. All payments imposed by state and federal laws including, but not limited to, compensation insurance, and social security payments.
  3. The amount paid for subsistence and travel required by collective bargaining agreements, or in accordance with the regular practice of the employer.
  4. At the beginning of the extra work and as later requested by the OWNER, the CONTRACTOR shall furnish the OWNER proof of labor compensation rates being paid.
- C. Materials: The cost of materials used in performing work will be the cost to the purchaser, whether CONTRACTOR or Subcontractor, from the Supplier thereof, except as the following are applicable:
1. Trade discounts available to the purchase shall be credited to the OWNER notwithstanding the fact that such discounts may not have been taken by the CONTRACTOR.
  2. For materials secured by other than a direct purchase and direct billing to the purchaser, the cost shall be deemed to be the price paid to the actual Supplier as

determined by the OWNER. Markup except for actual costs incurred in the handling of such materials will not be allowed.

3. Payment for materials from sources owned wholly or in part by the purchaser shall not exceed the price paid by the purchaser for similar materials from these sources on extra work items or current wholesale price for the materials delivered to the work site, whichever is lower.
4. If, in the opinion of the OWNER, the cost of material is excessive, or the CONTRACTOR does not furnish satisfactory evidence of the cost of the material, then the cost shall be deemed to be the lowest current wholesale price for the quantity concerned, delivered to the work site less trade discount. The OWNER reserves the right to furnish materials for the extra work and no claim shall be made by the CONTRACTOR for costs and profit on such materials.

D. Equipment: The CONTRACTOR will be paid for the use of equipment at the rental rate listed for the equipment specified in the Rental Rate Blue Book published by Dataquest, Inc. The rental rate will be used to compute payments for equipment whether the equipment is under the CONTRACTOR's control through direct ownership, leasing, renting, or another method of acquisition. The rental rate to be applied for use of each item of equipment shall be the rate resulting in the least total cost to the Owner for the total period of use.

1. All equipment shall, in the opinion of the OWNER, be in good working condition and suitable for the purpose for which the equipment is to be used.
2. Before construction equipment is used on the extra work, the CONTRACTOR shall plainly stencil or stamp an identifying number thereon at a conspicuous location, and shall furnish to the OWNER, in duplicate, a description of the equipment and its identifying number.
3. Unless otherwise specified, manufacturers' ratings and manufacturer-approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer.
4. Individual pieces of equipment or tools having a replacement value of \$100 or less, whether or not consumed by use, shall be considered to be small tools and no payment will be made therefore.
5. Rental time will not be allowed while equipment is inoperative due to breakdowns.

E. Equipment on the Work: The rental time to be paid for equipment used on the WORK shall be the time the equipment is in productive operation on the extra work being performed and, in addition, shall include the time required to move the equipment to the location of the extra work and return it to the original location or to another location that requires no more moving time than that required to return it to its original location. Moving time will not be paid if the equipment is used on other than the extra work, even though located at the site of the extra work. Loading and transporting costs will be allowed, in lieu of moving time, when the equipment is moved by means other than its own power. However, no payment will be made for loading and transporting costs when



the equipment is used on other than the extra work even though located at the site of the extra work. The following shall be used in computing the rental time of equipment on the WORK.

1. When hourly rates are listed, any part of an hour less than 30 minutes of operation shall be considered to be 1/2-hour of operation, and any part of an hour in excess of 30 minutes will be considered one hour of operation.
2. When daily rates are listed, any part of a day less than 4 hours operation shall be considered to be 1/2-day of operation. When owner-operated equipment is used to perform extra work to be paid for on a time and materials basis, the CONTRACTOR will be paid for the equipment and operator, as set forth in Paragraph (3), (4), and (5), following.
3. Payment for the equipment will be made in accordance with the provisions in Paragraph 11.02D, herein.
4. Payment for the cost of labor and subsistence or travel allowance will be made at the rates paid by the CONTRACTOR to other workers operating similar equipment already on the WORK, or in the absence of such labor, established by collective bargaining agreements for the type of workmen and location of the extra work, whether or not the operator is actually covered by such an agreement. A labor surcharge will be added to the cost of labor described herein in accordance with the provisions of Paragraph 11.02B, herein, which surcharge shall constitute full compensation for payments imposed by state and federal laws and all payments made to on behalf of workers other than actual wages.
5. To the direct cost of equipment rental and labor, computed as provided herein, will be added the allowances for equipment rental and labor as provided in Paragraph 11.04, herein.

### 11.03 SPECIAL SERVICES

- A. Special work or services are defined as that work characterized by extraordinary complexity, sophistication, or innovation or a combination of the foregoing attributes which are unique to the construction industry. The following may be considered by the OWNER in making estimates for payment for special services:
  1. When the OWNER and the CONTRACTOR, by agreement, determine that a special service or work is required which cannot be performed by the forces of the CONTRACTOR or those of any of its Subcontractors, the special service or work may be performed by an entity especially skilled in the work to be performed. After validation of invoices and determination of market values by the OWNER, invoices for special services or work based upon the current fair market value thereof may be accepted without complete itemization of labor, material, and equipment rental cost.
  2. When the CONTRACTOR is required to perform work necessitating special fabrication or machining process in a fabrication or a machine shop facility away from the job site, the charges for that portion of the work performed at the off-site facility may by agreement, be accepted as a special service and accordingly, the invoices from the work may be accepted without detailed itemization.

3. All invoices for special services will be adjusted by deducting all trade discounts offered or available, whether the discounts were taken or not. In lieu of the allowances for overhead and profit specified in Paragraph 11.04, herein, an allowance of 5 percent will be added to invoices for special services.
- B. All work performed hereunder shall be subject to all of the provisions of the Contract Documents and the CONTRACTOR's sureties shall be bound with reference hereto as under the original Agreement. Copies of all amendments to surety bonds or supplemental surety bonds shall be submitted to the OWNER for review prior to the performance of any work hereunder.

#### 11.04 CONTRACTOR'S FEE

- A. Work ordered on the basis of time and materials will be paid for at the actual necessary cost as determined by the OWNER, plus allowances for overhead and profit. For extra work involving a combination of increases and decreases in the WORK, the actual necessary cost will be the arithmetic sum of the additive and deductive costs. The allowance for overhead and profit shall include full compensation for superintendence, bond and insurance premiums, taxes, office expenses, and all other items of expense or cost not included in the cost of labor, materials, or equipment provided for under Paragraphs 11.02B, C, and D herein, including extended overhead and home office overhead. The allowance for overhead and profit will be made in accordance with the following schedule:

##### OVERHEAD AND PROFIT ALLOWANCE

Labor .....	10 percent
Materials .....	10 percent
Equipment .....	10 percent

- B. It is understood that labor, materials, and equipment may be furnished by the CONTRACTOR or by a Subcontractor, and that the allowance specified herein shall be applied to the labor, materials, and equipment costs of the Subcontractor, to which the CONTRACTOR may add 5 percent of the Subcontractor's total cost of work. Regardless of the number of hierarchical tiers of Subcontractors, the 5 percent markup may be applied one time only for each separate work transaction.

### ARTICLE 12 - CHANGE OF CONTRACT TIME

#### 12.01 GENERAL

- A. The Contract Time may only be changed by a Change Order. Any claim for an extension of the Contract time shall be based on written notice delivered by the CONTRACTOR to the OWNER promptly (but in no event later than 30 days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within 30 days after such occurrence (unless the OWNER allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR's written statement that the adjustment claimed is the entire adjustment to which the CONTRACTOR has reason to believe it is entitled as a result of the occurrence of said event. Claims for adjustment in the Contract Time shall be determined by the OWNER in accordance with Paragraph 9.08 if the OWNER's representative and the CONTRACTOR cannot otherwise agree. No claim for an

adjustment in the Contract Time will be valid if not submitted in accordance with the requirements of this paragraph.

- B. The Contract Time will be extended in an amount equal to time lost if the CONTRACTOR makes a claim as provided in Paragraph 12.01A and the OWNER determines that the delay was caused by events beyond the control of the CONTRACTOR. Examples of events beyond the control of the CONTRACTOR include acts or neglect by the OWNER or others performing additional work as contemplated by Article 7, or by acts of God or of the public enemy, fire, floods, epidemics, quarantine restrictions, strikes, labor disputes, sabotage, or freight embargoes.
- C. All time limits stated in the Contract Documents are of the essence.
- D. None of the aforesaid time extensions shall entitle the CONTRACTOR to any adjustment in the Contract Price or any damages for delay. Furthermore, the CONTRACTOR hereby indemnifies and holds harmless the OWNER and ENGINEER, their officers, agents and employees from and against all claims, damages, losses and expenses (including lost property and attorney's fees) arising out of or resulting from the temporary suspension of work whether for the OWNER's convenience as defined in Article 15.01A or for whatever other reasons including the stoppage of work by the OWNER for the CONTRACTOR's failure to comply with any order issued by the OWNER.

#### 12.02 EXTENSIONS OF THE TIME FOR DELAY DUE TO INCLEMENT WEATHER

- A. "Inclement weather" is any weather condition or conditions resulting immediately therefrom, causing the CONTRACTOR to suspend construction operations or preventing the CONTRACTOR from proceeding with at least 75 percent of the normal labor and equipment force engaged on the WORK.
- B. Should the CONTRACTOR prepare to begin work at the regular starting time at the beginning of any regular work shift on any day on which inclement weather, or its effects on the condition of the WORK prevents work from beginning at the usual starting time and the crew is dismissed as a result thereof, the CONTRACTOR will not be charged for a working day whether or not conditions change thereafter during the day and the major portion of the day could be considered to be suitable for construction operations.
- C. The CONTRACTOR shall base its construction schedule upon the inclusion of the number of days of inclement weather specified in the Supplementary General Conditions. No extension of the Contract Time due to inclement weather will be considered until after the stated number of days of inclement weather has been reached. However, no reduction in Contract Time will be made if the number of inclement weather days is not reached.

#### 12.03 EXTENSIONS OF TIME FOR OTHER DELAYS

- A. If the CONTRACTOR is delayed in completion of the WORK beyond the Contract Time, by acts of God or of the public enemy, fire, floods, epidemics, quarantine restrictions, strikes, labor disputes, industry-wide shortage of raw materials, sabotage or freight embargoes, the CONTRACTOR shall be entitled to an adjustment in the Contract Time. No such adjustment will be made unless the CONTRACTOR shall notify the OWNER in writing of the causes of delay within 15 calendar days from the beginning of any such delay. The OWNER shall ascertain the facts and the extent of the delay. No adjustment in time shall be made for delays resulting from noncompliance with the Contract

Documents, accidents, failure on the part of the CONTRACTOR to carry out the provisions of the Contract Documents including failure to provide materials, equipment or workmanship meeting the requirements of the Contract Documents; the occurrence of such events shall not relieve the CONTRACTOR from the necessity of maintaining the required progress.

- B. If the CONTRACTOR is delayed in completing the WORK beyond the Contract Time by reason of shortages of raw materials required for CONTRACTOR-furnished items, the CONTRACTOR shall be entitled to an adjustment in the Contract Time in like manner as if the WORK had been suspended for the convenience and benefit of the OWNER; provided, however, that the CONTRACTOR shall furnish documentation acceptable to the OWNER that he placed or attempted to place firm orders with Suppliers at a reasonable time in advance of the required date of delivery of the items in question, that such shortages shall have developed following the date such orders were placed or attempts made to place same, that said shortages are general throughout the affected industry, that said shortages are shortages of raw materials required to manufacture CONTRACTOR furnished items and not simply failure of CONTRACTOR's Suppliers to manufacture, assemble or ship items on time, and that the CONTRACTOR shall, to the degree possible, have made revisions in the sequence of his operations, within the terms of the Contract Documents, to offset the expected delay. The CONTRACTOR shall notify the OWNER, in writing, concerning the cause of delay, within 15 calendar days of the beginning of such delay. The validity of any claim by the CONTRACTOR to an adjustment in the Contract Time shall be determined by the OWNER, and his findings thereon shall be based on the OWNER's knowledge and observations of the events involved and documentation submitted by the CONTRACTOR, showing all applicable facts relative to the foregoing provisions. Only the physical shortage of raw materials will be considered under these provisions as a cause for adjustment of time and no consideration will be given to any claim that items could not be obtained at a reasonable, practical, or economical cost or price, unless it is shown to the satisfaction of the OWNER that such items could have been obtained only at exorbitant prices entirely out of line with current rates taking into account the quantities involved and the usual practices in obtaining such quantities.
- C. If the CONTRACTOR is delayed in completion of the WORK by any act of the OWNER not authorized by the Contract Documents, an adjustment in the Contract Time will be made by the OWNER in like manner as if the WORK had been suspended for the convenience and benefit of the OWNER. In the event of such delay, the CONTRACTOR shall notify the OWNER in writing of the causes of delay within 15 calendar days from the beginning of any such delay.

### **ARTICLE 13 - WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK**

#### **13.01 WARRANTY, GUARANTEE AND CORRECTION PERIOD**

- A. The CONTRACTOR warrants and guarantees to the OWNER and the ENGINEER that all work, equipment, materials and workmanship are in accordance with the Contract Documents and are not defective. Reasonably prompt notice of defects discovered by the OWNER or ENGINEER shall be given to the CONTRACTOR. All defective work, whether or not in place, may be rejected, corrected, or accepted as provided in this Article 13.

- B. If within one (1) year after the date of final completion, as set by the Contractor's Certificate of Final Completion, or a longer period of time prescribed by Laws or Regulations or by the terms of any applicable special guarantee or specific provisions of the Contract Documents, any part of the WORK is found to be defective, the OWNER shall notify the CONTRACTOR in writing and the CONTRACTOR shall promptly, without cost to the OWNER and in accordance with the OWNER's written notification, either correct the defective work, or, if it has been rejected by the OWNER, remove it from the site and replace it with non-defective work. In the event the CONTRACTOR does not promptly comply with the notification, or in an emergency where delay would cause serious risk of loss or damage, the OWNER may have the defective work corrected or rejected work removed and replaced. All direct, indirect, and consequential costs of the removal and replacement including but not limited to fees and charges of engineers, architects, attorneys and other professionals will be paid by the CONTRACTOR. This paragraph shall not be construed to limit nor diminish the CONTRACTOR's absolute guarantee to complete the WORK in accordance with the Contract Documents.

### 13.02 ACCESS TO WORK

- A. The ENGINEER, other representatives of the OWNER, testing agencies, and governmental agencies with jurisdictional interests shall have access to the work at reasonable times for their observation, inspections, and testing. The CONTRACTOR shall provide proper and safe conditions for their access.

### 13.03 TESTS AND INSPECTIONS

- A. The CONTRACTOR shall give the OWNER timely notice of readiness of the WORK for all required inspections, tests, or approvals.
- B. If Laws or Regulations of any public body other than the OWNER, with jurisdiction over the WORK require any work to be specifically inspected, tested, or approved, the CONTRACTOR shall pay all costs in connection therewith. The CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with the OWNER's acceptance of a Supplier of materials or equipment proposed as a substitution or "or-equal" to be incorporated in the WORK and of materials or equipment submitted for review prior to the CONTRACTOR's purchase for incorporation in the WORK. The cost of all inspections, tests, and approvals, with the exception of the above which are required by the Contract Documents, shall be paid by the OWNER (unless otherwise specified).
- C. The OWNER will make, or have made, such inspections and tests as the OWNER deems necessary to see that the WORK is being accomplished in accordance with the Contract Documents. The CONTRACTOR, without additional cost to the OWNER, shall provide the labor and equipment necessary to make the WORK available for inspections. Unless otherwise specified in the Supplementary General Conditions, all other costs of inspection and testing will be borne by the OWNER. In the event the inspections or tests reveal non-compliance with the requirements of the Contract Documents, the CONTRACTOR shall bear the cost of corrective measures deemed necessary by the OWNER, as well as the cost of subsequent re-inspection and retesting. Neither observations by the OWNER nor inspections, tests, or approvals by others shall relieve the CONTRACTOR from the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

- D. All inspections, tests, or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by properly licensed organizations selected by the OWNER.
- E. If any work (including the work of others) that is to be inspected, tested, or approved is covered without the OWNER's written authorization, it must, if requested by the OWNER, be uncovered for testing, inspection, and observation. The uncovering shall be at the CONTRACTOR's expense unless the CONTRACTOR timely notified the OWNER of the CONTRACTOR's intention to cover the same and the OWNER failed to act with reasonable promptness in response to the notice.
- F. If any work is covered contrary to the written request of the OWNER, it must, if requested by the OWNER, be uncovered for the OWNER's observation at the CONTRACTOR's expense.
- G. If the OWNER considers it necessary or advisable that covered work be observed, inspected or tested by the OWNER or others, the OWNER shall direct the CONTRACTOR to uncover, expose, or otherwise make available for observation, inspection, or testing that portion of the work in question. The CONTRACTOR shall comply with the OWNER's direction and furnish all necessary labor, material, and equipment. If the work is defective, the CONTRACTOR shall bear all direct, indirect and consequential costs of uncovering, exposure, observation, inspection, and testing and of satisfactory reconstruction of the work, including, but not limited to, fees and charges for engineers, architects, attorneys, and other professionals. However, if the work is not defective, the CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Time, or both. The increase in Contract Time and Contract Price shall be the CONTRACTOR's actual time and costs directly attributable to uncovering and exposing the work. If the parties are unable to agree as to the amount or extent of the changes, the CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

#### 13.04 OWNER MAY STOP THE WORK

- A. If the WORK is defective, or the CONTRACTOR fails to perform work in such a way that the completed WORK will conform to the Contract Documents, the OWNER may order the CONTRACTOR to stop the WORK, or any portion thereof, until the cause for the order has been eliminated. This right of the OWNER to stop the WORK shall not give rise to any duty on the part of the OWNER to exercise this right for the benefit of the CONTRACTOR or any other party.

#### 13.05 CORRECTION OR REMOVAL OF DEFECTIVE WORK

- A. When directed by the OWNER, the CONTRACTOR shall promptly correct all defective work, whether or not fabricated, installed, or completed, or, if the work has been rejected by the OWNER, remove it from the site and replace it with non-defective work. The CONTRACTOR shall bear all direct, indirect and consequential costs of correction or removal, including but not limited to fees and charges of engineers, architects, attorneys, and other professionals made necessary thereby. If the CONTRACTOR does not correct the defective work within 30 days, the OWNER may correct the WORK and charge the CONTRACTOR for the cost of correcting the defective WORK.

### 13.06 ACCEPTANCE OF DEFECTIVE WORK

- A. If, instead of requiring correction or removal and replacement of defective work, the OWNER prefers to accept the work, the OWNER may do so. The CONTRACTOR shall bear all direct, indirect, and consequential costs attributable to the OWNER's evaluation of and determination to accept the defective work. If any acceptance of defective work occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the WORK, and the OWNER shall be entitled to an appropriate decrease in the Contract Price.

## **ARTICLE 14 - PAYMENTS TO CONTRACTOR, LIQUIDATED DAMAGES AND COMPLETION**

### 14.01 LUMP SUM BID

- A. A schedule of values or lump sum price breakdown will serve as the basis for progress payments for a lump sum Bid and will be incorporated into the form of Application for Payment included in the Contract Documents.

### 14.02 UNIT PRICE BID

- A. Progress payments for a unit price Bid will be based on the number of units completed.

### 14.03 APPLICATION FOR PROGRESS PAYMENT

- A. Unless otherwise prescribed by the OWNER, on the 25th of each month, the CONTRACTOR shall submit to the OWNER for review and approval, an Application for Payment completed and signed by the CONTRACTOR covering the WORK completed as of the date of the Application and accompanied by such supporting documentation as required by the Contract Documents.
- B. The Application for Payment shall identify, as a sub-total, the amount of the CONTRACTOR's Total Earnings to Date, plus the Net Value of Materials On-site which have not yet been incorporated in the WORK.
- C. The Net Payment Due to the CONTRACTOR shall be the above-mentioned sub-total, from which shall be deducted the retainage amount and the total amount of all previous payments made to the CONTRACTOR.
- D. The OWNER may retain five percent of the amount otherwise due to the Contractor as retainage. Monies retained shall be placed in an interest-bearing account for the benefit of the CONTRACTOR.
- E. Except as otherwise provided in the Supplementary General Conditions, the value of materials stored at the site shall be valued at 95 percent of the value of the materials. This amount shall be based upon the value of all acceptable materials and equipment stored at the site or at another location agreed to in writing by the OWNER; provided, each individual item has a value of more than \$5000 and will become a permanent part of the WORK. The Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that the CONTRACTOR has received the materials and equipment free and clear of all liens, charges, security interests, and encumbrances (which are hereinafter referred to as "Liens") and evidence that the materials and equipment are covered by appropriate property insurance and

other arrangements to protect the OWNER's interest therein, all of which will be satisfactory to the OWNER.

#### 14.04 CONTRACTOR'S WARRANTY OF TITLE

- A. The CONTRACTOR warrants and guarantees that title to all work, materials, and equipment covered by an Application for Payment, whether incorporated in the WORK or not, will pass to the OWNER no later than the time of final payment, free and clear of all liens.

#### 14.05 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

- A. The OWNER will, within 7 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to the OWNER, or return the Application to the CONTRACTOR indicating in writing the OWNER's reasons for refusing to recommend payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the Application. Thirty days after presentation of the Application for Payment with the OWNER's REPRESENTATIVE recommendation, the amount recommended will (subject to the provisions of Paragraph 14.05B) become due and when due will be paid by the OWNER to the CONTRACTOR.
- B. The OWNER may refuse to make payment of the full amount recommended by the OWNER's REPRESENTATIVE to compensate for claims made by the OWNER on account of the CONTRACTOR's performance of the WORK or other items entitling the OWNER to a credit against the amount recommended, but the OWNER must give the CONTRACTOR written notice within 7 days stating the reasons for such action.

#### 14.06 PARTIAL UTILIZATION

- A. The OWNER may utilize or place into service any item of equipment or other usable portion of the WORK at any time prior to completion of the WORK. The OWNER shall notify the CONTRACTOR in writing of its intent to exercise this right. The notice will identify the equipment or specific portion or portions of the WORK to be utilized or otherwise placed into service.
- B. It shall be understood by the CONTRACTOR that until such written notification is issued, all responsibility for care and maintenance of all items or portions of the WORK to be partially utilized shall be borne by the CONTRACTOR. Upon the issuance of a notice of partial utilization, the OWNER's REPRESENTATIVE will deliver to the OWNER and the CONTRACTOR a written recommendation as to division of responsibilities between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance.
- C. The CONTRACTOR shall retain full responsibility for satisfactory completion of the WORK, regardless of whether a portion thereof has been partially utilized by the OWNER, and the CONTRACTOR's one-year correction period shall commence only after the date of Final Completion for the WORK.

#### 14.07 DAMAGES

- A. The CONTRACTOR shall pay to the OWNER the amount specified in the Supplementary General Conditions, not as a penalty but as liquidated damages, if he



fails to complete the WORK or specified parts of the WORK within the Contract Time. The periods for which these damages shall be paid shall be the number of Days from the Contract Time as contained in the Agreement, or from the date of termination of any extension of time approved by the OWNER, to the date or dates on which the OWNER issues the Notice of Substantial Completion as provided in Article 14.08, herein. The OWNER may deduct the amount of said damages from any monies due or to become due the CONTRACTOR. After Substantial Completion, if the CONTRACTOR fails to complete the remaining WORK within 45 days or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER the amount stated in the Supplementary General Conditions as liquidated damages for each day that expires after the 45 days, until readiness for final payment.

- B. The said amount is fixed and agreed upon by and between the CONTRACTOR and the OWNER because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the OWNER would sustain; and said amount is agreed to be the amount of damages which the OWNER would sustain.
- C. If actual damages are assessed, they will include all costs incurred by the OWNER as a result of a delay in the completion time of the work beyond the contract time.
- D. All times specified in the Contract Documents are hereby declared to be of the essence.

#### 14.08 SUBSTANTIAL COMPLETION

- A. When the CONTRACTOR considers the WORK ready for its intended use, the CONTRACTOR will notify the OWNER in writing that the WORK is Substantially Complete. Within a reasonable time thereafter, the OWNER and the CONTRACTOR, shall make an inspection of the WORK to determine the status of completion. If the OWNER does not consider the WORK Substantially Complete, the OWNER will notify the CONTRACTOR in writing giving the reasons therefor. If the OWNER considers the WORK Substantially Complete, the OWNER will execute the Notice of Substantial Completion signed by the CONTRACTOR, which shall fix the date of Substantial Completion.
- B. The Notice of Substantial Completion shall be a release by the CONTRACTOR of the OWNER and its agents from all claims and liability to the CONTRACTOR for anything done or furnished for, or relating to, the WORK or for any act or neglect of the OWNER or of any person relating to or affecting the WORK, to the date of Substantial Completion, except demands against the OWNER for the remainder of the amounts kept or retained from progress payments and excepting pending, unresolved claims filed in writing prior to the date of Substantial Completion. At the time of delivery of the Notice of Substantial Completion, the OWNER's REPRESENTATIVE will deliver to the OWNER and the CONTRACTOR, if applicable, a written recommendation as to division of responsibilities between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance. Upon the OWNER's acceptance of these recommendations, the recommendation will be binding on the OWNER and the CONTRACTOR until final payment.
- C. The OWNER, upon written notice to the CONTRACTOR, shall have the right to exclude the CONTRACTOR from the WORK after the date of Substantial Completion, and complete all or portions of the WORK at the CONTRACTOR's expense.

#### 14.09 COMPLETION AND FINAL PAYMENT

- A. Upon written certification from the CONTRACTOR that the WORK is complete (if a Notice of Substantial Completion has been issued this certification must occur within 45 days of that date), the OWNER will make a final inspection with the CONTRACTOR. If the OWNER does not consider the WORK complete, the OWNER will notify the CONTRACTOR in writing of all particulars in which this inspection reveals that the WORK is incomplete or defective. The CONTRACTOR shall immediately take the measures necessary to remedy these deficiencies. If the OWNER considers the WORK complete, the CONTRACTOR may proceed to file its application for final payment pursuant to this Article. At the request of the CONTRACTOR, the OWNER's REPRESENTATIVE may recommend to the OWNER that certain minor deficiencies in the WORK that do not prevent the entire WORK from being used by the OWNER for its intended use, and the completion of which will be unavoidably delayed due to no fault of the CONTRACTOR, be exempted from being completed prerequisite to final payment. These outstanding items of pickup work, or "punch list items", shall be listed on the Notice of Substantial Completion, together with the recommended time limits for their completion, and extended warranty requirements for those items and the value of such items.
- B. After the issuance of the Notice of Completion and after the CONTRACTOR has completed corrections that have not been exempted to the satisfaction of the OWNER and delivered to the OWNER all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, marked-up record documents and other documents, all as required by the Contract Documents; and after the OWNER has indicated that the WORK is acceptable, the CONTRACTOR may make application for final payment following the procedure for progress payments. The final application for payment shall be accompanied by all documentation called for in the Contract Documents and other data and schedules as the OWNER may reasonably require, including an affidavit of the CONTRACTOR that all labor, services, material, equipment and other indebtedness connected with the WORK for which the OWNER or his property might in any way be responsible, have been paid or otherwise satisfied, and a consent of the payment bond surety to final payment, all in forms approved by the OWNER.

#### 14.10 FINAL APPLICATION FOR PAYMENT

- A. If, on the basis of the OWNER's observation of the WORK during construction and final inspection, and the OWNER's review of the final application for payment and accompanying documentation, all as required by the Contract Documents, the OWNER is satisfied that the WORK has been completed and the CONTRACTOR has fulfilled all of his obligations under the Contract Documents, the OWNER's REPRESENTATIVE will, within ten days after receipt of the final application for payment, indicate in writing his recommendation of payment and present the application to the OWNER for payment. Thereupon, the OWNER's REPRESENTATIVE will give written notice to the OWNER and the CONTRACTOR that the WORK is acceptable by executing the Notice of Completion. Otherwise, the OWNER will return the application to the CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case the CONTRACTOR shall make the necessary corrections and resubmit the application.
- B. Within 45 calendar days after the Notice of Completion, the OWNER will make final payment including all deducted retainage and interest to the CONTRACTOR. The OWNER's remittance of final payment shall be the OWNER's acceptance of the WORK

if formal acceptance of the WORK is not indicated otherwise. The final payment shall be that amount remaining after deducting all prior payments and all amounts to be kept or retained under the provisions of the Contract, including the following items:

1. Liquidated or actual damages, as applicable.
2. Two times the value of any outstanding items of pickup work or "punch list items", indicated on the OWNER's Notice of Completion as being yet uncompleted.

#### 14.11 CONTRACTOR'S CONTINUING OBLIGATIONS

- A. The CONTRACTOR's obligation to perform and complete the WORK in accordance with the Contract Documents shall be absolute. Neither recommendation of any progress or final payment by the OWNER, nor the issuance of a Notice of Substantial Completion or Notice of Completion, nor payment by the OWNER to the CONTRACTOR under the Contract Documents, nor any use or occupancy of the WORK or any part thereof by the OWNER, nor any act of acceptance by the OWNER nor any failure to do so, nor any review of a shop drawing or sample submittal, will constitute an acceptance of work or materials not in accordance with the Contract Documents or a release of the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

#### 14.12 FINAL PAYMENT TERMINATES LIABILITY OF OWNER

- A. Final payment is defined as the last progress payment made to the CONTRACTOR for earned funds, less deductions listed in Paragraph 14.10B herein. The acceptance by the CONTRACTOR of the final payment referred to in Paragraph 14.10 herein, shall be a release of the OWNER and its agents from all claims of liability to the CONTRACTOR for anything done or furnished for, or relating to, the work or for any act or neglect of the OWNER or of any person relating to or affecting the work, except demands against the OWNER for the remainder, if any, of the amounts kept or retained under the provisions of Paragraph 14.10 herein; and excepting pending, unresolved claims filed prior to the date of the Notice of Substantial Completion.

### ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

#### 15.01 SUSPENSION OF WORK BY OWNER

- A. The OWNER may, by written notice to the Contractor, temporarily suspend the WORK, in whole or in part, for a period or periods of time, but not to exceed 90 days, for the convenience and benefit of the OWNER upon the occurrence of any one or more of the following: (1) unsuitable weather; (2) delay in delivery of OWNER- furnished equipment or materials, or such other conditions as are considered unfavorable for prosecution of the work; (3) Shortfall in construction funds; (4) Constraints imposed by public entities, public utilities, property owners or legal proceedings; (5) Failure or delay in acquisition of easements or right-of-way by the OWNER; or (6) Other conditions which, in the opinion of the OWNER, warrant a delay in the WORK. Suspended WORK shall be resumed by the CONTRACTOR within 10 calendar days of receipt from the OWNER of written notice to resume work. Whenever the OWNER temporarily suspends work for any conditions enumerated in this Article, the CONTRACTOR shall be entitled to an adjustment in the Contract Time as specified in Article 12.03 C.

- B. The suspension of work shall be effective upon receipt by the CONTRACTOR of a written order suspending the work and shall be terminated upon receipt by the Contractor of a written order terminating the suspension.
- C. The CONTRACTOR hereby indemnifies and holds harmless the OWNER, their officers, agents and employees, from and against all claims, damages, losses and expenses, including lost profits and attorney's fees, arising out of or resulting from the temporary suspension of the WORK, whether for the OWNER's convenience described in this Article or for whatever other reasons, including the stoppage of work by the OWNER for the CONTRACTOR's failure to comply with any order issued by the OWNER.

#### 15.02 TERMINATION OF AGREEMENT BY OWNER (CONTRACTOR DEFAULT)

- A. In the event of default by the CONTRACTOR, the OWNER may give written notice to the CONTRACTOR of OWNER's intent to terminate the Agreement. The notice shall state the event of default and the time allowed to remedy the default. It shall be considered a default by the CONTRACTOR whenever the CONTRACTOR shall: (1) declare bankruptcy, become insolvent, or assign its assets for the benefit of its creditors; (2) fail to provide materials or workmanship meeting the requirements of the Contract Documents; (3) disregard or violate provisions of the Contract Documents or OWNER's instructions, (4) fail to prosecute the WORK according to the approved progress schedule; or, (5) fail to provide a qualified superintendent, competent workmen, or materials or equipment meeting the requirements of the Contract Documents. If the CONTRACTOR fails to remedy the conditions constituting default within the time allowed, the OWNER may then issue a Notice of Termination.
- B. In the event the Agreement is terminated in accordance with Paragraph 15.02A, the OWNER may take possession of the WORK and may complete the WORK by whatever method or means the OWNER may select. The cost of completing the WORK shall be deducted from the balance which would have been due the CONTRACTOR had the Agreement not been terminated and the WORK completed in accordance with the Contract Documents. If such cost exceeds the balance which would have been due, the CONTRACTOR shall pay the excess amount to the OWNER. If such cost is less than the balance which would have been due, the CONTRACTOR shall have no claim to the difference.

#### 15.03 TERMINATION OF AGREEMENT BY OWNER (FOR CONVENIENCE)

- A. The OWNER may terminate the Agreement at any time if it is found that reasons beyond the control of either the OWNER or CONTRACTOR make it impossible or against the OWNER's interests to complete the WORK. In such a case, the CONTRACTOR shall have no claims against the OWNER except: (1) for the value of the work, as determined by the OWNER, performed by the Contractor up to the date the Agreement is terminated; and, (2) for the cost of materials and equipment on hand, in transit, or on definite commitment, as of the date the Agreement is terminated, which would be needed in the WORK and which meet the requirements of the Contract Documents. The value of work performed and the cost of materials and equipment delivered to the site, as mentioned above, shall be determined by the OWNER in accordance with the procedure prescribed from making the final application for payment and final payment under Paragraphs 14.09 and 14.10.

#### 15.04 TERMINATION OF AGREEMENT BY CONTRACTOR

- A. The CONTRACTOR may terminate the Agreement upon 10 days written notice to the OWNER, whenever: (1) the WORK has been suspended under the provisions of Paragraph 15.01, for more than 90 consecutive days through no fault or negligence of the CONTRACTOR, and notice to resume work or to terminate the agreement has not been received from the OWNER within this time period; or, (2) the OWNER should fail to pay the CONTRACTOR any monies due him in accordance with the terms of the Contract Documents and within 60 days after presentation to the OWNER by the CONTRACTOR of a request therefore, unless within said 10-day period the OWNER shall have remedied the condition upon which the payment delay was based. In the event of such termination, the CONTRACTOR shall have no claims against the OWNER except for those claims specifically enumerated in Paragraph 15.03, and as determined in accordance with the requirements of that paragraph.

### ARTICLE 16 - NOTICE

#### 16.01 GIVING NOTICE

- A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

#### 16.02 TITLE TO MATERIALS FOUND ON THE WORK

- A. The OWNER reserves the right to retain title to all soils, stone, sand, gravel, and other materials developed and obtained from excavations and other operations connected with the WORK. Unless otherwise specified in the Contract Documents, neither the CONTRACTOR nor any Subcontractor shall have any right, title, or interest in or to any such materials. The CONTRACTOR will be permitted to use in the WORK, without charge, any such materials which meet the requirements of the Contract Documents.

#### 16.03 RIGHT TO AUDIT

- A. If the CONTRACTOR submits a claim to the OWNER for additional compensation, the OWNER shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the CONTRACTOR's books. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the CONTRACTOR's plants, or such parts thereof, as may be or have been engaged in the performance of the WORK. The CONTRACTOR further agrees that the right to audit encompasses all subcontracts and is binding upon subcontractors. The right to examine and inspect herein provided for shall be exercisable through such representatives as the OWNER deems desirable during the CONTRACTOR's normal business hours at the office of the CONTRACTOR. The CONTRACTOR shall make available to the OWNER for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the OWNER.

#### 16.04 HAZARDOUS MATERIALS

- A. If the CONTRACTOR during the course of work observes the existence of hazardous material, the CONTRACTOR shall promptly notify the OWNER. The OWNER shall consult with others regarding removal or encapsulation of the hazardous material and the CONTRACTOR shall not perform any work pertinent to the hazardous material prior to receipt or special instruction from the OWNER.

#### **ARTICLE 17 - SUBCONTRACT LIMITATIONS**

##### 17.01 SUBCONTRACT LIMITATIONS

- A. In addition to the provisions of Paragraph 6.05 of the General Conditions, the CONTRACTOR shall perform not less than 30 percent of the WORK with its own forces (i.e., without subcontracting). The 30 percent requirement shall be understood to refer to the WORK, the value of which totals not less than 30 percent of the Contract Price.

#### **ARTICLE 18 - PATENTS AND COPYRIGHTS**

##### 18.01 PATENTS AND COPYRIGHTS

- A. The CONTRACTOR shall indemnify and save harmless the OWNER, the ENGINEER, and their officers, agents, and employees, against all claims or liability arising from the use of any patented or copyrighted design, device, material, or process by the CONTRACTOR or any of his subcontractors in the performance of the WORK.

-END OF SECTION-

## **SECTION 00800**

### **SUPPLEMENTARY GENERAL CONDITIONS**

#### **PART 1 - GENERAL**

These Supplementary General Conditions make additions, deletions, or revisions to the General Conditions as indicated herein. All provisions which are not so added, deleted, or revised remain in full force and effect. Terms used in these Supplementary General Conditions which are defined in the General Conditions have the meanings assigned to them in the General Conditions.

#### **SGC-1 DEFINITIONS**

Add the following definitions to Article 1:

**OWNER** - The OWNER is further defined as South Valley Water Reclamation Facility, 7495 South 1300 West, West Jordan, Utah 84084. Telephone No.: (801) 566-7711.

**OWNER'S REPRESENTATIVE** - The OWNER'S REPRESENTATIVE is defined in SGC - 9.03 on page 00800-5. The OWNER'S REPRESENTATIVE for this project shall be Taigon Worthen.

**BIDDER** - The person, firm, or corporation, partnership or joint venture or LLC submitting a Bid for the Work.

**CONTRACTOR** - The person, firm, or corporation, partnership or joint venture or LLC with whom the OWNER has executed the Agreement.

**ENGINEER** - Defined as Carollo Engineers, Inc. 7090 South Union Park Avenue, Suite 600, Midvale, Utah 84047.

#### **SGC-2.02 COPIES OF DOCUMENTS**

The OWNER shall furnish to the CONTRACTOR 5 copies of the Contract Documents which may include bound reduced drawings, if any, together with 2 sets of full-scale Drawings if requested. Additional quantities of the Contract Documents will be furnished at reproduction cost plus mailing costs if copies are mailed.

#### **SGC-4.02 REPORTS OF PHYSICAL CONDITIONS**

In the preparation of the Contract Documents, the OWNER has relied upon:

- A. The following drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground utilities) which are at or contiguous to the site of the WORK.
  - 1. Drawings dated May 28, 1982, prepared by James M. Montgomery, Consulting Engineers, Inc. entitled "SVWRF - Project 2A."

2. Drawings dated May 8, 1984, prepared by James M. Montgomery, Consulting Engineers, Inc. entitled "SVWRF - Project 2B."
  3. Drawings dated January 23, 1992, prepared by James M. Montgomery, Consulting Engineers, Inc. entitled "SVWRF - Project 3."
  4. Drawings dated November 2011 prepared by Carollo Engineers, Inc., entitled "2011 Headworks VFD Replacement."
  5. Drawings dated January 2006 prepared by James M. Montgomery, Consulting Engineers, Inc., entitled "SVWRF - Project 4C."
  6. Drawings dated January 2008 prepared by Bowen Collins & Associates, Inc., entitled "SVWRF - Project 4D."
- B. Copies of these drawings may be examined at the office of the OWNER, during regular business hours. As provided in Paragraph 4.02 of the General Conditions and as identified and established above, the CONTRACTOR may rely upon the accuracy of the technical data contained in such reports and drawings, except for such physical dimensions that can be field verified; however, the interpretation of such technical data, including any interpolation or extrapolation thereof, and opinions contained in such reports and drawings are not to be relied on by the CONTRACTOR.

#### SGC-5.01 BONDS

Delete the first sentence of Paragraph 5.1A and add the following:

The CONTRACTOR shall furnish a satisfactory Performance Bond in the amount of 100 percent of the Contract Price and a satisfactory Payment Bond in the amount of 100 percent of the Contract Price as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents.

#### SGC-5.02 INSURANCE

- A. Substitute for Paragraph 5.02.B. the following:

All insurance required by the Contract Documents to be purchased and maintained by the CONTRACTOR shall be obtained from insurance companies that are duly licensed, admitted, and authorized to issue insurance policies for the limits and coverage so required in the State in which the Project is located. Such insurance companies shall have a current Best's Rating of at least an "A" (Excellent) general policy holder's rating and a Class VIII financial size category and shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.

- B. Add the following to Paragraph 5.02.B.5:

If the OWNER finds it necessary to occupy or use a portion or portions of the project prior to Substantial Completion, the OWNER shall provide notice of occupancy without the need for mutual agreement between the OWNER and the CONTRACTOR and to which the insurance company providing the Builder's Risk Insurance has consented by endorsement to the policy or policies.



- C. The limits of liability for the insurance required by Paragraph 5.2 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations. Limits may be provided by a combination of primary and excess liability policies or through a single policy. If the limits are provided by a combination of primary and excess liability policies, then the excess or umbrella liability coverages shall include commercial general, comprehensive automobile, and employer's liability and shall provide coverage at least as broad as the underlying policies.

1. Workers' Compensation:

- |    |                                   |             |
|----|-----------------------------------|-------------|
| a. | State:                            | Statutory   |
| b. | Applicable Federal (e.g. USHL&H): | Statutory   |
| c. | Employer's Liability:             | \$1,000,000 |

2. Comprehensive or Commercial General Liability:

Combined Single Limit:

- |    |   |                  |
|----|---|------------------|
| a. | Premises/operations   |                  |
|    | \$ 1,000,000  | Each Occurrence  |
|    | \$ 2,000,000  | Annual Aggregate |
| b. | Products/completed operations   |                  |
|    | \$ 1,000,000  | Each Occurrence  |
|    | \$ 2,000,000  | Annual Aggregate |
| c. | Personal Injury   |                  |
|    | \$ 1,000,000  | Each Occurrence  |
|    | \$ 2,000,000  | Annual Aggregate |
| d. | Policies shall include premises/operations, products, completed operations, independent contractors, owners' and contractors' protective, explosion, collapse, underground hazards, broad form contractual, personal injury with employment contractual exclusions deleted, and broad form property damage. |                  |
| e. | If policies are written on a Commercial General Liability form, the General Aggregate shall be at least two times the each occurrence limit or be written on a "per project" basis.   |                  |
| f. | All policies shall be written on an occurrence basis. If the CONTRACTOR would like to substitute any "claims made" liability policies, then these must be pre-approved in writing according to the terms and conditions they may impose.  |                  |
| g. | If policies are written for split limits, limits shall be equal for bodily injury and property damage liability.  |                  |

3. Comprehensive Automobile Liability (including owned, hired, and non-owned vehicles):  
Combined Single Limit:
  - a. Bodily Injury and Property Damage: \$2,000,000 each accident.
  - b. If policies are written for split limits, limits shall be equal for bodily injury per person, bodily injury per accident and property damage.
4. Excess Liability Insurance:
  - a. \$4,000,000 over all underlying coverage lines.
5. Builder's Risk Insurance:
  - a. In an amount equal to the replacement cost of the completed value of the project or \$4,000,000 whichever is greater.
  - b. Any deductibles of self-insured retentions shall be as agreed to by the OWNER and CONTRACTOR.
  - c. The CONTRACTOR shall include flood and earthquake coverage in the Builder's Risk Insurance requirements under Paragraph 5.02.B.5 of the General Conditions, with a minimum limit of \$4,000,000 per event or occurrence.
- D. All policies shall provide that the CONTRACTOR agrees to waive all rights of subrogation against the OWNER, the ENGINEER, and their subconsultants, employees, officers and directors, for WORK performed under the Agreement. Endorsements shall be provided with certificates of insurance.
- E. All policies shall also specify that the insurance provided by the CONTRACTOR will be considered primary and not contributory to another insurance available to the OWNER or ENGINEER.
- F. All policies except Workers' Compensation and Builders Risk shall name the OWNER, including their officers, directors or board members, employees agents or any others associated with the management or operations of South Valley Water Reclamation Facility; Engineer, their consultants, subconsultants, shall be additional insureds on the Auto Liability and Commercial General Liability policies. The Builders Risk insurance shall name the CONTRACTOR, OWNER, and ENGINEER as named insureds and subcontractors and additional insureds. The Workers' Compensation policy shall name the OWNER as additional insured by means of an alternative employer endorsement, with respect to the employer's liability coverage only.
- G. All policies shall provide for 60 days' notice prior to any cancellation, reduction in coverage or nonrenewal.
- H. The deductible or self-insured retention on Comprehensive or Commercial General Liability shall not be greater than \$25,000. All deductibles are the responsibility of the CONTRACTOR.

#### SGC-6.05 SUBCONTRACT LIMITATIONS

Add the following as paragraph 6.05.B of the General Conditions

- B. The CONTRACTOR shall perform not less than 30 percent of the WORK with its own forces (i.e., without subcontracting). The 30 percent requirement shall be understood to refer to the WORK, the value of which totals not less than 30 percent of the Contract Price.

#### SGC-6.06 PERMITS

- A. The CONTRACTOR shall acquire and comply with the following permits if applicable:
  - 1. State permits to construct and/or operate sources of air pollution.
  - 2. Certificates and permits are required for sources such as, but not limited to, the following:
    - a. Fuel burning equipment.
    - b. Gasoline and petroleum distillate storage containers.
    - c. Land disturbing activities.
    - d. Processing equipment (sand, gravel, concrete batch plant, etc.).
    - e. Odors.
  - 3. Permit-Required Confined Space: The workspace in which the WORK is to be performed may contain permit-required confined spaces (permit spaces) as defined in 29 CFR 1910.146. Permit space entry is allowed in such spaces only through compliance with a confined space entry program meeting the requirements of 29 CFR 1910.146.
  - 4. Encroachment Permit.
- B. The CONTRACTOR shall comply with OWNER requirements for a "Hot Work Permit" as described in Section 01520 - Security/Process Safety Management.

#### SGC-9.03 PROJECT REPRESENTATION

- A. The OWNER's Representative, will act as directed by and under the supervision of the OWNER and will confer with the OWNER regarding its actions. The OWNER's REPRESENTATIVE dealings in matters pertaining to the WORK shall, in general, be only with the OWNER and the CONTRACTOR, and dealings with Subcontractors shall only be through or with the full knowledge of the CONTRACTOR.
- B. The OWNER's REPRESENTATIVE shall have the duties and responsibilities set forth in this paragraph.
  - 1. Review the progress schedule of Shop Drawing submittals and schedule of values prepared by the CONTRACTOR and consult with the ENGINEER concerning their acceptability, as applicable.
  - 2. Attend preconstruction conferences. Arrange a schedule of progress meetings and other job conferences as required and notify in advance those expected to

attend.

Attend meetings and maintain and circulate copies of minutes thereof.

3. Serve as the OWNER's liaison with the CONTRACTOR, working principally through the CONTRACTOR's superintendent and assist said superintendent in understanding the intent of the Contract Documents.
4. Receive Shop Drawings and samples furnished by the CONTRACTOR.
5. Conduct on-site observations of the WORK in progress to assist the OWNER in determining if the WORK is proceeding in accordance with the Contract Documents.
6. Transmit to the CONTRACTOR the OWNER's or ENGINEER's clarifications and interpretations of the Contract Documents.
7. Consider and evaluate the CONTRACTOR's suggestions for modifications in the Contract Documents and report them with recommendations to the OWNER.
8. Review applications for payment with the CONTRACTOR for compliance with the established procedure for their submittal and forward them with recommendations to the OWNER, noting particularly their relation to the schedule of values, work completed, and materials and equipment delivered at the Site but not incorporated in the WORK.
9. During the course of the WORK, verify that certificates, maintenance and operation manuals, and other data required to be assembled and furnished by the CONTRACTOR are applicable to the items actually installed.
10. Before the OWNER prepares a Notice of Completion, as applicable, submit to the CONTRACTOR a list of observed items requiring completion or correction.
11. Conduct final inspection in the company of the ENGINEER, the OWNER, and the CONTRACTOR, and prepare a punch list of items to be completed or corrected.
12. Verify that all items on the punch list have been completed or corrected and make recommendations concerning acceptance.

#### SGC-11.03D EQUIPMENT

The CONTRACTOR will be paid for the use of equipment at the rental rate listed for such equipment specified in the current edition of the following reference publication:

- A. "Rental Rate Blue Book for Construction Machinery" as published by the Machinery Information Division of the K-III Directory Corporation, telephone number (800) 669-3282.

#### SGC-12.02 WEATHER DELAYS

The CONTRACTOR's construction schedule shall anticipate 30 days of delay due to unusually severe weather.

#### SGC-14.03C AMOUNT OF RETENTION

Add the following to Paragraph 14.03C of the General Conditions:

Unless otherwise prescribed by law, the OWNER may retain a portion of the amount otherwise due to the CONTRACTOR, as follows:

1. Retention of 5 percent of each approved progress payment until the WORK is certified as having reached substantial completion.

#### SGC-14.03D VALUE OF MATERIALS STORED AT THE SITE

Unless otherwise prescribed by law or prescribed in Assigned Purchase Order Agreements, the value of materials stored at the SVWRF shall be 95 percent of the value of such materials.

#### SGC-14.05.A REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

Replace the last sentence with the following: "Forty-Five days after presentation of the Application for Payment with the ENGINEER'S recommendation, the amount recommended will (subject to the provisions of Paragraph 14.05B) become due and when due will be paid by the OWNER to the CONTRACTOR."

#### SGC-14.07.A DAMAGES

Add the following sentence: "The amount of liquidated damages shall be \$2,500 per calendar day."

-END OF SECTION-



## SECTION 00810

### SUPPLEMENTARY GENERAL CONDITIONS (UTAH)

#### SGC-18 UTAH STATE REQUIREMENTS

- A. Retainage of Compensation to CONTRACTOR: Pursuant to Utah Code Ann. 13-8-5, any retainage of CONTRACTOR's compensation hereunder shall be placed in an interest-bearing escrow account and the interest which accrues thereon shall do so for the benefit of CONTRACTOR and Subcontractors. Release of the retainage shall be as contemplated by the General Conditions and Supplementary General Conditions, Article 14 – Payments to Contractor, Liquidated Damages and Completion. Any interest which has accrued on the retainage and which is released to the CONTRACTOR shall be promptly disbursed by CONTRACTOR to itself and/or to Subcontractors on a pro rata basis.
- B. Certification of Change Orders: Pursuant to Utah Code Ann. Section 63G-6-602, no change order shall be authorized without a written certification, signed by an official representative of the OWNER responsible for monitoring and reporting the status of the costs of the total Project or the contract budget, stating that funds are available for the subject change order.
- C. Adjustments in Price: Pursuant to Utah Code Ann. Section 63G-6-601, any adjustment in compensation due CONTRACTOR under this agreement shall be computed in one or more of the following ways:
1. By agreement on a fixed-price adjustment before commencement of the pertinent performance or as soon as practicable;
  2. By unit prices specified in the contract or subsequently agreed upon;
  3. By the costs attributable to the events or situations with adjustment of profit or fee, all as specified in the contract or subsequently agreed upon;
  4. In any other manner as OWNER and CONTRACTOR may mutually agree;
  5. In the absence of agreement between CONTRACTOR and OWNER, by a unilateral determination by OWNER of the costs attributable to the events or situations with adjustment of profit or fee, all as computed by the OWNER in accordance with Utah Code Ann. Section 63G-6-415 and/or the rules and regulations promulgated thereunder.
- D. Cost Principles: CONTRACTOR shall comply in all respects with applicable provisions of Utah Code Ann. Section 63G-6-415, and the rules and regulations promulgated thereunder. To the extent that such provisions are inconsistent with the other terms and conditions of this agreement, the former shall prevail. OWNER may, at reasonable times and places, audit the books and records of CONTRACTOR, any Subcontractor, or any other person who has submitted cost or pricing data pursuant to said section. The books and records of CONTRACTOR shall be maintained for 3 years following the end of the fiscal year in which final payment is made under the Contract. The books and records of the Subcontractor and all other persons shall be maintained for 3 years following the end of the fiscal year in which final payment is made under the subcontract and/or to the person, unless a shorter period is otherwise authorized in writing.

- E. Project Safety: CONTRACTOR shall comply in all respects with the Utah Occupational Safety and Health Act, Utah Code Ann. Sections 34A-6-101 et seq., and the rules, regulations and standards promulgated thereunder by the Utah State Industrial Commission, as such act, rules, regulations or standards now exist or may be amended during the term of this agreement. Specifically, but not in limitation, CONTRACTOR shall comply with Construction Standards, Rules and Regulations, promulgated by the Utah Occupation and Safety and Health Division, Utah State Industrial Commission.
- F. Protection of Underground Utility Facilities: CONTRACTOR shall comply in all respects with Utah Code Ann. Section 54 Chapter 8a et seq. and the rules and regulations promulgated thereunder, as it now exists or may be amended during the term of this agreement, with regard to the protection of underground utility facilities. Specifically, but not in limitation, CONTRACTOR shall notify the appropriate public utility(s) when making an excavation with power equipment. CONTRACTOR shall further refrain from proceeding with excavation until such time as the appropriate public utility(s) have advised CONTRACTOR of the location of any underground facilities in the area proposed for excavation by marking such facilities with stakes, paint, or other customary way, indicating horizontal location within 24 inches of the outside dimensions of both sides of the underground facility.
- G. Review of Construction by OWNER: OWNER may, at its option, assign a field representative to review the construction of the Project in progress. Said representative will cooperate with the ENGINEER/OWNER in attempting to note deviations from, or necessary adjustments to, the Contract Documents or deficiencies or defects in the construction. Said representative's presence on the Project, however, shall in no way relieve CONTRACTOR of its primary responsibility for construction of the Project in accordance with the Contract Documents.
- H. OWNER Inspection: Pursuant to Utah Code Ann. Section 63G-6-418, OWNER may, at reasonable times, inspect the plant or place of business of the CONTRACTOR or any Subcontractor which is related to the performance of this contract or any subcontract entered into hereunder.
- I. Code Requirements: The provisions of the latest editions of the International Building Code, National Electric Code, and Utah Plumbing Code, as adopted or followed in Utah, including standards adopted in relation thereto, as supplemented or amended, shall apply to the Project except as specific variances may be expressly authorized by the OWNER. If the Contract Documents fail to meet the minimum standards of the referenced codes, CONTRACTOR shall be responsible to bring such information to the attention of the architect/OWNER associated with the Project. Subcontractors shall also inform CONTRACTOR of any infractions of the above-referenced codes regarding their own particular trades. In the event that workmanship or incidental materials are not specified or indicated, they shall at least conform to the above-referenced codes and shall be incorporated into the Work without any additional cost to the OWNER. If the Contract Documents call for items or workmanship which exceed code requirements, the Contract Documents shall take precedence over such requirements.
- J. Workers Compensation: CONTRACTOR shall comply in all respects with Utah Code Ann. Section 34A-2-101, et seq. and the rules and regulations promulgated thereunder by the Utah State Industrial Commission, as such law, rules or regulations now exist or may be amended during the term of this agreement.
- K. Archaeological, Anthropological, or Paleontological Findings: CONTRACTOR shall comply with Utah Code Ann. Section 9-8-301 et seq., with respect to the discovery of archaeological, anthropological, or paleontological findings at or on the Project site.



Specifically, but not in limitation, CONTRACTOR shall promptly notify the Utah Division of State History of any such findings.

L. Nondiscrimination Equal Employment Opportunity: CONTRACTOR shall comply in all respects with the Utah Anti-Discrimination Act of 1965, Utah Code Ann. Section 34A-5-101 et seq., and the rules and regulations promulgated thereunder by the Utah State Industrial Commission and/or its Anti-Discrimination Division, as such act, rules or regulations now exist or may be amended during the term of this agreement, specifically:

1. CONTRACTOR shall not discriminate against any employee or applicant for employment because of race, color, sex, religion, ancestry or national origin.
2. In all solicitations or advertisements for employees, CONTRACTOR shall state that all qualified applicants shall receive consideration without regard to race, color, sex, religion, ancestry or national origin.
3. CONTRACTOR shall send to each labor union or worker's representative notices to be provided, stating the CONTRACTOR's responsibilities under the statute.
4. CONTRACTOR shall furnish such information or reports as are requested by the Utah State Industrial Commission and/or its Anti-Discrimination Division, for the purpose of determining compliance with the statute.
5. CONTRACTOR shall include the provisions of paragraphs 1 through 4 above in all subcontracts for this Project.
6. Failure of the CONTRACTOR to comply with the statute, the rules and regulations promulgated thereunder, and this provision, shall be deemed a breach of contract entitling OWNER, in its discretion, to cancel, terminate, or suspend this agreement in whole or in part.

M. Affirmative Action: CONTRACTOR shall take affirmative action to insure that applicants are employed and that employees are treated during employment without regard to their race, color, religion, sex or national origin. Such action shall include, but shall not be limited to: employment; upgrading; demotion or transfer; recruitment or recruitment advertising; layout or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

At its discretion, OWNER may perform a compliance review at CONTRACTOR's place of business and/or the Project site to verify CONTRACTOR's compliance with this provision. Such compliance verifications may be conducted with such frequency as is needed to assure CONTRACTOR's compliance with this provision.

N. Citizens Preferred: Pursuant to Utah Code Ann. Section 34-30-1, CONTRACTOR shall give preference in hiring to citizens of the United States or those having declared their intention to become citizens; failure to comply may render this contract null and void at the discretion of OWNER.

- O. Veterans' Preference: Pursuant to Utah Code Ann. Section 71-10-2, CONTRACTOR shall give preference in hiring to honorable discharged veterans who have served in the Armed Forces of the United States during a period of conflict, war, or other national emergencies as defined by Congress, and to any un-remarried surviving spouse of an honorably discharged veteran, if they possess qualifications for that employment and if the honorably discharged veteran is or, if deceased, was a resident of the State of Utah.
- P. Specific OWNER Requirements: CONTRACTOR shall comply with the specific rules and regulations promulgated by OWNER pursuant to authority granted or retained under the Utah Procurement Code, Utah Code Ann. Section 63G-6-101, et seq.

-END OF SECTION-

## **DOCUMENT 00823**

### **ESCROW BID DOCUMENTS**

#### **ARTICLE 1 - SCOPE**

- 1.01 The 3 lowest Bidders shall submit, within the specified time after receipt of Bids, 1 copy of all documentary information generated in preparation of Bid prices for this Project. This material is hereinafter referred to as "Escrow Bid Documents." The Escrow Bid Documents of the Successful Bidder will be held in escrow for the duration of the contract.
- 1.02 The Successful Bidder agrees, as a condition of award of the contract, that the Escrow Bid Documents constitute the complete, only, and all documentary information used in preparation of his Bid. No other Bid preparation information shall be considered in resolving disputes.
- 1.03 Nothing in the Escrow Bid Documents shall change or modify the terms or conditions of the Contract Documents.

#### **ARTICLE 2 - OWNERSHIP**

- 2.01 The Escrow Bid Documents are, and shall always remain, the property of Contractor, subject only to joint review by Owner and Contractor, as provided in this Document.
- 2.02 Owner stipulates and expressly acknowledges that the Escrow Bid Documents, as defined in this Document, constitute trade secrets. This acknowledgment is based on Owner's express understanding that the information contained in the Escrow Bid Documents is not known outside the Bidder's business, is known only to a limited extent and only by a limited number of employees of the Bidder, is safeguarded while in Bidder's possession, is extremely valuable to Bidder, and could be extremely valuable to Bidder's competitors by virtue of it reflecting Bidder's contemplated techniques of construction. Owner acknowledges that the Bidder expended substantial sums of money in developing the information included in the Escrow Bid Documents and further acknowledges that it would be difficult for a competitor to replicate the information contained therein. Owner further acknowledges that the Escrow Bid Documents and the information contained therein are made available to Owner only because such action is an express prerequisite to award of the contract. Owner further acknowledges that the Escrow Bid Documents include a compilation of information used in the Bidder's business, intended to give the Bidder an opportunity to obtain an advantage over competitors who do not know of or use the contents of the documentation. Owner agrees to safeguard the Escrow Bid Documents, and all information contained therein, against disclosure to the fullest extent permitted by law.

## **ARTICLE 3 - PROGRAM**

- 3.01 Escrow Bid Documents will be used to assist in the negotiation of price adjustments and Change Orders and in the settlement of disputes, claims, and other controversies. They will not be used for pre-award evaluation of Contractor's anticipated methods of construction or to assess Contractor's qualifications for performing the Work.

## **ARTICLE 4 - FORMAT AND CONTENTS**

- 4.01 Bidders may submit Escrow Bid Documents in their usual cost-estimating format. It is not the intention of this section to cause the Bidder extra work during the preparation of the Bid, but to ensure that the Escrow Bid Documents will be adequate to enable complete understanding and proper interpretation for their intended use. The Escrow Bid Documents shall be in the language of the Specifications.
- 4.02 It is required that the Escrow Bid Documents clearly itemize the estimated costs of performing the work of each Bid item contained in the Bid schedule. Bid items should be separated into subitems as required to present a complete and detailed cost estimate and allow a detailed cost review. The Escrow Bid Documents shall include all quantity takeoffs; crew; equipment; calculations of rates of production and progress; copies of quotations from equipment manufacturers, Subcontractors, and Suppliers; and memoranda, narratives, consultants' reports, add/deduct sheets, and all other information used by the Bidder to arrive at the prices contained in the Bid Form. Estimated costs should be broken down into the Bidder's usual estimate categories, such as direct labor, repair labor, equipment operation, equipment ownership, expendable materials, permanent materials, and subcontract costs as appropriate. Plant and equipment and indirect costs should be detailed in the Bidder's usual format. Contractor's allocation of plant and equipment, indirect costs, contingencies, markup, and other items to each Bid item shall be included.
- 4.03 All costs shall be identified. For Bid items amounting to less than \$10,000, estimated unit costs are acceptable without a detailed cost estimate, provided that labor, equipment, materials, and subcontracts, as applicable, are included, and provided that indirect costs, contingencies, and markup, as applicable, are allocated.
- 4.04 Bidding Documents provided by the Owner should not be included in the Escrow Bid Documents unless needed to comply with the requirements of this section.

## **ARTICLE 5 - SUBMITTAL**

- 5.01 The Escrow Bid Documents shall be submitted in a sealed container within 72 hours after the time of receipt of Bids. The container shall be clearly marked on the outside with the Bidder's name, date of submittal, project name, and the words "Escrow Bid Documents."
- 5.02 The Escrow Bid Documents shall be accompanied with the Bid Documentation Certification, signed by an individual authorized by the Bidder to execute the Bid Form, stating that the material in the Escrow Documentation constitutes the complete, only, and all documentary information used in preparation of the Bid and that he has personally examined the contents of the Escrow Bid Documents container and has found that the documents in the container are complete.

- 5.03 Prior to award, Escrow Bid Documents of the apparent Successful Bidder will be unsealed, examined, organized, and inventoried by representatives of Owner, together with members of Contractor's staff who are knowledgeable in how the Bid was prepared.
- 5.04 This examination is to ensure that the Escrow Bid Documents are authentic, legible, and complete. It will not include review of, and will not constitute approval of, proposed construction methods, estimating assumptions, or interpretations of Contract Documents. This examination is subject to the condition that, as trade secrets, the Escrow Bid Documents are proprietary and confidential as described in this Document. Examination will not alter any condition(s) or term(s) of the contract.
- 5.05 If all the documentation required in this Document has not been included in the original submittal, additional documentation shall be submitted, at Owner's discretion, prior to award of the contract. The detailed breakdown of estimated costs shall be reconciled and revised, if appropriate, by agreement between Contractor and Owner before making the award.
- 5.06 If the contract is not awarded to the apparent Successful Bidder, the Escrow Bid Documents of the Bidder next to be considered for award shall be processed as described above.
- 5.07 Timely submission of complete Escrow Bid Documents is an essential element of the Bidder's responsibility and a prerequisite to contract award. Failure to provide the necessary Escrow Bid Documents will be sufficient cause for Owner to reject the Bid.
- 5.08 If the Bidder's proposal is based on subcontracting any part of the Work, each Subcontractor whose total subcontract price exceeds 5 percent of the total Contract Price proposed by the Bidder shall provide separate Escrow Bid Documents to be included with those of the Bidder. These documents will be opened and examined in the same manner and at the same time as the examination described above for the apparent Successful Bidder.
- 5.09 If Contractor subcontracts any portion of the Work after award, Owner retains the right to require Contractor to submit Escrow Bid Documents from the Subcontractor before the subcontract is approved.
- 5.10 Escrow Bid Documents submitted by unsuccessful Bidders will be returned unopened, unless opened as provided above, as soon as they are no longer needed by Owner and no later than immediately following award of the contract.

## **ARTICLE 6 - STORAGE**

- 6.01 The Escrow Bid Documents of the Successful Bidder will be placed in escrow prior to award of the contract, for the life of the contract, in a mutually agreeable institution. The cost of storage will be paid by Owner.

## **ARTICLE 7 - EXAMINATION AFTER AWARD OF CONTRACT**

- 7.01 The Escrow Bid Documents shall be examined by both Owner and Contractor, at any time deemed necessary after award of the contract by either Owner or Contractor, to assist in the negotiation of price adjustments and Change Orders, or the settlement of disputes.
- 7.02 Examination of the Escrow Bid Documents after award of the contract is subject to the following conditions:
1. As trade secrets, the Escrow Bid Documents are proprietary and confidential as described in this Document.
  2. Owner and Contractor shall each designate, in writing to the other party and a minimum of 10 days prior to examination, representatives who are authorized to examine the Escrow Bid Documents. No other person shall have access to the Escrow Bid Documents.
  3. Access to the Escrow Bid Documents will take place only in the presence of duly designated representatives of both Owner and Contractor.

## **ARTICLE 8 - FINAL DISPOSITION**

- 8.01 The Escrow Bid Documents will be returned to Contractor at such time as the contract has been completed and final settlement has been achieved.

BID DOCUMENTATION

---- CERTIFICATION ----

I, THE UNDERSIGNED, HEREBY CERTIFY THAT THE BID DOCUMENTATION CONTAINED IN THIS DOCUMENT CONSTITUTES THE COMPLETE, ONLY, AND ALL DOCUMENTARY INFORMATION USED IN PREPARATION OF THE BID AND THAT I HAVE PERSONALLY EXAMINED THESE CONTENTS AND HAVE FOUND THAT THIS BID DOCUMENTATION IS COMPLETE.

BY: \_\_\_\_\_

TITLE: \_\_\_\_\_

FIRM: \_\_\_\_\_

DATE: \_\_\_\_\_

END OF DOCUMENT





**SECTION 01110**  
**SUMMARY OF WORK**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Detailed description of the Work.

**1.02 THE WORK**

- A. The Work consists of construction of new diesel generator, including modifications to existing Generator Building, removal of existing diesel generator, new diesel generator EGU-3510, new switchgear lineup, new PLC Control Panel PCM-3500, new field wiring, and provision of temporary generators.

**1.03 LOCATION OF PROJECT**

- A. The Work is located at:  
South Valley Water Reclamation Facility  
7495 South 1300 West  
West Jordan, Utah 84084

**1.04 ACTIVITIES BY OTHERS**

- A. Activities by others which may affect performance of work include:  
1. SVWRF Project 5 (Grit Building and Bioreactor improvements).

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

END OF SECTION



## **SECTION 01116**

### **CONTRACT DOCUMENT LANGUAGE**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section Includes: Explanation of arrangement, language, reference standards, and format.

##### **1.02 REFERENCES**

- A. Construction Specifications Institute (CSI):
  - 1. MasterFormat™.
  - 2. SectionFormat™.
  - 3. PageFormat™.

##### **1.03 PROJECT MANUAL ARRANGEMENT**

- A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.
- B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.
- C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

##### **1.04 CONTRACT DOCUMENT LANGUAGE**

- A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section.
  - 1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.
- B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all."
  - 1. Assume missing portions by inference.
- C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.
- D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

- E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
  - 1. When used as an appositive after designation of product, colons are used in place of words "shall be."
- F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, or render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.
- G. Words "Contractor shall" are implied when direction is stated in imperative mood.
- H. Term "products" includes materials and equipment as specified in Section 01600 - Product Requirements.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

**SECTION 01140**  
**WORK RESTRICTIONS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Requirements for scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

**1.02 SUBMITTALS**

- A. Baseline Schedule with MOP tasks.
- B. Method of Procedure (MOP) Form.
- C. Method of Procedure (MOP) Log.
- D. Progress Schedule with MOP tasks.

**1.03 GENERAL CONSTRAINTS ON WORK AND SCHEDULING OF WORK**

- A. Plant access for Contractor will be provided at the main entrance gate.
- B. Wastewater projects:
  - 1. The South Valley WRF is the Owner's only means of treating domestic and industrial wastewater prior to discharging. Impairing the operational capabilities of this treatment plant will result in serious environmental damage and monetary fines.
  - 2. Conduct Work in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.
  - 3. Conduct commissioning activities as specified in Section 01756 - Commissioning in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.
  - 4. The status of the treatment plant shall be defined as "operational" when it is capable of treating the entire quantity of wastewater received to the water quality limits specified in the discharge permit.

**1.04 SHUTDOWN AND CONSTRUCTION CONSTRAINTS**

- A. General shutdown constraints:
  - 1. Execute the Work while the existing facility is in operation.
  - 2. Some activities may be accomplished without a shutdown.
  - 3. Apply to activities of construction regardless of process or work area.

4. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
  5. Organize work to be completed in a minimum number of shutdowns.
  6. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
  7. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
  8. Final determination of the permitting of shutdowns will be the sole judgment of the Owner.
  9. Owner maintains the ability to abort on the day of the scheduled shutdown.
  10. The Contractor shall coordinate parking, storage, and construction area limits with the Owner. All requests by the Contractor related to these items must be approved in advance by the Owner.
- B. General maximum plant flow work limitations:
1. Activities that disrupt plant operations are prohibited during the following flow conditions, unless otherwise approved in writing by the Owner and Engineer.
    - a. Flow condition: NA.
- C. Shutdown activities:
1. Scheduling:
    - a. Perform as approved by Owner.
  2. Unplanned shutdowns due to emergencies are not defined in this Section.
- D. Emergency Power:
1. At no time shall the SVWRF be without emergency power sufficient to run the six influent pumps.
  2. Any interruption to full emergency power capacity equal to that which existed before construction of this project, shall be kept to an absolute minimum, never to exceed eight hours within any one calendar day.
  3. The generator building itself shall never be left without adequate lighting to operate and maintain the existing equipment within the building during construction of the project.

## **1.05 METHOD OF PROCEDURE (MOP)**

- A. MOP Instructions: See Appendix A.
- B. Prepare MOP for the following conditions:
1. Power interruption and tie-ins.
  2. Switch over between temporary and permanent electrical and instrumentation systems.
- C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.
- D. Submit Baseline Schedule, as specified in Section 01321 - Schedules and with proposed MOPs.
- E. Submit MOP Log at construction progress meetings.

- F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.
- G. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary generators, conduit and wire, lighting, controls, instrumentation, and safety devices.

#### **1.06 COMPLIANCE WITH NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT**

- A. The existing facility is operating under the terms of a National Pollutant Discharge Elimination System permit issued by the State of Utah Department of Environmental Quality. This permit specifies the water quality limits that the plant must meet prior to discharge of effluent. A copy of the existing permit is on file for review at the Owner's office.
- B. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.
- C. Bear the cost of penalties imposed on the Owner for discharge violations caused by actions of the Contractor.

#### **1.07 REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES**

- A. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.
- B. Demolition of the existing generator EGU-3510, switchboard SG-EDA, conduit, wire etc. in the Emergency Generator Building shall not begin before the new generator and switchboard have been delivered to the site and are ready for installation and all temporary generators have been installed and the transfer to and from utility power has been tested.
- C. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
  - 1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

#### **1.08 OPERATIONS AND MAINTENANCE ACCESS**

- A. Provide safe, continuous access to process control equipment for plant operations personnel.
- B. Provide access on 1-hour advance notice to electrical and instrumentation equipment for plant maintenance personnel and associated maintenance equipment.

## **1.09 UTILITIES**

- A. Provide advance notice to and utilize services of Blue Stake for location and marking of underground utilities operated by utility agencies other than the Owner.
- B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION



**APPENDIX A**  
**“Method of Procedure” (MOP)**  
**Instructions and Forms**

**Definition and Purpose**

“Method of Procedure” (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

**MOP Process Summary**

<b>WHO</b>	<b>STEP</b>	<b>TIMING</b>
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	No later than 7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	No later than 7 days prior to work
Contractor	6. Complete Readiness Checklist.	No later than 5 days prior to work
Contractor	7. Complete Safety Checklist.	Immediately prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

## **MOP Process Detail**

### **STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.**

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

### **STEP 2. Pre-MOP Meeting.**

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

### **STEP 3. Submits MOP.**

Contractor completes the MOP Form and submit 3 copies for approval to the Owner's Project Manager (OPM).

### **STEP 4. Reviews MOP.**

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

### **STEP 5. MOP finalized.**

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

### **STEP 6. Complete Readiness Checklist.**

Contractor verifies everything is ready for the work.

### **STEP 7. Complete Safety Checklist.**

Contractor ensures safety.

### **STEP 8. Complete work.**

Contractor complete work.

### **STEP 9. Update MOP Log and Progress Schedules.**

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.



## METHOD OF PROCEDURE (MOP) FORM

Owner:	_____	Date:	_____
Contractor:	_____	Carollo Project No.:	_____
Project Name:	_____	Submittal No.:	_____
Submittal Title:	_____	Spec/Dwg. Reference:	_____

MOP #	Task Title (Provide <10 word title):	Submittal Date: (No later than 28 days prior to work)					
SCHEDULE OF WORK ACTIVITY START: (Date/Time) _____ END: (Date/Time) _____							
REQUESTOR: _____							
PRIMARY POINT OF CONTACT:		PHONE/PAGER: _____					
SECONDARY POINT OF CONTACT:		PHONE/PAGER: _____					
NOTIFY	<input type="checkbox"/> Control Room, Phone	<input type="checkbox"/> Security, Phone					
BUILDING: _____		LOCATION OF WORK FLOOR/LEVEL: _____					
DESCRIPTION OF WORK: (Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)							
Task Summary: _____							
Processes Affected: _____							
Trades Affected: _____							
WORK PLAN:							
Work Sequencing: _____							
Process Isolation: _____							
Spill Prevention Plan: _____							
Contingency Plans: _____							
CRITICAL EQUIPMENT/TOOLS: (pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)							
<input type="checkbox"/>	Acoustic Ceiling/or Walls Access	<input type="checkbox"/>	Excavation Permit	<input type="checkbox"/>	Lock Out/Tag Out		
<input type="checkbox"/>	Chemical Use Approval	<input type="checkbox"/>	Fire Sprinkler Impairment	<input type="checkbox"/>	Life Safety Systems		
<input type="checkbox"/>	Confined Space Permit	<input type="checkbox"/>	Flammable Materials	<input type="checkbox"/>	Roof Protocol		
<input type="checkbox"/>	Critical Lift Plan	<input type="checkbox"/>	Flush / Discharge	<input type="checkbox"/>	Work After Dark		
<input type="checkbox"/>	Energized Electrical Work	<input type="checkbox"/>	High Pressure Test	<input type="checkbox"/>			
<input type="checkbox"/>	Elect. Panel Schedules	<input type="checkbox"/>	Hot Work/Open Flame	<input type="checkbox"/>			
EXISTING SERVICE(S) AT RISK:							
<input type="checkbox"/>	Breathing Air	<input type="checkbox"/>	Elect Normal	<input type="checkbox"/>	Process Access	<input type="checkbox"/>	Telephones
<input type="checkbox"/>	Chemical Distribution	<input type="checkbox"/>	Fire Protection	<input type="checkbox"/>	Safety Showers	<input type="checkbox"/>	UPS
<input type="checkbox"/>	City Water	<input type="checkbox"/>	HVAC	<input type="checkbox"/>	SCADA	<input type="checkbox"/>	VAX/DATA
<input type="checkbox"/>	Communication	<input type="checkbox"/>	Inert Gas	<input type="checkbox"/>	Security	<input type="checkbox"/>	
<input type="checkbox"/>	Domestic Drain	<input type="checkbox"/>	Instrument - Air	<input type="checkbox"/>	Solvent Drain	<input type="checkbox"/>	
<input type="checkbox"/>	Elect-Bus Duct	<input type="checkbox"/>	Life Safety System	<input type="checkbox"/>	Specialty Gases	<input type="checkbox"/>	

<input type="checkbox"/>	Elect Emergency	<input type="checkbox"/>	Natural Gas	<input type="checkbox"/>	Storm Drain	<input type="checkbox"/>	
REVIEWER'S INSTRUCTIONS / COMMENTS:							
<input type="checkbox"/>	PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:						
	<b>Full Name (printed)</b>	<b>Signature</b>	<b>Phone</b>	<b>Date</b>			
Submitted By							
System Owner							
Reviewer (if needed)							
Reviewer (if needed)							
Reviewer (if needed)							
Reviewer (if needed)							

**READINESS CHECKLIST**  
**(5 days prior to work)**

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: \_\_\_\_\_
2. Review work plan: \_\_\_\_\_
3. Review contingency plan: \_\_\_\_\_

**SAFETY CHECKLIST**  
**(Just prior to commencing work)**

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
  - a. Emergency exits: \_\_\_\_\_
  - b. Emergency shower and eyewash: \_\_\_\_\_
  - c. Telephones and phone numbers: \_\_\_\_\_
  - d. Shut-off valve: \_\_\_\_\_
  - e. Electrical disconnects: \_\_\_\_\_
2. Inspect work area:
  - a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
  - a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
  - a. Lockout/tagout energy sources before beginning work.
  - b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
  - c. Make sure the lines are depressurized.
5. Overhead work:
  - a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
  - b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
  - c. Spotter assigned and in position.
  - d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
  - a. Shepherd's hook.
  - b. ARC flash protection.
  - c. Fire extinguisher.
  - d. Other: \_\_\_\_\_.
7. Accidents:
  - a. Should accidents occur, do not shut off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
  - a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
  - a. Do not obstruct evacuation routes.
  - b. Take time to survey the area for evacuation routes.

**Method of Procedure (MOP) Log**  
***Sample***

<b>MOP Number</b>	<b>Task Title</b>	<b>Date Requested</b>	<b>Date Approved</b>	<b>Date Work Planned</b>	<b>Work Completed (yes/no)</b>
001					
002					
003					





## **SECTION 01220**

### **MEASUREMENT AND PAYMENT**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Procedures for measurement and payment of Work under this Contract for lump sum items and unit prices.

##### **1.02 REFERENCES**

- A. Occupational Safety and Health Administration (OSHA).

##### **1.03 LUMP SUM ITEMS**

- A. Item 1: Mobilization:
  - 1. Measurement:
    - a. Limit amounts included under mobilization to the following items:
      - 1) Moving on the site any equipment required for first month operations.
      - 2) Installing temporary construction power, wiring, and lighting facilities.
      - 3) Establish and submit fire protection plan and safety program.
      - 4) Provide temporary facilities as specified in Section 01500 - Temporary Facilities and Controls.
        - a) Providing on-site sanitary facilities and potable water facilities as specified.
        - b) Providing field office trailers for the Contractor and the Engineer, complete with specified furnishings and utility services including telephones and internet.
        - c) Developing construction water supply.
      - 5) Arranging for and erection of Contractor's work and storage yard, employee parking facilities, and entrance road.
      - 6) Submit required insurance certificates and bonds.
      - 7) Obtaining required permits, licenses, and fees.
      - 8) Submit preliminary schedule of values of the Work.
      - 9) Submit preliminary schedule and develop baseline schedule.
      - 10) Submit cash flow in tabular and graphical formats.
      - 11) Submit Schedule of Submittals.
      - 12) Submit standardized traffic maintenance and control plans.
      - 13) Post OSHA, Department of Labor, state, and other required notices.
      - 14) Location and flagging of construction and clearing.
      - 15) Submit Contractor's quality control plan.
      - 16) Submit pre-construction photographs and videos.
      - 17) Provide and erect the project sign.
      - 18) Have Contractor's project manager and/or general superintendent on job site full-time.
  - 2. Payment:
    - a. Furnish data and documentation to substantiate the amounts claimed under mobilization costs.

- b. Payment for mobilization shall not be made until mobilization items listed above have been completed as specified.
    - c. Limit price for mobilization to no more than 3 percent of Contract Price.
    - d. Lump sum.
- B. Item 2: Commissioning:
  - 1. Measurement:
    - a. Requirements as specified in Section 01756 - Commissioning, including planning, commissioning, and start-up phases for the Project devices, components, equipment, and/or facility.
  - 2. Payment:
    - a. Shall not be less than 3 percent of Contract Price.
    - b. Lump sum.
- C. Item 3: Demobilization:
  - 1. Measurement:
    - a. Removal of temporary facilities as specified in Section 01500 - Temporary Facilities and Controls.
    - b. Completion of closeout submittals as specified in Section 01770 - Closeout Procedures.
  - 2. Payment:
    - a. Shall not be less than 3 percent of Contract Price.
    - b. Lump sum.
- D. Item 4: Lump sum Item:
  - 1. Measurement:
    - a. Includes costs including Contractor's fee for overhead and profit for continuous, full-time management of the Contract as described in the Contract Documents, covering a period of time not less than from the Notice to Proceed through the entire length of the allowable Contract Times specified in the Contract Documents.
  - 2. Payment:
    - a. Lump sum.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## **SECTION 01260**

### **CONTRACT MODIFICATION PROCEDURES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section Includes:
  - 1. Administrative and procedural requirements for executing a change in the Work.

##### **1.02 PRELIMINARY REQUIREMENTS**

- A. Change Order Cost Basis Summary Form:
  - 1. Submit a sample to Engineer for review within 15 calendar days following Notice to Proceed.
    - a. Items will be reviewed and their value, percentage, or calculation method mutually agreed to by the Contractor and Owner prior to executing a Change Order on the Project.
  - 2. Used by the Contractor for pricing each Change Order required for additions, deletions, or revisions in the Work.
  - 3. Include the following information:
    - a. Agreed upon markups, percentages, and procedures for calculating all surcharges, etc. associated with the Cost of the Change Order Work.
    - b. References for unit price information and special unit price information.
    - c. Attachments with the following information:
      - 1) Certified labor rates breakdown.
      - 2) Equipment rates.
      - 3) Bond and insurance rates (PI&I).

##### **1.03 REQUEST FOR INFORMATION OR INTERPRETATION (RFI)**

- A. Contractor may issue RFIs to request interpretation of the documents or to request for information that may be missing.
- B. General Instructions:
  - 1. Use RFI Form as specified in Document 00632 - Request for Information or Interpretation (RFI).
    - a. Use of other RFI Forms is acceptable if the form includes the information in the form provided in the referenced form, at a minimum.
  - 2. Number RFIs consecutively.
    - a. Add a consecutive letter to the RFI number on modified submittals of the same RFI (i.e., RFI 4B).
  - 3. Provide RFI for 1 item.
    - a. There may be exceptions when multiple items are so functionally related that expediency indicates review of the group of items as a whole.
    - b. RFIs with multiple items will be rejected without review.
  - 4. Contractor sign and date RFIs indicating review and approval.
    - a. Contractor's signature indicates that they have satisfied RFI review responsibilities and constitutes Contractor's written approval of RFI.

- b. RFIs without Contractor's signature will be returned to the Contractor unreviewed. Subsequent submittal of this information will be counted as the first resubmittal.
- C. Engineer will render a written clarification, interpretation, or decision on the issue submitted or initiate an amendment or supplement to the Contract within 21 days.
  - 1. In the event the Contractor identifies an RFI as critical to the progress of the project, Engineer will make every effort to reduce the RFI response time.

#### **1.04 PRELIMINARY PROCEDURES**

- A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor including the following information:
  - 1. Detailed description of the Change, Products, and location of the change in the Project.
  - 2. Supplementary or revised drawings or specifications.
  - 3. Projected time span for making the change, and a specific statement if overtime work is authorized.
  - 4. A specific period of time during which the requested price will be considered valid.
  - 5. Such request is for information only, and is not an instruction to execute the changes, or to stop work in progress.
- B. Contractor may initiate changes by submitting a Change Proposal to Engineer containing the following:
  - 1. Description of proposed changes.
  - 2. Reason for making changes.
  - 3. Specific period of time during which requested price will be considered valid.
  - 4. Effect on Total Contract Cost and/or Contract Time.
  - 5. Documentation supporting any change in Total Contract Cost and/or Contract Time, as appropriate.

#### **1.05 WORK CHANGE DIRECTIVE AUTHORIZATION**

- A. In lieu of a Request for Proposal (RFP), Engineer may issue a Work Change Directive Authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.
- B. Authorization will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change, and will designation method of determining any change in the Contract Sum and/or the Contract Time, as appropriate.
- C. Owner and Engineer will sign and date the Work Change Directive Authorization as authorization for the Contractor to proceed with the changes.
- D. Contractor may sign and date the Work Change Directive Authorization to indicate agreement with the terms.

## **1.06 DOCUMENTATION OF CHANGE PROPOSALS**

- A. Change proposal:
  - 1. Support with sufficient substantiating data to allow Engineer to evaluate the quotation.
    - a. Lump sum.
    - b. Unit prices: Use previously established unit prices.
    - c. Time-and-material/force account basis:
      - 1) Name of the Owner's authorized agent who ordered the work, and date of the order.
      - 2) Dates and times work was performed, and by whom.
      - 3) Time record, summary of hours worked, and hourly rates paid.
      - 4) Receipts and invoices for:
        - a) Equipment used, listing dates and times of use.
        - b) Products used, listing of quantities.
        - c) Subcontracts.
  - 2. Provide additional data to support time and cost computations:
    - a. Labor required.
    - b. Equipment required.
    - c. Products required:
      - 1) Recommended source of purchase and unit cost.
      - 2) Quantities required.
    - d. Taxes, insurance, and bonds.
    - e. Credit for work deleted from Contract, similarly documented.
    - f. Overhead and profit.
    - g. Justification for change to Contract Time.

## **1.07 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS**

- A. Engineer will prepare each Change Order and Field Order.
- B. Change Orders:
  - 1. Will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
  - 2. Will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.
  - 3. Recommendation of Change Proposal is indicated by Engineer's signature.
  - 4. Upon signature and execution by Owner, the Change Proposal becomes a Change Order altering the Contract Time and Total Contract Cost, as indicated.
    - a. Owner's Representative will transmit one signed copy each to Contractor and Engineer.
  - 5. Contractor may only request payment for changes in the Work against an approved Change Order.
  - 6. If either Engineer or Owner's Representative disapproves the Change Proposal, the reason for disapproval will be stated.
    - a. A request for a revised proposal or cancellation of the proposal will be shown.
- C. Field Orders:
  - 1. Order minor changes in the Work without changes in Contract Price or Contract Times.

## **1.08 LUMP-SUM/FIXED PRICE CHANGE ORDER**

- A. Content of Change Orders will be based on, either:
  - 1. Engineer's Proposal Request and Contractor's responsive Change Proposal as mutually agreed between Owner and Contractor.
  - 2. Contractor's Change Proposal for a change, as recommended by Engineer.
- B. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.
- C. Contractor will sign and date the Change Order to indicate agreement with the terms.

## **1.09 UNIT PRICE CHANGE ORDER**

- A. Content of Change Orders will be based on, either:
  - 1. Engineer's definition of the scope of the required changes.
  - 2. Contractor's Change Proposal for a change, recommended by Engineer.
  - 3. Survey of completed work.
- B. The amounts of the unit prices to be:
  - 1. Those stated in the Contract.
  - 2. Those mutually agreed upon between Owner and Contractor.
- C. When quantities of each of the items affected by the Change Order can be determined prior to start of the work:
  - 1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.
  - 2. Contractor will sign and date the Change Order to indicate agreement with the terms.
- D. When quantities of the items cannot be determined prior to start of the work:
  - 1. Engineer or Owner will issue a Work Change Directive authorization directing Contractor to proceed with the change on the basis of unit prices, and will cite the applicable unit prices.
  - 2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.
  - 3. Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.
- E. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.
- F. Contractor will sign and date the Change Order to indicate their agreement with the terms.

## **1.10 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK CHANGE DIRECTIVE AUTHORIZATION**

- A. Engineer will issue a Work Change Directive for the Owner's signature authorizing Contractor to proceed with the changes.

- B. At completion of the change, Contractor shall submit itemized accounting and supporting data as specified in this Section.
- C. Engineer will determine the allowable cost of such work, as provided in the Contract Documents.
- D. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.
- E. Contractor will sign and date the Change Order to indicate their agreement.

#### **1.11 CORRELATION WITH CONTRACTOR'S SUBMITTALS**

- A. Periodically revise Schedule of Values and Applications for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted Contract Sum.
- B. Periodically revise the Construction Schedule to reflect each change in Contract Time. Revise subschedules to show changes for other items of work affected by the changes.
- C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

#### **PART 2 PRODUCTS**

Not Used.

#### **PART 3 EXECUTION**

Not Used.

END OF SECTION





**SECTION 01292**  
**SCHEDULE OF VALUES**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Requirements for preparation, format, and submittal of Schedule of Values.

**1.02 PREPARATION**

- A. Schedule of Values shall be a listing of all cost loaded, on-site construction activities from the progress schedule, listed in numerical order, showing that the sum total of all cost-loaded activities equal the Contract value.
- B. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all cost-loaded activities continuously equal the current Contract value.
  - 1. Equate the aggregate of these costs to the Lump Sum Contract Price.
- C. Prepare Schedule of Values identifying costs of Major Items of Work and other costs shown in sample included at end of this Section.
- D. Divide the work into following Major Items of Work:
  - 1. Mobilization.
  - 2. Generator Replacement
  - 3. General earthwork and grading.
  - 4. Miscellaneous yard piping.
  - 5. Electrical Work not included in Major Items of Work.
  - 6. Instrumentation Work not included in Major Items of Work.
  - 7. Commissioning.
  - 8. Demobilization.
  - 9. All other costs required to complete all Work in the Contract Documents not covered by the other Line Items listed above.

**1.03 SUBMITTALS**

- A. Submit Schedule of Values for the Preliminary Schedule as specified in, Section 01321 - Schedules and Reports.

## 1.04 SAMPLE SCHEDULE OF VALUES

A. Following is an acceptable form for Schedule of Values:

(SAMPLE ONLY) SCHEDULE OF VALUES		
NO.	DESCRIPTION OF ITEM	LUMP SUM COST
1	LUMP SUM ITEM TITLE	
1.A..	Mobilization	
1.B.	General earthwork and grading	
1.C.	Miscellaneous yard piping List Major Items of Work identified in Article 1.02 Paragraph C and number consecutively	
1.D.	Electrical Work not included in Major Items of Work.	
1.E	Major Items of Work (for example, pump station, headworks, etc.)	
1.F	Instrumentation work not included on Major Items of Work	
1.G	Commissioning	
1.H	Demobilization	
1.I	All other costs required to complete all Work in the Contract Documents not covered by the other Line Items listed above.	
	TOTAL LUMP COST	

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

Not Used.

END OF SECTION

## **SECTION 01294**

### **APPLICATIONS FOR PAYMENT**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Procedures for preparation and submittal of Applications for Payment.

##### **1.02 FORMAT**

- A. Develop satisfactory spreadsheet-type form generated by downloading cost data from the Progress Schedule.
  - 1. Submit payment requests using Document 00620 - Payment Bond and attach spreadsheet with cost data related to Progress Schedule.
- B. Fill in information required on form.
- C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
  - 1. Identify change order by number and description.
  - 2. Provide cost of change order in appropriate column.
- D. After completing, submit Application for Payment.
- E. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.
- F. Execute application with signature of responsible officer of Contractor.

##### **1.03 SUBSTANTIATING DATA**

- A. Provide Substantiating Data with cover letter identifying:
  - 1. Project.
  - 2. Application number and date.
  - 3. Detailed list of enclosures.
  - 4. For stored products with item number and identification on application, description of specific material, and proof of insurance coverage for offsite stored products.
  - 5. Submit "certified" payroll, if applicable.

##### **1.04 SUBMITTALS**

- A. Submit 1 electronic copy of Application for Payment and Substantiating Data with cover letter.

## **1.05 PAYMENT REQUESTS**

- A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.
- B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.
- C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.
- D. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.
- E. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.
- F. Payment period:
  - 1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
  - 2. Submit Application for Payment to Engineer no later than the 5th day of each month for work completed the previous month.
  - 3. Engineer will finalize and submit recommendation for Application for Payment to Owner by the 15th day of each month to allow time for processing and approval.

## **1.06 COST SUMMARIES**

- A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.
- B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

**SECTION 01312**  
**PROJECT MEETINGS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
  - 1. Preconstruction Conference.
  - 2. Progress Meetings.
  - 3. Pre-Process Start-up Meetings.
  - 4. Close-out meeting.

**1.02 QUALIFICATIONS OF MEETING PARTICIPANTS**

- A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

**1.03 PRECONSTRUCTION CONFERENCE**

- A. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, Engineer will arrange preconstruction conference in place convenient for most invitees.
- B. Preconstruction Conference invitees: Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to agenda.
- C. Engineer will preside at conference.
- D. Purpose of conference: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.
- E. Agenda will include:
  - 1. Adequacy of distribution of Contract Documents.
  - 2. Distribution and discussion of list of major subcontractors and suppliers.
  - 3. Proposed progress schedules and critical construction sequencing.
  - 4. Major equipment deliveries and priorities.
  - 5. Project coordination.
  - 6. Designation of responsible personnel.
  - 7. Procedures and processing of:
    - a. Field decisions.
    - b. Proposal requests.
    - c. Submittals.
    - d. Change Orders.
    - e. Request for Information/Interpretations.

- f. Applications for Payment.
    - g. Record Documents.
  - 8. Use of premises:
    - a. Office, construction, and storage areas.
    - b. Owner's requirements.
  - 9. Construction facilities, controls, and construction aids.
  - 10. Temporary utilities.
  - 11. Safety and first aid procedures.
  - 12. Security procedures.
  - 13. Housekeeping procedures.
- F. Engineer will record minutes of meeting and distribute copies of minutes within 7 days of meeting to participants and interested parties.

#### **1.04 PROGRESS MEETINGS**

- A. Engineer will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.
- B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.
- C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, superintendent, quality control manager, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meeting.
- D. Additional invitees: Owner utility companies when the Work affects their interests, and others necessary to agenda.
- E. Agenda:
  - 1. Review minutes of previous meeting/minutes.
  - 2. Safety and security.
  - 3. Construction schedule summary.
  - 4. Review of 6 weeks schedule.
  - 5. Review of off-site fabrication and delivery schedules.
  - 6. Review of submittals schedule and status of submittals.
  - 7. Request for information (RFI's) status.
  - 8. MOP's/shutdown coordination.
  - 9. Change order management status.
  - 10. Maintenance of quality standards (QA/QC).
  - 11. Field observations, problems, and conflicts.
  - 12. Commissioning and process start-up.
  - 13. Partnering recognition status (optional).
  - 14. General Items.
  - 15. Action items.
  - 16. Next meeting.
- F. Engineer will record minutes and distribute copies within 5 calendar days after meeting to participants, with copies to Contractor, Owner, and those affected by decisions made.

## **1.05 PRE-PROCESS START-UP MEETINGS**

- A. All processes and equipment that requires testing and process start-up also requires a pre-startup meeting at Project site before commencing process start-up of specific plant systems.
- B. Require attendance of parties directly affecting, or affected by process start-up and testing, including Engineer, specific work crews, Owner's construction operations, and maintenance staff.
- C. Notify Engineer no later than 7 calendar days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
  - 1. Review accepted MOP including conditions of process start-up and testing, preparation, and installation procedures.
  - 2. Review timelines and sequences.
  - 3. Review responsibilities.
  - 4. Review dry run plan and schedule, as necessary.
  - 5. Review coordination with related work.
- E. Contractor will record minutes and distribute electronic copies within 5 calendar days after meeting and prior to scheduled process start-up to participants, with copies to Engineer, Owner, and those affected by decisions made.
- F. Follow Owner's standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 - Work Restrictions for MOP format.

## **1.06 CLOSE-OUT MEETING**

- A. Engineer will schedule close-out meeting.
- B. Engineer will make arrangements for meeting, prepare agenda with copies for participants, and preside at meeting.
- C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, Superintendent.
- D. Agenda:
  - 1. Review punch list completion.
  - 2. Transfer of record documents.
  - 3. Finalize payment.
- E. Engineer will record minutes and within 5 calendar days after meeting distribute copies to participants.

## **PART 2    PRODUCTS**

Not Used.

## **PART 3    EXECUTION**

Not Used.

END OF SECTION



**SECTION 01321**  
**SCHEDULES AND REPORTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Preparation, submittal, and maintenance of schedules and reports.

**1.02 SUBMITTAL REQUIREMENTS**

- A. Submit preliminary and baseline schedule.
- B. Submit preliminary and baseline schedule of values.
- C. Submit preliminary and baseline schedule of submittals.
- D. Submit, on a monthly basis, updated schedules as specified.
- E. Submit final schedule update as specified.
- F. Submit revised schedules and time impact analyses as specified.
- G. Submit schedules in the media and number of copies as follows:
  - 1. Provide each submittal in PDF format and in other formats specified in this Section.
  - 2. 3 sets of the CPM network and/or bar chart (as specified by the Owner) on D-size sheets.
    - a. Color-coding to be specified by the Owner.
  - 3. 3 sets of tabular reports listing all activities sorted numerically identifying duration, early start, late start, early finish, late finish, total float, and all predecessor/successor information.
  - 4. 2 sets of CPM Schedule data electronic files in a native backed-up file (.xer).

**1.03 SCHEDULER**

- A. Designate, in writing and within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.
- B. Qualifications of scheduler:
  - 1. Authority to act on behalf of Contractor.
  - 2. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
  - 3. Knowledge of critical path method (CPM) scheduling utilizing Primavera P6 Professional or SureTrak or Microsoft Project software.
- C. Owner reserves the right to disapprove scheduler when submitted by Contractor if not qualified.

- D. Owner reserves the right to remove scheduler from the project if found to be unqualified.

#### **1.04 SCHEDULING FORMAT AND SOFTWARE**

- A. Schedule format: Utilize CPM format.
- B. Prepare computerized schedule utilizing Primavera P6 Professional or SureTrak or Microsoft Project software, most current version.
  - 1. Provide 1 licensed copy of the scheduling software to the engineer, registered in the Engineer's name, for the duration of the project.
  - 2. The provided copy of the software shall be a standalone version for installation on a standalone computer.
- C. Contractor and Engineer must agree on the format.

#### **1.05 PRECONSTRUCTION SCHEDULING MEETING**

- A. Engineer will conduct Preconstruction Scheduling Meeting with Contractor's Project Manager, General Superintendent, and scheduler within 7 calendar days after Notice to Proceed.
  - 1. This meeting is separate from the Preconstruction Conference Meeting and is intended to exclusively cover schedule issues.
- B. At the meeting, review scheduling requirements.
  - 1. These include schedule preparation, reporting requirements, labor and equipment loading, updates, revisions, and schedule delay analysis.
  - 2. Present schedule methodology, planned sequence of operations, cost and resource loading methodology, and proposed activity coding structure.
  - 3. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule.
    - a. Example 1: 2014\_07\_30 rev 1 draft baseline schedule.xer.
    - b. Example 2: 2014\_09\_30 rev 2 sep final update.xer.
- C. Filing: Post submitted files to Owner's construction document control system.

#### **1.06 REVIEW AND ACCEPTANCE OF SCHEDULES**

- A. Engineer will review Baseline Schedule, Schedule Updates, Schedule Revisions and Time Impact Analyses to ascertain compliance with specified project constraints, compliance with milestone dates, reasonableness of durations and sequence, accurate inter-relationships, and completeness.
- B. Engineer and Owner will issue written comments following completion of review of Baseline Schedule within 21 calendar days after receipt.
- C. Written comments on review of Schedule Updates and Schedule Revisions and Time Impact Analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.
- D. Revise and resubmit schedule in accordance with Engineer's comments within 7 calendar days after receipt of such comments, or request joint meeting to resolve objections.

- E. If Engineer requests a meeting, the Contractor and all major subcontractors must participate in the meeting with Engineer.
  - 1. Revise and resubmit schedule within 7 calendar days after meeting.
- F. Use accepted schedule for planning, organizing, and directing the work and for reporting progress.
- G. Engineer's submittal review response:
  - 1. When schedule reflects Owner's and Contractor's agreement of project approach and sequence, schedule will be accepted by Owner.
  - 2. Engineer's submittal review response for schedule submittal will be "Receipt Acknowledged - Filed for Record" including applicable comments.
  - 3. Acceptance of the schedules by the Owner is for general conformance with the Contract Documents and for Owner's planning information, and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the contract completion dates. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

## **1.07 SCHEDULE UPDATES**

- A. Any update:
  - 1. Prepare update using most recent accepted version of schedule including:
    - a. Actual start dates of activities that have been started.
    - b. Actual finish dates of activities that have been completed.
    - c. Percentage of completion of activities that have been started but not finished.
    - d. Actual dates on which milestones were achieved.
    - e. Update activities by inputting percent complete figures with actual dates.
    - f. Use retained logic in preparing Schedule Updates.
    - g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
    - h. Revisions to the schedule may be included that have been previously approved as specified in this Section under Revisions to Schedule.
- B. Monthly updates:
  - 1. Submit written narrative report in conjunction with each Schedule Update including descriptions of the following:
    - a. Activities added to or deleted from the schedule are to adhere to cost and other resource loading requirements.
      - 1) Identify added activities in manner distinctly different from original activity designations.
    - b. Changes in sequence or estimated duration of activities.
    - c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
    - d. Assumptions made and activities affected by incorporating change order work into the schedule.
  - 2. Submit updated schedule and materials specified under Submittal of Progress Schedules, 5 calendar days before the monthly schedule update meeting.

3. Since Monthly Schedule Update is the application for progress payment required as specified in Section 01294 - Applications for Payment, submittal and acceptance of the monthly Schedule Update is a condition precedent to the making of any progress payments.
- C. Weekly progress meeting:
1. Update the schedule prior to weekly progress meeting.
    - a. Identify overall progress of each Major Item of Work in the Summary Schedule.
    - b. If there are significant changes to the schedule, submit a written report at the weekly progress meeting.
  2. Should monthly Schedule Update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as "Project Float".
  3. Should monthly Schedule Update show project completion later than current Contract completion date, prepare and submit a Schedule Revision in accordance with the Revisions to Schedule.

## **1.08 REVISIONS TO SCHEDULE**

- A. Submit Revised Schedule within 5 days:
1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
  2. When delays in submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
  3. When the schedule does not represent the actual progress of activities.
  4. When any change to the sequence of activities, the completion date for major portions of the work, or when changes occur which affect the critical path.
  5. When Contract modification necessitates schedule revision, submit schedule analysis of change order work with cost proposal.
- B. Create a separate submittal for Schedule Revisions.
1. Comply with schedule updates as specified in this Section.
  2. Do not submit with Schedule Updates.
- C. Schedule Revisions will not be reflected in the schedule until after the revision is accepted by the Owner.
1. This includes Schedule Revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

## **1.09 ADJUSTMENT OF CONTRACT TIMES**

- A. Contract Time will be adjusted only for causes specified in Contract Documents.
1. Non-excusable delay:
    - a. Non-excusable delays include actions or inactions of the Contractor, or events for which the Contractor has assumed contractual responsibility (including actions or inactions of subcontractors, suppliers, or material manufacturers at any tier) that would independently delay the completion of the Work beyond the current Contract completion date).
    - b. No time extensions will be granted for non-excusable delays.

2. Excusable delay:
    - a. Events which are unforeseeable, outside the control of, and without the fault or negligence of either the Owner or the Contractor (or any party for whom either is responsible), which would independently delay the completion of the Work beyond the current Contract completion date.
    - b. The Contractor is entitled to a time extension only.
    - c. No other damages will be approved.
  3. Compensable delay:
    - a. Actions or inactions of the Owner, or events for which the Owner has assumed contractual responsibility, which would independently delay the completion of the Work beyond the current Contract completion date.
    - b. The Contractor is entitled to a time extension and delay damages.
  4. Concurrent delay:
    - a. Concurrent delay is any combination of the above 3 types of delay occurring on the same calendar date.
    - b. Exception to concurrent delay: Cases where the combination consists of 2 or more instances of the same type of delay occurring on the same calendar date. When one cause of delay is Owner-caused or caused by an event which is beyond the control and without the fault or negligence of either the Owner or the Contractor and the other Contractor-caused, the Contractor is entitled only to a time extension and no delay damages.
- B. If the Contractor believes that the Owner has impacted its work, such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path.
1. This proof, in the form of a Time Impact Analysis, may entitle the Contractor to an adjustment of Contract Time.
- C. Time Impact Analysis:
1. Use the accepted schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the schedule by:
    - a. Inserting new activities associated with the delay event into the schedule.
    - b. Revising activity logic.
    - c. Revising activity durations.
  2. If the project schedule's critical path and completion date are impacted as a result of adding this delay event to the schedule, a time extension equal to the magnitude of the impact may be warranted.
  3. The Time Impact Analysis submittal must include the following information:
    - a. A fragment of the portion of the schedule affected by the delay event.
    - b. A narrative explanation of the delay issue and how it impacted the schedule.
    - c. A schedule file used to perform the Time Impact Analysis.
- D. When a delay to the project as a whole can be avoided by revising preferential sequencing or logic, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.
- E. Indicate clearly that the Contractor has used, in full, all project float available for the work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date.

1. Utilize the latest version of the Schedule Update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.
- F. Adjustment of the Contract Times will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date.
  1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.
- G. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.
- H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to jobsite or home office overhead beyond the Contractor's originally planned occupancy of the site.
- I. Notify Engineer of a request for Contract Time adjustment.
  1. Submit request as specified with Contract Documents.
  2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.
- J. The Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing.
  1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule Update.
  2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
  3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
  4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

## **1.10 SCHEDULE PREPARATION**

- A. Preparation and submittal of Progress Schedule represents Contractor's intention to execute the Work within specified time and constraints.
  1. Failure to conform to requirement may result in termination for cause.
- B. Contractor's bid covers all costs associated with the execution of the Work in accordance with the Progress Schedule.

- C. During preparation of the preliminary Progress Schedule, Engineer will facilitate Contractor's efforts by being available to answer questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.
- D. Prepare schedule utilizing Precedence Diagramming Method (PDM).
- E. Prepare schedule utilizing activity durations in terms of working days.
  - 1. Do not exceed 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
  - 2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
  - 3. Coordinate holidays to be observed with the Owner and incorporate them into the schedule as non-working days.
- F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract.
  - 1. Contract requirements are not waived by failure of Contractor to include required schedule constraints, sequences, or milestones in schedule.
  - 2. Contract requirements are not waived by Owner's acceptance of the schedule. In event of conflict between accepted schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.
- G. Reference schedule to working days with beginning of Contract Time as Day "1".
- H. Baseline Schedule and Project Completion:
  - 1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's schedule completion date.
  - 2. Adjust accordingly any Contract milestone dates.
- I. Imposed dates, hidden logic prohibited: Do not use imposed dates or hidden logic in preparation of schedule.
- J. Interim milestone dates, operational constraints:
  - 1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on schedule.
  - 2. Do not use Zero Total Float constraint or Mandatory Finish Date on such Contract requirements.
- K. Resource loading and leveling: Input labor and equipment data on each schedule activity.
  - 1. Manpower data consist of the man-hours estimated to perform each task, categorized by trade.
  - 2. Equipment data consist of equipment hours estimated to perform each task, categorized by piece of equipment. Optimize and level manpower and equipment requirements.
  - 3. Resource leveling reflect a reasonable plan for accomplishing Work.
  - 4. Individual activities may be sequenced within limits of available float.

5. Keep to a minimum critical or near critical paths resulting from use of labor or equipment restraints.
  6. Near critical path identified as path with 15 or less working days of float.
- L. Schedule logic:
1. Assembled to show order in which Contractor proposes to carry out Work, indicate restrictions of access, availability of Work areas, and availability and use of manpower, materials, and equipment.
  2. Form basis for assembly of schedule logic on the following criteria:
    - a. Which activities must be completed before subsequent activities can be started?
    - b. Which activities can be performed concurrently?
    - c. Which activities must be started immediately following completed activities?
    - d. What major facility, equipment, or manpower restrictions are required for sequencing these activities?
- M. Major subcontractor, parallel prime contractor sign-off:
1. Provide written confirmation of concurrence from all major subcontractors and independent prime contractors on site with all schedule submittals.
  2. Term "major subcontractor" as used in this Section means any subcontractor, at any tier, with a subcontract worth 5 percent or more of the total cost of the Work.
- N. Schedule windows for Owner-furnished, Contractor-installed equipment or materials:
1. Immediately after Award of Contract, obtain from Engineer anticipated delivery dates of Owner furnished equipment or materials.
  2. Show these dates in the schedule in same manner indicated by Engineer.
- O. Cost loading: All schedules:
1. Only on-site construction activities.
  2. The sum total of all cost loaded activities equal to the current value of the Contract, including change orders, at all times.
  3. Payment for mobilization or payment for materials or equipment delivered to the site, not yet incorporated into the Work,
  4. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01292 - Schedule of Values
  5. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01294 - Applications for Payment.
  6. Payments will not be made until updated Schedule of Values is accepted.

## **1.11 NETWORK DETAILS AND GRAPHICAL OUTPUT**

- A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram.
1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.
- B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.



- C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished.
  - 1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.
- D. Indicate the critical path for the project.
- E. Delineate the specified contract duration and identify the planned completion of the Work as a milestone.
  - 1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as project float unless a Change Order is issued to officially change the Contract completion date.
- F. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion date as milestones.
- G. Include, in addition to construction activities:
  - 1. Submission dates and review periods for major equipment submittals, shoring submittals, and indicator pile program:
    - a. Shoring reviews: Allow 4-week review period for each shoring submittal.
    - b. Pile indicator program: Allow 3-week review period for analysis of program.
  - 2. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
  - 3. Equipment and long-lead material deliveries over 8 weeks.
  - 4. Approvals required by regulatory agencies or other third parties.
- H. Produce network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.
- I. Identify the execution of the following:
  - 1. Mobilization.
  - 2. All required submittals and submittal review times showing 30 calendar day duration for such activities and equal amount of time for re-submittal reviews.
  - 3. Equipment and materials procurement/fabrication/delivery.
  - 4. Grading, subbase, base, paving, and curb and gutters.
  - 5. Fencing and landscaping.
  - 6. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
  - 7. Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.
  - 8. Doors and windows, including hardware and glazing.
  - 9. Finishes including coating and painting, flooring, ceiling, and wall covering.
  - 10. Process equipment, including identification of ordering lead-time, factory testing, and installation.
  - 11. Pumps and drives, including identification of ordering lead time, factory testing, and installation.
  - 12. Conveying equipment including hoists and cranes, conveyor systems, and materials handling equipment, including identification of ordering lead-time and installation.

13. Other mechanical equipment including fans and heating, ventilating, and air conditioning equipment.
14. Trenching, pipe laying, and trench backfill and compaction.
15. Piping, fittings, and appurtenances, including identification of ordering and fabrication lead time, layout, installation and testing.
16. Valves, gates, and operators, including identification of order lead-time, installation, and testing.
17. Plumbing specialties.
18. Electric transmission, service, and distribution equipment, including identification of ordering lead-time, and factory testing.
19. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
20. Instrumentation and controls, including identification of ordering lead-time.
21. Preliminary testing of equipment, instrumentation, and controls.
22. Commissioning Phase:
  - a. Source Testing.
  - b. Owner Training.
  - c. Installation Testing.
  - d. Functional Testing.
  - e. Clean Water Facility Testing.
23. Process Start-up Phase:
  - a. Process Start-up.
  - b. Process Operational Period.
  - c. Instrumentation and Controls Performance Testing.
24. Substantial completion.
25. Punch list work.
26. Demobilization.

## **1.12 WEATHER DAY ALLOWANCE**

- A. Definition:
  1. Weather conditions that prevent or inhibit the Contractor's performance of the Work and affect the Critical Path indicated on the Schedule shall be referred to as a Weather Day.
  2. A Weather Day is defined as the Contractor being unable to perform at least 4 hours of work on the Critical Path.
- B. Allowance:
  1. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Days Allowance".
- C. Actual weather day:
  1. Insert a weather delay activity in critical path to reflect actual weather day occurrences when weather days are experienced and accepted by Engineer.
  2. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of project is considered float.
  3. The Contractor shall provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and shall describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted.
    - a. A schedule update will not suffice as a written notice.

- b. The Engineer will determine if the weather day constitutes a use of a portion of the Weather Day Allowance.
- c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.
- d. Weather days are considered excusable delay as defined in this Section.

### **1.13 PRELIMINARY SCHEDULE AND PRELIMINARY SCHEDULE OF VALUES**

- A. Due date:
  - 1. Submit proposed preliminary schedule and Preliminary Schedule of Values within 14 calendar days after Notice to Proceed.
  - 2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule and Preliminary Schedule of Values to review and make necessary adjustments.
  - 3. Submit revised preliminary schedule and Preliminary Schedule of Values within 5 calendar days after meeting.
  - 4. Update Preliminary Schedule and Preliminary Schedule of Values monthly during first 90 calendar days after Notice to Proceed.
    - a. Use Preliminary Schedule and Preliminary Schedule of Values as the payment application as specified in Section 01294 - Applications for Payment.
- B. Format:
  - 1. Schedule of manpower and costs for all activities for first 90 calendar days of Work after receipt of Notice to Proceed.
    - a. Provide realistic and level manpower and costs so as not to have unusual manpower requirements.
  - 2. Schedule of costs:
    - a. Schedule of Values as specified in Section 01292 - Schedule of Values for first 90 calendar days of Work.
    - b. Submittal and acceptance of Preliminary Schedule is condition precedent to making of progress payments as specified in Section 01294 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.
    - c. Proceed with pay item Work after Preliminary Schedule and schedule of costs have been accepted by Owner.
- C. Incorporate unchanged, the accepted Preliminary Schedule as first 90 calendar days of activity in Contractor's Baseline Schedule.

### **1.14 SCHEDULE OF SUBMITTALS**

- A. Schedule of Submittals shall include submittals required in the Contract Documents but not limited to Commissioning Plans, Training Plans, test procedures, operation and maintenance manuals, shop drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.
- B. Preliminary Schedule of Submittals:
  - 1. Due date: After Preliminary Schedule has been submitted and accepted by Owner.

2. Format:
    - a. Include submittals anticipated in the first 90 calendar days after Notice to Proceed using early start dates.
    - b. Indicate week and month anticipated for each submittal.
    - c. Indicate "Priority" submittals where review time can impact Contractor's schedule.
      - 1) "Priority" indication will not alter review times specified in Section 01330 - Submittal Procedures.
      - 2) Engineer will endeavor to provide early review of "Priority" submittals where possible.
  3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after Notice to Proceed.
- C. Final Schedule of Submittals:
1. Due date: After Baseline Schedule has been submitted and accepted by Owner.
  2. Format:
    - a. Include submittals using early start dates.
    - b. Include all submittals, including those required in the Preliminary Schedule of Submittals.
    - c. Indicate week and month anticipated for each submittal.
    - d. Indicate "Priority" submittals where review time can impact Contractor's schedule.
      - 1) "Priority" indication will not alter review times specified in Section 01330 - Submittal Procedures.
      - 2) Engineer will endeavor to provide early review of "Priority" submittals where possible.
  3. Submittal of Final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.
- D. Provide updated Schedule of Submittals with updated schedules if schedule revisions change listing and timing of submittals.

## **1.15 BASELINE SCHEDULE AND BASELINE SCHEDULE OF VALUES**

- A. Due date: No more than 45 calendar days after Notice to Proceed.
- B. Format:
  1. Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
  2. Schedule of Values: As specified in Section 01292 - Schedule of Values.
- C. Acceptance of the Baseline Schedule and Baseline Schedule of Values by the Owner is a condition precedent to making payments as specified in Section 01294 - Applications for Payment after the first 90 calendar days after Notice to Proceed.

## **1.16 SUMMARY SCHEDULE**

- A. Due date: At weekly progress meetings and after each Schedule Update or Schedule Revision.

- B. Format:
  - 1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
  - 2. intended to give an overall indication of the project schedule without a large amount of detail.

#### **1.17 COST FLOW SUMMARY**

- A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Section 01294 - Applications for Payment.
- B. Format:
  - 1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
  - 2. Base tabulation on the summation of the cost-loaded activities each month.
  - 3. Show planned amounts.
  - 4. Show actual earned amounts and anticipated remaining earnings.
  - 5. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

#### **1.18 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES**

- A. Due date: Submit on a monthly basis as specified in Section 01294 - Applications for Payment.
- B. Format: Schedule of Values: As specified in Section 01292 - Schedule of Values.

#### **1.19 WEEKLY SCHEDULE**

- A. Due date: At every weekly progress meeting.
- B. Format:
  - 1. Contractor and Engineer must agree on the format.
  - 2. 6-Week Schedule showing the activities completed during the previous week and the Contractor's schedule of activities for following 5 weeks.
  - 3. Use the logic and conform to the status of the current progress schedule when producing a Weekly Schedule in CPM schedule or a bar chart format.
    - a. In the event that the Weekly Schedule no longer conforms to the current schedule, Contractor may be required to revise the schedule as specified in this Section.
  - 4. The activity designations used in the Weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule Updates.

#### **1.20 MANPOWER SCHEDULE**

- A. Due date: With progress payments after Baseline Schedule has been submitted and accepted by Owner.
- B. Format:
  - 1. Schedule histogram depicting total craft manpower and craft manpower for Contractor's own labor forces and those of each subcontractor.
  - 2. Submit electronically in Excel format, with 1 paper copy.

- C. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until manpower schedule is provided.

#### **1.21 EQUIPMENT SCHEDULE**

- A. Due date: With any progress payment after Baseline Schedule has been submitted and accepted by Owner if it includes payment for equipment.
- B. Format:
  - 1. Tabular report listing each major piece of construction equipment to be used in performing the Work.
  - 2. Include major equipment for Contractor and each subcontractor.
  - 3. Submit electronically in Excel format with 1 paper copy.
- C. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until equipment schedule is provided.

#### **1.22 COMMISSIONING SCHEDULE**

- A. Proposed Commissioning Schedule:
  - 1. Due date: As specified in Section 01756 - Commissioning.
  - 2. Schedule requirements: As specified in Section 01756 - Commissioning.
  - 3. Engineer response due within 20 calendar days of receipt.
  - 4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.
- B. The Commissioning Schedule may not be combined with the Detailed Schedule until Engineer acceptance of the Proposed Commissioning and Process Start-up Schedule.
- C. Commissioning Schedule monthly update requirements:
  - 1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.
  - 2. Include activities not previously included in the previously accepted detail work plan Commissioning Schedule.
  - 3. Change Order required for any change to contractual dates.
  - 4. Reviews of these submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

#### **1.23 FINAL SCHEDULE**

- A. The final Schedule Update becomes the As-Built Schedule.
  - 1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
  - 2. Contractor's Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.
- B. Retainage will not be released until final Schedule Update is provided.

**PART 2    PRODUCTS**

Not Used.

**PART 3    EXECUTION**

Not Used.

END OF SECTION





## **SECTION 01322**

### **WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Requirements for web-based construction document management.

##### **1.02 REQUIREMENTS**

- A. Owner, Engineer, and Contractor shall utilize EADOC (EADOC is a registered trademark of EADOC LLC). For submission of all data and documents (unless specified otherwise in this Section) throughout the duration of the Contract.
  - 1. EADOC is a web-based electronic media site hosted by EADOC LLC.
  - 2. EADOC is available to all Contractor's personnel, subcontractor personnel, suppliers, consultants, Owner, and Engineer at no cost.
  - 3. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
  - 4. EADOC shall be the primary means of project information submission and management.

##### **1.03 USER ACCESS LIMITATIONS**

- A. Provide a list of Contractor's key EADOC personnel for the Engineer's acceptance. The Engineer reserves the right to perform a security check on all potential users. The Contractor will be allowed to add additional personnel and subcontractors to EADOC.
- B. The Engineer will grant initial access to EADOC by creating user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function-based authorizations and user privileges. Subcontractors and suppliers will be given access to EADOC by and through the Contractor. Contractor is responsible for adding and removing users from the system after the initial setup by the Engineer.

##### **1.04 JOINT OWNERSHIP OF DATA**

- A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EADOC system) by Engineer and Contractor will be jointly owned.

##### **1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING**

- A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents.

Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

## **1.06 COMPUTER REQUIREMENTS**

- A. Contractor shall use computer hardware and software that meets the requirements of the EADOC system as recommended by EADOC LLC to access and utilize EADOC. As recommendations are modified by EADOC, Contractor will upgrade their system(s) to meet or exceed the recommendations. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.
- B. Contractor shall ensure that connectivity to the EADOC system is accomplished through DSL, cable, T-1 or wireless communications systems. The minimum bandwidth requirement for using the system is 128 kb/s. It is recommended a faster connection be used when uploading pictures and files into the system.
- C. EADOC supports the current and prior 2 major versions of Chrome, Mozilla's Firefox, Microsoft's Internet Explorer and Apple's Safari on a rolling basis.
  - 1. Each time a new version of one of these browsers is released, EADOC will begin supporting the update and stop supporting the fourth-oldest version.

## **1.07 CONTRACTOR RESPONSIBILITY**

- A. Contractor shall be responsible for the validity of their information placed in EADOC and for the abilities of their personnel.
- B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on EADOC shall be the responsibility of the Contractor.
- C. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program.
- D. Contractor shall utilize the existing forms in EADOC to the maximum extent possible. If a form does not exist in EADOC the Contractor must include a form of their own or provided by Engineer as an attachment to a submittal.
- E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of EADOC (outside what is provided by Owner) and the other programs indicated above as needed.

## **1.08 TRAINING**

- A. The Owner will provide web-based training on EADOC for the Contractor.
- B. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate Contractor's training.

## **PART 2 PRODUCTS**

### **2.01 DESCRIPTION**

- A. EADOC project management application (no equal). Provided by EADOC LLC, [www.EADOCsoftware.com](http://www.EADOCsoftware.com).

## **PART 3 EXECUTION**

### **3.01 EADOC UTILIZATION**

- A. EADOC shall be utilized in connection with all document and information management required by these Contract Documents.

### **3.02 SUBMITTALS**

- A. Use EADOC for submittals.
- B. Content: As specified in Section 01330 - Submittal Procedures.
- C. Format: As specified in Section 01330 - Submittal Procedures.
- D. Submit Portable Document Format (PDF) documents to the EADOC submittal workflow process and forms.
  - 1. Consolidate electronic format submittals with multiples pages into a single file.
- E. Samples:
  - 1. Contractor shall enter submittal data information into EADOC.
  - 2. Attach a copy of the submittal form(s) to the sample.
- F. Record and Closeout Submittals:
  - 1. Operation and maintenance data as specified in Section 01782 - Operation and Maintenance Data.
  - 2. Extra materials, spare parts, etc.

### **3.03 REQUESTS FOR INFORMATION/INTERPRETATION (RFI)**

- A. Use EADOC for RFIs as specified in Section 01260 - Contract Modification Procedures.

### **3.04 OFFICIAL CORRESPONDENCE**

- A. Use EADOC for memos, notices, change proposals, or any official correspondence.

### **3.05 INSPECTION REQUESTS**

- A. Use EADOC to request inspection for a portion of Work that is ready for inspection and prior to covering up the Work.

### **3.06 FINANCIAL SUBMITTALS**

- A. Use EADOC for financial submittals as specified in Section 01330 - Submittal Procedures.

### **3.07 OTHER**

- A. Use EADOC for daily reports, meeting agendas and minutes, and other construction documents.

END OF SECTION

## **SECTION 01329**

### **SAFETY PLAN**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Development and maintenance of a Construction Safety Plan.

##### **1.02 REFERENCES**

- A. 29 CFR 1926, Subpart C in Utah.
- B. National Fire Protection Association (NFPA):
  - 1. 70E - Standard for Electrical Safety in the Workplace.
- C. Occupational Safety and Health Administration (OSHA).

##### **1.03 CONSTRUCTION SAFETY PLAN**

- A. Detail the Methods and Procedures to comply with 29 CFR 1926 Subpart C in Utah, NFPA 70E, Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Methods and procedures must also comply with the Owner's Safety Plan. Include the following:
  - 1. Identification of the Certified or Licensed Safety Consultant who will prepare, initiate, maintain and supervise safety programs, and procedures.
  - 2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
  - 3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, safety equipment used in multi-level structures, personal protective equipment (PPE) as required by NFPA 70E.
  - 4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
  - 5. Procedures for reporting safety or health hazards.
  - 6. Procedures to follow to correct a recognized safety and health hazard.
  - 7. Procedures for investigation of accidents, injuries, illnesses, and unusual events that have occurred at the construction site.
  - 8. Periodic and scheduled inspections of general work areas and specific workstations.
  - 9. Training for employees and workers at the jobsite.
  - 10. Methods of communication of safe working conditions, work practices and required personal protection equipment.
  - 11. Provision of a site-specific emergency action and evaluation plan.
  - 12. Verify safety plan includes reference to and compliance with latest Owner safety policies.

- B. Assume sole responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
  - 1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
  - 2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.
- C. Transmit to Owner and Engineer copies of reports and other documents related to accidents or injuries encountered during construction.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

**SECTION 01330**  
**SUBMITTAL PROCEDURES**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Requirements and procedures for submittals.

**1.02 REFERENCES**

- A. NSF International:
  - 1. NSF 61 - Drinking Water System Components - Health Effects.

**1.03 DEFINITIONS**

- A. Certificates: Describe certificates that document affirmations by the Contractor or other entity that the work is in accordance with the Contract Documents.
- B. Extra stock materials: Describe extra stock materials to be provided for the Owner's use in facility operation and maintenance.
- C. Maintenance material submittals: Use this article to categorize maintenance materials submittals requiring no Engineer action other than confirmation of receipt under an explanatory heading.
- D. Manufacturer's instructions: Instructions, stipulations, directions, and recommendations issued in printed form by the manufacturer of a product addressing handling, installation, erection, and application of the product; manufacturer's instructions are not prepared especially for the Work.
- E. Product data: Product data usually consists of manufacturers' printed data sheets or catalog pages illustrating the products to be incorporated into the project.
- F. Samples: Samples are full-size actual products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.
- G. Spare parts: Describe spare parts necessary for the Owner's use in facility operation and maintenance; identify the type and quantity here, but include the actual characteristics of the spare parts in Product as part of the specification of the product.
- H. Shop drawings: Shop drawings are prepared specifically for the project to illustrate details, dimensions, and other data necessary for satisfactory fabrication or construction that are not shown in the contract documents. Shop drawings could include graphic line-type drawings, single-line diagrams, or schedules and lists of products and their application.

- I. Submittals: Submittals are samples, product data, shop drawings, and others that demonstrate how Contractor intends to conform with the Contract Documents.
- J. Tools: Tools are generally defined as items such as special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit.

#### **1.04 GENERAL INSTRUCTIONS**

- A. Certification: Contractor is responsible to determine and verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved shop drawings and all Contract requirements.
- B. Provide submittals that are specified or reasonably required for construction, operation, and maintenance of the Work.
- C. Where multiple submittals are required, provide a separate submittal for each specification section.
  - 1. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
    - a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section.
    - b. For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.
- D. Edit all submittals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
- E. Prepare submittals in the English language. Do not include information in other languages.
- F. Present measurements in customary American units (feet, inches, pounds, etc.).
- G. Must be clear and legible, and of sufficient size for presentation of information.
- H. Minimum page size will be 8 1/2 inches by 11 inches:
  - 1. Maximum page size will be 11 inches by 17 inches.
- I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
- J. Provide submittal information from only 1 manufacturer for a specified product. Submittals with multiple manufacturers for 1 product will be rejected without review.
- K. Indicate project designated equipment tag numbers from P&IDs for submittal of devices, equipment, and assemblies.



## **1.05 SUBMITTAL ORGANIZATION**

- A. Fully indexed with bookmarks for every section.
- B. Sequentially number pages within the tabbed sections:
  - 1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
- C. Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
- D. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is used.
- E. Attachments:
  - 1. Specification section: Include with each submittal a copy of the relevant specification section.
    - a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).
    - b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
  - 2. Drawings: Include with each submittal a copy of the relevant Drawing, including relevant addendum updates.
    - a. Indicate either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).
    - b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
    - c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.
- F. Contractor: Prepare submittal information in sufficient detail to show compliance with specified requirements.
  - 1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
  - 2. Coordinate submittal with other submittals and with the requirements of the Contract Documents.
  - 3. Check, verify, and revise submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

## **1.06 SUBMITTAL METHOD AND FORMAT**

- A. As specified in Section 01322 - Web Based Construction Document Management.
- B. Submittals in electronic media format:
  - 1. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.
  - 2. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).
  - 3. Graphics: Provide graphic submittals (drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

4. Contractor using other software shall be required to provide to the Engineer conclusive evidence of 100 percent data transfer compatibility.

## **1.07 SUBMITTAL PROCEDURE**

- A. Engineer: Review submittal and provide response:
  1. Review description:
    - a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
    - b. Engineer's review of submittals shall not release Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall Engineer's review release Contractor from fulfilling purpose of installation nor from Contractor's liability to replace defective work.
    - c. Engineer's review of shop drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
    - d. Engineer's review does not extend to:
      - 1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by Contractor.
      - 2) Contractor's means, methods, techniques, sequences, or procedures except when specified, indicated on the Drawings, or required by Contract Documents.
      - 3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.
    - e. Engineer can Approve or Not Approve any exception at their sole discretion.
  2. Review timeframe:
    - a. Except as may be provided in technical specifications, a submittal will be returned within 30 days.
    - b. When a submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the submittal, give notice of the date by which that submittal will be returned.
    - c. Engineer's acceptance of progress schedule containing submittal review times less than those specified or agreed to in writing by Engineer will not constitute Engineer's acceptance of review times.
    - d. Critical submittals:
      - 1) Contractor will notify Engineer in writing that timely review of a submittal is critical to the progress of Work.
  3. Schedule delays:
    - a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of submittals, unless all of the following criteria are met:
      - 1) Engineer has failed to review and return first submission within the agreed upon time frame.
      - 2) Contractor demonstrates that delay in progress of Work is directly attributable to Engineer's failure to return submittal within time indicated and accepted by Engineer.

4. Review response will be returned to Contractor with one of the following dispositions:
  - a. Approved:
    - 1) No Exceptions:
      - a) There are no notations or comments on the submittal and the Contractor may release the equipment for production.
    - 2) Make Corrections Noted - See Comments:
      - a) The Contractor may proceed with the work; however, all notations and comments must be incorporated into the final product.
      - b) Resubmittal not required.
    - 3) Make Corrections Noted - Confirm:
      - a) The Contractor may proceed with the work; however, all notations and comments must be incorporated into the final product.
      - b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
  - b. Not Approved:
    - 1) Correct and resubmit:
      - a) Contractor may not proceed with the work described in the submittal.
      - b) Contractor assumes responsibility for proceeding without approval.
      - c) Resubmittal of complete submittal package is required within 30 calendar days of the date of the Engineer's submittal review response.
    - 2) Rejected - See Remarks:
      - a) Contractor may not proceed with the work described in the submittal.
      - b) The submittal does not meet the intent of the Contract Documents. Resubmittal of complete submittal package is required with materials, equipment, methods, etc. that meet the requirements of the Contract Documents.
  - c. Receipt Acknowledged - Filed for Record:
    - 1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
  - d. Receipt Acknowledged with Comments - Resubmit:
    - 1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.
- B. Contractor: Prepare resubmittal, if applicable:
  1. Clearly identify each correction or change made.
  2. Include a response in writing to each of the Engineer's comments or questions for submittal packages that are resubmitted in the order that the comments or questions were presented throughout the submittal and numbered consistent with the Engineer's numbering.

- a. Acceptable responses to Engineer's comments are listed below:
  - 1) "Incorporated" Engineer's comment or change is accepted and appropriate changes are made.
  - 2) "Response" Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
- b. Reviews and resubmittals:
  - 1) Contractor shall provide resubmittals which include responses to all submittal review comments separately and at a level of detail commensurate with each comment.
  - 2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment. Responses such as "acknowledged" or "noted" are not acceptable.
  - 3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
  - 4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant submittals.
  - 5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.
- c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for Revision and Resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.
- 3. Resubmittal timeframe:
  - a. Contractor shall provide resubmittal within 15 days.
  - b. When a resubmittal cannot be returned within the specified period, Contractor shall notify Engineer in writing.
- 4. Review costs:
  - a. Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
  - b. Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

## 1.08 SHOP DRAWINGS

- A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of shop drawings.
- B. Details:
  - 1. Fabrication drawings: Drawn to scale and dimensioned.
  - 2. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
  - 3. Locations of conduit entrances and access plates.
  - 4. Component layout and identification.
  - 5. Weight.
  - 6. Finish.
  - 7. Temperature limitations, as applicable.
  - 8. Nameplate information.

- C. Minor or incidental products and equipment schedules:
  - 1. Details:
    - a. Shop Drawings of minor or incidental fabricated products will not be required, unless requested.
    - b. Submit tabulated lists of minor or incidental products showing the names of the manufacturers and catalog numbers, with Product Data and Samples as required to determine acceptability.

## **1.09 PRODUCT DATA**

- A. Details:
  - 1. Supplier name and address.
  - 2. Subcontractor name and address.
- B. Include:
  - 1. Catalog cuts.
  - 2. Bulletins.
  - 3. Brochures.
  - 4. Manufacturer's Certificate of Compliance: Signed by product manufacturer along with supporting reference data, affidavits, and tests, as appropriate.
  - 5. Manufacturer's printed recommendations for installation of equipment.
  - 6. Quality photocopies of applicable pages from manufacturer's documents.
- C. Test reports including the following information:
  - 1. Test description.
  - 2. List of equipment used.
  - 3. Name of the person conducting the test.
  - 4. Date and time the test was conducted.
  - 5. Ambient temperature and weather conditions.
  - 6. All raw data collected.
  - 7. Calculated results.
  - 8. Clear statement if the test passed or failed the requirements stated in Contract Documents.
  - 9. Signature of the person responsible for the test.
- D. Certificates:
  - 1. As specified in technical sections.
  - 2. For products that will be in contact with potable water, submit evidence from a nationally recognized laboratory that the products comply with the requirements of the NSF 61 standard.

## **1.10 SAMPLES**

- A. Details:
  - 1. Submit labeled samples.
  - 2. Samples will not be returned.
  - 3. Provide samples from manufacturer's standard colors, materials, products, or equipment lines.
    - a. Clearly label samples to indicate any that represent non-standard colors, materials, products, or equipment lines and that if selected, will require an increase in Contract Time or Contract Price.
  - 4. Provide number of sample submittals as below:
    - a. Total: 2 minimum.

- 1) Owner: 1.
- 2) Engineer: 1.
- 3) Contractor: None.

- B. Field samples:
1. As specified in technical sections.

#### **1.11 DESIGN CALCULATIONS**

- A. Defined in technical sections:
1. Calculations must bear the original seal and signature of a Professional Engineer licensed in the state where the project is located and who provided responsible charge for the design.

#### **1.12 SCHEDULES**

- A. Progress schedules: As specified in Section 01321 - Schedules and Reports.
- B. Progress reports and quantity charts: As specified in Section 01321 - Schedules and Reports.

#### **1.13 REQUESTS FOR SUBSTITUTIONS (RFS)**

- A. As specified in Section 01600 - Product Requirements.

#### **1.14 REQUESTS FOR INFORMATION (RFI)**

- A. As specified in Section 01260 - Contract Modification Procedures.

#### **1.15 CONTRACTOR'S PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM**

- A. Submit a completed Contractor's P.E. Certification Form, provided in this Section, to comply with technical sections requirement for a professional engineer's certification from an engineer licensed in the state the project is located.

#### **1.16 CLOSEOUT SUBMITTALS**

- A. Provide closeout submittals as specified in Section 01770 - Closeout Procedures.
- B. Operation and Maintenance Manuals: final documents shall be submitted as specified in Section 01782 - Operation and Maintenance Data.
- C. Extra materials, spare parts, etc.: Submittal forms shall indicate when actual materials are submitted.

### **PART 2 PRODUCTS**

Not Used.

### **PART 3 EXECUTION**

Not Used.

END OF SECTION

APPENDIX A  
CONTRACTOR'S P.E. CERTIFICATION FORM

**DOCUMENT 01330**  
**CONTRACTOR'S P.E. CERTIFICATION FORM**

**Owner:** Click here to enter text. **Date:** MM/DD/YYYY.  
**Contractor:** Click here to enter text. **Registration State:** Click here to enter text.  
**Project Name:** Click here to enter text. **Project No.:** 00000.00.  
**Responsibilities:** Click here to enter text.  
**Spec Section:** Click here to enter text.

**Statement of Certification**

The undersigned hereby certifies that he/she is a professional engineer registered in the State of \_\_\_\_\_ and that he/she has been employed by \_\_\_\_\_

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state, and federal codes, rules, and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculation and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to:

Click here to enter text.

(Name of Owner, or Owner's representative within 7 days of receiving a written request by the Owner.)

**Prof. Engineer Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Printed Name:** \_\_\_\_\_ **Company Name:** \_\_\_\_\_

**Contractor's Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Printed Name:** \_\_\_\_\_



**APPENDIX B**  
**CONTRACTOR SUBMITTAL TRANSMITTAL FORM**

**DOCUMENT 01330**  
**CONTRACTOR SUBMITTAL TRANSMITTAL FORM**

<b>Owner:</b>	<u>Click here to enter text.</u>	<b>Date:</b>	<u>MM/DD/YYYY</u>
<b>Contractor:</b>	<u>Click here to enter text.</u>	<b>Project No.:</b>	<u>XXXXX.XX</u>
<b>Project Name:</b>	<u>Click here to enter text.</u>	<b>Submittal Number:</b>	<u>000</u>
<b>Submittal Title:</b>	<u>Click here to enter text.</u>		
<b>To:</b>	<u>Click here to enter text.</u>		
<b>From:</b>	<u>Click here to enter text.</u>	<u>Click here to enter text.</u>	
	<u>Click here to enter text.</u>	<u>Click here to enter text.</u>	

Specification No. and Subject of Submittal / Equipment Supplier			
<b>Spec ##:</b>	Spec ##.	<b>Subject:</b>	Click here to enter text.
<b>Authored By:</b>	Click here to enter text.		<b>Date Submitted:</b> XX/XX/XXXX

Submittal Certification	
<p><b>Check Either (A) or (B):</b></p> <p><input type="checkbox"/> (A) We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings with no exceptions.</p> <p><input type="checkbox"/> (B) We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings except for the deviations listed.</p>	
<p>Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.</p>	
<p><b>General Contractor's Reviewer's Signature:</b></p>	
<p><b>Printed Name:</b></p>	
<p>In the event, Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.</p>	
<p><b>Firm:</b> <a href="#">Click here to enter text.</a></p>	<p><b>Signature:</b></p>
<p><b>Date Returned:</b> XX/XX/XXXX</p>	

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

## **SECTION 01340**

### **PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes requirements for photographs and videos.
- B. The purpose of the photographs and videos is to document the condition of the facilities prior to the Contractor beginning work at the Project site, the progress of the Work, and the Project site after Substantial Completion of the Work.
- C. The scope of the photographic and videographic documentation shall be the sole responsibility of the Contractor, but shall be acceptable to the Engineer.

##### **1.02 SUBMITTALS**

- A. Pre-construction photographs and videos: Submit prior to beginning work at the Project site or prior to the Preconstruction Conference specified in Section 01312 - Project Meetings, whichever occurs earlier.
- B. Construction photographs and videos: Submit with each application for payment.
- C. Post-construction photographs and videos: Submit with project closeout documents as specified in Section 01770 - Closeout Procedures.

##### **1.03 PHOTOGRAPHER**

- A. Photographer qualified and equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to telephoto.
- B. Submit example work of previous photographs and video recording meeting the requirements of this Section.
  - 1. Provide to Engineer no later than the pre-construction conference.
  - 2. Provide photographs used for site examination.
  - 3. Provide video of site examination.
  - 4. Provide samples that used same camera and lighting equipment proposed for the Work.
  - 5. Engineer will review work examples to determine if the quality of the images is acceptable.
  - 6. Contractor is responsible for modifications to equipment and/or inspection procedures to achieve report material of acceptable quality.
  - 7. Do not commence Work prior to approval of the material by the Engineer.
  - 8. Once accepted, the standard report material shall serve as a standard for the remaining work.

#### **1.04 KEY PLAN**

- A. Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph.
- B. Include the same label information as the corresponding set of photographs.

#### **1.05 PHOTOGRAPHS**

- A. Provide prints of each photograph for each area of Work.
- B. Provide a digital copy of each photograph for each area of Work.
  - 1. Monthly: Indexed digital CD.
  - 2. Project record documents:
    - a. Catalog and index prints in chronological sequence.
    - b. Include typed table of contents.

#### **1.06 PRE-CONSTRUCTION PHOTOGRAPHS AND VIDEOS**

- A. Provide photographs and video of the condition entire site including each area of Work prior to the start of Work.
  - 1. Areas to be photographed and videoed shall include the site of the Work and all existing facilities, either on or adjoining the Project site, including the interior of existing structures, that could be damaged as a result of the Contractor's Work.
  - 2. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.

#### **1.07 CONSTRUCTION PHOTOGRAPHS AND VIDEOS**

- A. Provide photographs and videos of construction in each area of Work throughout progress of Work including a key plan designating where each photograph was taken.
- B. Take site and interior photographs and videos from differing directions of building demolition, pre-excavation, footing excavation, soil testing, utility crossings, installation of bypass piping, excavation of access pits, installation of lining system in pipes, rehabilitation of manholes, building modifications, utilities, electrical and instrumentation modifications, and other applicable activities indicating relative progress of the work.
- C. Take photos a maximum of 7 calendar days prior to submittal.

#### **1.08 POST-CONSTRUCTION PHOTOGRAPHS AND VIDEOS**

- A. Provide photographs of the entire site including each area of Work at the completion of Work.
  - 1. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.
  - 2. Take photos and video from same points in same direction as pre-construction examination.
- B. Submittal of photos and videos is a condition of final payment.

## **PART 2 PRODUCTS**

### **2.01 MEDIA**

#### **A. Paper media:**

1. Commercial grade, glossy surface, acid-free photographic paper.
2. Submit 3 prints of each photographic view within 7 days of taking photographs.
3. Format:
  - a. Ground photos: Color, matte finish, 8-1/2-inch by 11-inch size, mounted on soft card stock.
  - b. Aerial photos: Color, matte finish, 11-inch by 17-inch size, mounted on soft card stock.
  - c. Mount each print in a separate, archival type, non-glare, 3-hole punched protector.
4. Identification: On photograph, provide the following information:
  - a. Name of project.
  - b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
  - c. Description of vantage point, indicating location and direction by compass point.
5. Provide a suitably sized 3-ring binder for each set of prints.
  - a. Furnish binders in sufficient quantities to hold entire set of prints taken for the duration of the Contract.
  - b. Label binder spine and front with project name.

#### **B. Digital media:**

1. 120 millimeters, 700-MB, 80-minute CD compatible with current Microsoft Windows.
2. Provide photos as individual, indexed JPG files with the following characteristics:
  - a. Compression shall be set to preserve quality over file size.
  - b. Highest resolution JPG images shall be submitted. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
  - c. JPG image resolution shall be 5 megapixels at 2,400 by 1,800 or higher.
  - d. Images shall have rectangular clean images. Artistic borders, beveling, drop shadows, etc., are not permitted.
3. Identification: On photograph, provide the following information:
  - a. Name of project.
  - b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
  - c. Description of vantage point, indicating location and direction by compass point.

#### **C. Videos:**

1. Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
2. Digital color video format.
3. Provide audio portion of the composite CD sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
4. Identification: On each copy provide a label with the following information:
  - a. Name of project.

- b. Date video was recorded.
- 5. Submit 4 copies of each video within 7 days of recording.
- 6. Display continuous running time.
- 7. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

### **PART 3 EXECUTION**

Not Used.

END OF SECTION

## **SECTION 01353**

### **SPECIAL PROCEDURES FOR LOCATING AND VERIFYING CONCEALED EXISTING UTILITIES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Special procedures for locating and verifying concealed existing utilities.

##### **1.02 CONCEALED EXISTING UTILITIES**

- A. Verify locations of utilities which may exist by consulting with the Owner, utility companies, and Blue Stake or other service available in area of Project:
  - 1. Abide by easement and right-of-way restrictions.
- B. Perform exploratory vacuum excavation potholing, as necessary to more accurately identify location, depth, configuration, and utility service in congested utility areas prior to preparation of shop drawings and subsequent excavation.
  - 1. Potholing shall be backfilled immediately after purpose has been satisfied and the surface restored and maintained in a manner satisfactory to Engineer.
  - 2. Adjustments in construction methods shall be made to accommodate utility location information gained from potholing as necessary to protect existing utilities and maintain plant in operations.
  - 3. Note that installation of all underground yard piping and utilities in this project are considered to be installed in congested utility areas.
  - 4. Some variation from the conditions indicated on the Drawings is to be expected.
- C. Notify the Owner, owners of facilities when the Work will be in progress.
- D. Make arrangements for potential emergency repairs in accordance with requirements of owners of utility facilities, including individual or residential facilities.
- E. Assume responsibility for repair of utilities and facilities damaged by performance of the Work.
- F. Expose sanitary and storm sewers, water, gas, electric, telephone utility lines, and other underground facilities indicated to permit survey location prior to commencement of Work in affected area:
  - 1. Expose in ample time to permit relocation of interfering utilities with minimum delaying effect on Contract Time.
- G. Work required for raising, lowering, or relocating utilities not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities:
  - 1. When part of the Work, perform work in accordance with standards of affected utility owner, and adjustment to Contract Price and Contract Times will be made as stipulated in conditions of Contract.

## **PART 2    PRODUCTS**

Not Used.

## **PART 3    EXECUTION**

Not Used.

END OF SECTION



## **SECTION 01354**

### **HAZARDOUS MATERIAL PROCEDURES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Procedures required when encountering hazardous materials at the Work site.

##### **1.02 REFERENCES**

- A. Occupational Safety and Health Administration (OSHA).
- B. United States Code of Federal Regulation (CFR):
  - 1. Title 29 - Labor:
    - a. 1926.62 - Lead.
  - 2. Title 40 - Protection of Environment:
    - a. 261 - Identification and Listing of Hazardous Waste.

##### **1.03 SUBMITTALS**

- A. Submit laboratory reports, hazardous material removal plans, and certifications.
- B. Submit the following work plan:
  - 1. Removal and Legal Disposal of Asbestos Cement Pipe Plan.
    - a. Work plan shall include, but not be limited, to the following:
      - 1) Schedule of work.
      - 2) Security measures for work and disposal area.
      - 3) Staff training: Contractor shall provide at least one competent person who is capable of identifying asbestos hazards at the job site for the entire duration of the AC pipe removal and disposal operation.
      - 4) Trenching and removal of pipe procedure.

##### **1.04 DEFINITIONS**

- A. Adequately Wet: Penetration of the pipe wall with liquid to prevent release of particulates.
- B. Asbestos Cement Pipe: Also commonly referred to as AC Transite Pipe, AC pipe or ACP. Pipe that is generally composed of cement and asbestos fibers.
- C. Competent Person: A trained worker who is capable of identifying existing and predictable asbestos hazards, perform exposure assessment and monitoring, is qualified to train other workers, and has the authority to take immediate corrective action to eliminate a hazardous exposure.
- D. Non-friable Asbestos - Containing Material (NACM): Material containing more than 1 percent asbestos, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

- E. Regulated Asbestos - Containing Material (RACM): Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder in the course of work.

## **1.05 OPERATING DIGESTERS**

- A. Observe safety precautions in vicinity of operating digesters which contain digester gases, including methane, hydrogen sulfide, and carbon dioxide.

## **1.06 HAZARDOUS MATERIALS PROCEDURES**

- A. Hazardous materials are those defined by 40 CFR and State specific codes.
- B. When hazardous materials have been found:
  - 1. Prepare and initiate implementation of plan of action.
  - 2. Notify immediately Owner, Engineer, and other affected persons.
  - 3. Notify such agencies as are required to be notified by Laws and Regulations with the times stipulated by such Laws and Regulations.
  - 4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.
  - 5. Identify and contact subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.
- C. Forward to Engineer, copies of reports, permits, receipts, and other documentation related to remedial work.
- D. Assume responsibility for worker health and safety, including health and safety of subcontractors and their workers.
  - 1. Instruct workers on recognition and reporting of materials that may be hazardous.
- E. File requests for adjustments to Contract Times and Contract Price due to the finding of Hazardous Materials in the Work site in accordance with Contract Documents.
  - 1. Minimize delays by continuing performance of the Work in areas not affected by hazardous materials operations.

## **PART 2 EXECUTION**

### **2.01 ASBESTOS MATERIALS**

- A. Notifications:
  - 1. Notify OSHA 24 hours prior to performing asbestos material removal operations.
  - 2. Contractor shall notify Owner 3 working days in advance of commencing asbestos material removal operations.
- B. Work area:
  - 1. Establish a regulated work area, using at a minimum, construction warning tape to establish limits of work area for the asbestos material removal.

2. On site stockpiling or storage of asbestos material designated for disposal shall not be allowed.
- C. Safety:
  1. Conduct an Initial Exposure Assessment (IEA).
  2. Provide a hand/face wash station.
- D. Worker qualifications:
  1. Asbestos removal shall be performed by trained employees in conformance with Section (g) Methods of Compliance, of CCR, Title 8, § 1529, "Asbestos," mandating wet methods, vacuum cleaners with HEPA filters to collect debris and prompt cleanup.
- E. Legal disposal:
  1. Legal disposal of asbestos material is the Owner's responsibility.
  2. Contractor shall transport the asbestos material to the location designated by the Owner and place into the location designated for this project.

## **2.02 EXCAVATION OF AC PIPE**

- A. Machine excavates to expose asbestos cement pipe.
- B. Hand excavates areas under pipe where breaks are planned.
- C. Pipe shall be pre-wetted prior to any breaks being made.
- D. Pipe shall be snapped using mechanical snapping methods.

## **2.03 AC PIPE REMOVAL**

- A. All required pipe breaking operations shall require adequate pre-wetting with potable water.
- B. The Contractor shall make every effort to minimize the number of pipe breaks. Wherever possible, the pipe should be removed by pulling the pipe out of the pipe joint collars.
- C. Remove sections of AC pipe intact at joint collars by mechanical snapping methods between collars.
- D. Wet and containerize waste materials as removed from the trench. Use lifting straps and methods that do not further damage the pipe.
- E. Sections of AC pipe that become cut, have broken edges or have any friable surface shall be wet at exposed fractures and immediately wrapped.
  1. The pipe ends shall be sealed completely using a minimum 6-mil poly film wrap, which is securely fastened, taped to completely enclose the pipe and ACP appurtenances and shall have conspicuous, legible labeling that has the following or equivalent labeling: CAUTION: CONTAINS ASBESTOS FIBERS. BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM.
- F. AC Pipe sections shall not be left exposed in public view, either in trench or in disposal area.

- G. All connecting parts of pipe, rubber gaskets, and pipe couplings shall be discarded with pipe.
- H. AC pipe from this project only, shall be placed in the bin designated.

END OF SECTION

**SECTION 01410**  
**REGULATORY REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Regulatory authorities and codes.

**1.02 AUTHORITIES HAVING JURISDICTION**

- A. Building Department: City of West Jordan.
- B. Fire Department: City of West Jordan.

**1.03 APPLICABLE CODES**

- A. International Code Council (ICC).
  - 1. Building code:
    - a. International Building Code (IBC), 2015.
      - 1) Utah state amendments.
    - b. International Existing Building Code (IEBC), 2015.
  - 2. Electrical code:
    - a. National Electrical Code (NEC), 2014.
  - 3. Energy code:
    - a. International Energy Conservation Code (IECC), 2015.
  - 4. Fire code:
    - a. International Fire Code (IFC), 2015.
  - 5. Mechanical code:
    - a. International Mechanical Code (IMC), 2015.
  - 6. Plumbing code:
    - a. International Plumbing Code (IPC), 2015.
  - 7. Fuel gas code:
    - a. International Fuel Gas Code (IFGC), 2015.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

END OF SECTION



## SECTION 01424

### ABBREVIATIONS AND ACRONYMS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes: Abbreviations and meanings.

##### 1.02 INTERPRETATIONS

- A. Interpret abbreviations by context in which abbreviations are used.

##### 1.03 ABBREVIATIONS

- A. Abbreviations used to identify reference standards:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ABC	Associated Air Balance Council
AATCC	American Association of Textile Chemists and Colorists.
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
ABPA	Acoustical and Board Products Association
ACGIH	American Conference of Government Industrial Hygienists
ACI	American Concrete Institute
ACIL	American Council of Independent Laboratories
ADC	Air Diffusion Council
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers' Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AI	Asphalt Institute
AIA	American Institute of Architects
AIMA	Acoustical and Insulating Materials Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association International, Inc.
AMG	Arizona Masonry Guild
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWSC	American Welding Society Code
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America
BSI	Building Stone Institute
CFR	United States Code of Federal Regulations
CLFMI	Chain Link Fence Manufacturers Institute
CPSC	U.S. Consumer Product Safety Commission
CRA	California Redwood Association
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
CSA	CSA International
CSI	Construction Specifications Institute
CTI	Ceramic Tile Institute
DHI	Door and Hardware Institute
EIFS	Exterior Insulation and Finish System
EJCDC	Engineers Joint Contract Documents Committee
EPA	United States Environment Protection Agency
FDA	Food and Drug Administration
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	FM (Factory Mutual) Global
FS	Federal Specifications
FTI	Facing Tile Institute
GA	Gypsum Association
HI	Hydraulic Institute
HMMA	Hollow Metal Manufacturers Association
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineer's Association
ICRI	International Concrete Repair Institute
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers



ISA	International Society of Automation
ISO	International Organization for Standardization
JIC	Joint Industrial Council
MAG	Maricopa Association of Governments
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International
NAPA	National Asphalt Pavement Association
NAVFAC	Department of the Navy Facilities Engineering Command
NBHA	National Builders Hardware Association
NCMA	National Concrete Masonry Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NETA	InterNational Electrical Testing Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMWIA	National Mineral Wool Insulation Association
NPCA	National Paint and Coatings Association
NRCA	National Roofing Contractors Association
NSF	NSF International
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturer's Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDCA	Paint and Decorating Contractors of America
PDI	Plumbing and Drainage Institute
PEI	Porcelain Enamel Institute
PS	Product Standard
RCSC	Research Council on Structural Connections
RILEM	International Union of Testing and Research Laboratories for Materials and Structures
RTI	Resilient Tile Institute
SAE	SAE International
SCPA	Structural Clay Products Association
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association

SSPC	Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
TCA	Tile Council of America
UL	Underwriters Laboratories, Inc.
UNS	Unified Numbering System
USDA	United States Department of Agriculture
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VA	Vermiculite Association
WCLA	West Coast Lumberman's Association
WCLIB	West Coast Lumber Inspection Bureau
WPA	Western Pine Association
WPOA	Western Plumbing Officials Association
WRC	Welding Research Council
WSCPA	Western States Clay Products Association
WWPA	Western Wood Products Association

B. Abbreviations used in Specifications and Drawings:

a	year or years (metric unit)
A	ampere or amperes
am	ante meridian (before noon)
ac	alternating current
ac-ft	acre-foot or acre-feet
atm	atmosphere
AWG	American Wire Gauge
bbf	barrel or barrels
bd	board
bhp	brake horsepower
BIL	basic impulse insulation level
bil gal	billion gallons
BOD	biochemical oxygen demand
Btu	British thermal unit or units
Btuh	British thermal units per hour
bu	bushel or bushels
BV	bed volume(s)
C	degrees Celsius
cal	calorie or calories
cap	capita
cd	candela or candelas
cfm	cubic feet per minute
Ci	curie or curies
CIPP	Cured-in-Place Pipe
cm	centimeter or centimeters
cmu	concrete masonry unit

CO	carbon monoxide
Co.	Company
CO <sub>2</sub>	carbon dioxide
COD	chemical oxygen demand
Corp.	Corporation
counts/min	counts per minute
cu	cubic
cu cm	cubic centimeter or centimeters
cu ft	cubic foot or feet
cu ft/day	cubic feet per day
cu ft/hr	cubic feet per hour
cu ft/min	cubic feet per minute
cu ft/sec	cubic feet per second
cu in	cubic inch or inches
cu m	cubic meter or meters
cu yd	cubic yard or yards
d	day (metric units)
day	day (English units)
db	decibels
D/d	column diameter to particle diameter ratio
DB	dry bulb (temperature)
dc	direct current
diam	diameter
DO	dissolved oxygen
DS	dissolved solids
EBCT	empty bed contact time
EER	energy efficiency ratio
emf	electromotive force
fpm	feet per minute
F	degrees Fahrenheit
ft	feet or foot
fc	foot-candle or foot candles
ft/day	feet per day
ft/hr	feet per hour
ft/min	feet per minute
ft/sec	feet per second
g	gram or grams
G	gravitational force
gal	gallon or gallons
gal/day	gallons per day
gal/min	gallons per minutes
gal/sec	gallons per second
gfd	gallons per square foot per day
g/L	grams per liter
gpd	gallons per day
gpd/ac	gallons per day per acre
gpd/cap	gallons per day per capita
gpd/sq ft	gallons per day per square foot

gph	gallons per hour
gpm	gallons per minute
gpm/sq ft	gallons per minute per square foot
gps	gallons per second
g/cm <sup>3</sup>	grams per cubic centimeter
h	hour or hours (metric units)
ha	hectare or hectares
hp	high point
hp	horsepower
hp-hr	horsepower-hour or horsepower-hours
hr	hour or hours (English units)
Hz	hertz
ID	inside diameter
ihp	indicated horsepower
Inc.	Incorporated
inch	inch
inches	inches
inches/sec	inches per second
I/O	input/output
J	joule or joules
JTU	Jackson turbidity unit or units
k	kips
K	kelvin
K	thermal conductivity
kA	kiloampere
kcal	kilocalorie or kilocalories
kcmil	thousand circular mils
kg	kilogram or kilograms
kip	kilopound or kilopounds
km	kilometer or kilometers
kN	kilonewton or kilonewtons
kPa	kilopascal or kilopascals
ksi	kips per square inch
kV	kilovolt or kilovolts
kVA	kilovolt-ampere or kilovolt-amperes
kW	kilowatt or kilowatts
kWh	kilowatt hour
L	liter or liters
lb/1000 cu ft	pounds per thousand cubic foot
lb/acre-ft	pounds per acre-foot
lb/ac	pounds per acre
lb/cu ft	pounds per cubic foot
lb/day/cu ft	pounds per day per cubic foot
lb/day/acre	pounds per day per acre
lb/sq ft	pounds per square foot
L/D Ratio	Ratio of filter height to filter media particle diameter
lin	linear, lineal

lin ft	linear foot or feet
lm	lumen or lumens
lmh	liters per square meter per hour
log	logarithm (common)
ln	logarithm (natural)
lx	lux
m	meter or meters
M	molar (concentration)
mA	milliampere or milliamperes
max	maximum
mCi	millicurie or millicuries
meq	milliequivalent
meq/mL	milliequivalents per milliliter
MFBM	thousand feet board measure
mfr	manufacturer
mg	milligram or milligrams
mgd/ac	million gallons per day per acre
mgd	million gallons per day
mg/L	milligrams per liter
mrem	millirem
μF	microfarad or microfarads
Mil	0.001 inch (used for coating thickness)
mile	mile
mil. gal	million gallons
miles	miles
min	minimum
min	minute or minutes
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter or millimeters
mol wt	molecular weight
mol	mole
Mpa	megapascal or megapascals
mph	miles per hour
MPN	most probable number
MPT	National Pipe Thread, male fitting
mR	milliroentgen or milliroentgens
Mrad	megarad or megarads
mV	millivolt or millivolts
MW	megawatt or megawatts
μg/L	micrograms per liter
μm	micrometer or micrometers
μS/cm	microSeimens per centimeter
N	newton or newtons
N	normal (concentration)
ND	not detected
nm	nanometer
No.	number
Nos	numbers
NPT	National Pipe Thread

NRC	noise reduction coefficient
NTU or ntu	nephelometric turbidity unit
oc	on center
OD	outside diameter
ORP	oxidation-reduction potential
OT	ortho-tolidine
OTA	ortha-tolidine-arsenite
oz	ounce or ounces
oz/sq ft	ounces per square foot
Pa	pascal or pascals
pl	plate or property line
pm	post meridiem (afternoon)
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
pr	pair
psf/hr	pounds per square foot per hour
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PVC	polyvinyl chloride
qt	quart or quarts
R	radius
R	roentgen or roentgens
rad	radiation absorbed dose
RH	relative humidity
rpm	revolutions per minute
rps	revolutions per second
s	second (metric units)
S	Siemens (mho)
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
SDI	sludge density index or silt density index
sec	second (English units)
SI	International System of Units
sp	static pressure
sp gr	specific gravity
sp ht	specific heat
sq	square
cm <sup>2</sup> or sq cm	square centimeter or centimeters
sq ft	square feet or foot
sq inch	square inch
sq inches	square inches
km <sup>2</sup> or sq km	square kilometer or kilometers
m <sup>2</sup> or sq m	square meter or meters
mm <sup>2</sup> or sq mm	square millimeter or millimeters

sq yd	square yard or yards
SS	suspended solids
STC	Sound Transmission Class
SVI	sludge volume index
TDS	total dissolved solids
TEFC	totally enclosed, fan-cooled
TKN	total Kjeldahl nitrogen
TLM	median tolerance limit
TOC	total organic carbon
TOD	total oxygen demand
TOW	top of weir
TS	total solids
TSS	total suspended solids
TVS	total volatile solids
U	U Factor/U Value
U	Coefficient of Heat Transfer
U	heat transfer coefficient
UNS	Uniform Numbering System
US	United States
V	volt or volts
VA	volt-ampere or volt-amperes
W	watt or watts
WB	wet bulb
wg	water gauge
wk	week or weeks
WRT	water remediation technologies
wt	weight
yd	yard or yards
yr	year or years (English unit)

C. Abbreviations used on Drawings: As listed on Drawings or in Specifications.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION





**SECTION 01450**  
**QUALITY CONTROL**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes:
  - 1. Quality control and control of installation.
  - 2. Tolerances.
  - 3. References.
  - 4. Mock-up requirements.
  - 5. Authority and duties of Owner's representative or inspector.
  - 6. Sampling and testing.
  - 7. Testing and inspection services.
  - 8. Contractor's responsibilities.

**1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION**

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. When specified, products will be tested and inspected either at point of origin or at Work site:
  - 1. Notify Engineer in writing 30 days in advance unless specified otherwise of when products will be ready for testing and inspection at point of origin.
  - 2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.
- I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

### **1.03 TOLERANCES**

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

### **1.04 REFERENCES**

- A. ASTM International (ASTM):
  - 1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

### **1.05 PRODUCT REQUIREMENTS**

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

### **1.06 MOCK-UP REQUIREMENTS**

- A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be comparison standard for remaining Work.
- D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

### **1.07 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR**

- A. Owner's Project Representative employed or retained by Owner is authorized to inspect the Work.
- B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

- C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.
- D. Inspector will not:
  - 1. Alter or waive provisions of Contract Documents.
  - 2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
  - 3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.
- E. Inspector will:
  - 1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
  - 2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

## **1.08 SAMPLING AND TESTING**

- A. General:
  - 1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
  - 2. When specified in sections where products are specified:
    - a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
    - b. Test materials in accordance with standards of national technical organizations.
- B. Sampling:
  - 1. Furnish specimens of materials when requested.
  - 2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
  - 3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
  - 4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

## **1.09 TESTING AND INSPECTION SERVICES**

- A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.
- B. Owner will employ and pay for specified services of an "Owner's independent testing firm" certified to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01455B -

Special Tests and Inspections to confirm Contractor's compliance with Contract Documents.

- C. The Owner's independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.
- D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
  - 1. Has authorization to operate in the state where the project is located.
  - 2. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
  - 3. Meets requirements of ASTM E329.
  - 4. Laboratory Staff: Maintain full time specialist on staff to review services.
  - 5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards (NBS) or accepted values of natural physical constants.
  - 6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NBS during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.
- E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.
- F. Contractor shall cooperate with Owner's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
  - 1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
  - 2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.
- G. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
  - 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
  - 2. Agency or laboratory may not approve or accept any portion of the Work.
  - 3. Agency or laboratory may not assume duties of Contractor.
  - 4. Agency or laboratory has no authority to stop the Work.
- H. Testing and employment of an Owner's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.
- J. The Owner's independent testing firm responsibilities will include:
  - 1. Test samples of mixes submitted by Contractor.

2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
  3. Perform specified sampling and testing of products in accordance with specified standards.
  4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
  5. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of Work or products.
  6. Perform additional tests required by Engineer.
  7. Attend preconstruction meetings and progress meetings.
- K. Owner's independent testing firm individual test reports: After each test, Owner's independent testing firm will promptly submit electronically and 3 hard copies of report to Engineer and to Contractor. Include the following:
1. Date issued.
  2. Project title and number.
  3. Name of inspector.
  4. Date and time of sampling or inspection.
  5. Identification of product and specifications section.
  6. Location in Project.
  7. Type of inspection or test.
  8. Date of test.
  9. Certified test results stamped and signed by a registered Engineer in the State of Utah.
  10. Summary of conformance with Contract Documents.
  11. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results.
- L. Owner's independent testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
1. Results of testing.
  2. Testing logs.
  3. Outstanding deficiencies.
  4. Various statistical data.
  5. Testing curves (up to 4 types) as required by the Engineer.

#### **1.10 CONTRACTOR'S RESPONSIBILITIES**

- A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.
- B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.
- C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.
- D. Furnish electronically and 5 hard copies of product test reports.

- E. Furnish incidental labor and facilities:
  - 1. To provide access to construction to be tested.
  - 2. To obtain and handle samples at Work site or at source of product to be tested.
  - 3. To facilitate inspections and tests.
  - 4. For storage and curing of test samples.
- F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## **SECTION 01455B**

### **SPECIAL TESTS AND INSPECTIONS PROVIDED BY OWNER**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: This Section describes the requirements for providing special inspections, special tests, and structural observation.
- B. Special Tests and Inspections specified by this Section will be provided by the Owner. Contractor to coordinate with as needed with Owner's Special Inspector to accommodate the requirements of this specification.

##### **1.02 REFERENCES**

- A. American Concrete Institute (ACI):
  - 1. 318 - Building Code Requirements for Structural Concrete.
  - 2. 530 - Building Code Requirements for Masonry Structures.
  - 3. 530.1 - Specification for Masonry Structures.
- B. American Institute of Steel Construction (AISC):
  - 1. 360 - Specification for Structural Steel Buildings.
- C. American Society of Civil Engineers (ASCE):
  - 1. 7 - Minimum Design Loads for Buildings and Other Structures.
- D. American Welding Society (AWS):
  - 1. D1.3 - Structural Welding Code - Sheet Steel.
  - 2. D1.4 - Structural Welding Code - Reinforcing Steel.
- E. ASTM International (ASTM):
  - 1. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
  - 2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  - 3. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
  - 4. C1611 Standard Test Method for Slump Flow of Self-Consolidating Concrete.
- F. International Building Code (IBC) 2015 with State of Utah amendments.

##### **1.03 DEFINITIONS**

- A. Special Inspection: Inspection of the materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.
- B. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

- C. Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed and at the completion of the work.
- D. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system.

#### **1.04 DESCRIPTION**

- A. This Section describes special inspections, special tests, and structural observation of structural assemblies and components to be performed in compliance with the regulatory building code specified in Section 01410 - Regulatory Requirements.
- B. These special tests and inspections are in addition to the requirements specified in Section 01450 - Quality Control, and by the individual Sections.

#### **1.05 SPECIAL INSPECTION**

- A. Owner will employ 1 or more special inspectors who will provide special inspections during construction.
- B. Special inspectors shall be qualified for inspection of the particular type of materials or operations requiring special inspection.
- C. Duties of Special Inspector:
  - 1. General: Required duties of the special inspector(s) shall be as described in Chapter 17 of the building code, specified in Section 01410 - Regulatory Requirements, and this Section.
  - 2. Reporting: Special inspector(s) shall provide reports of each inspection to the Building Official and the Engineer.
    - a. Reports shall, at a minimum, indicate the following items:
      - 1) Date and time of inspection, and name(s) of individual(s) performing the inspection.
      - 2) Structures and areas of the structure where work or testing was observed.
      - 3) Discrepancies between the requirements of the Contract Documents and the work or testing observed.
      - 4) Other areas of deficiency in the Work.
- D. Special inspections shall not be construed as fulfilling the requirements for structural observation.

#### **1.06 TESTING**

- A. Testing laboratory: Special tests will be performed by Owner's testing laboratory as specified in Section 01450 - Quality Control.
- B. Selection of the material to be tested shall be by Engineer or by Owner's testing laboratory, and not by the Contractor.



## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

### **3.01 SPECIAL TESTING AND INSPECTIONS**

- A. The following types of work require special inspection as described in Section 1705 of the building code as specified in Section 01410 - Regulatory Requirements and shall be provided wherever such work occurs unless otherwise specified. Refer to the following schedules:
  - 1. Appendix A: Concrete Special Inspection Schedule.
  - 2. Appendix B: Architectural, Mechanical, and Electrical Component Special Inspection Schedule.
  - 3. Appendix C: Level C Masonry Special Inspection and Minimum Tests Schedule.
  - 4. Appendix D: Soils Verification and Inspection Schedule.
  - 5. Appendix E: Structural Steel Welding Special Inspection Schedule.
  - 6. Appendix F: Structural Steel Bolting Special Inspection Schedule.
- B. Testing and qualification for seismic resistance (Section 1705.12 of the regulatory building code):
  - 1. The following designated systems shall be subject to the testing and qualification requirements of Section 1705.12.3 of the regulatory building code and shall require special certification as set forth in ASCE 7, Section 13.2:
    - a. Mechanical equipment with an importance factor of 1.50 as specified in Section 01612 - Seismic Design Criteria.
    - b. All electrical equipment.
  - 2. Seismic certification requirements for designated systems:
    - a. Submittals for mechanical and electrical equipment identified in this Section as designated systems shall include certification that the equipment is seismically qualified. Certifications shall be subject to review and acceptance by the Contractor.
      - 1) Certifications may be at least 1 of the following in accordance with ASCE 7, Section 13.2:
        - a) Analysis.
        - b) Testing.
        - c) Experience data.
    - b. Special inspector shall examine the designated seismic system and determine whether the designated system components, including anchorage, conform to the evidence of compliance submitted.

### **3.02 STRUCTURAL OBSERVATION**

- A. The following work requires structural observation in accordance with Section 1704.5 of the regulatory building code:
  - 1. All structures in all areas:
    - a. Foundations.
    - b. Elevated slabs.
    - c. Walls and columns.
    - d. Roof framing and diaphragms.

### **3.03 OTHER SPECIFIC TESTS**

- A. Any unusual materials that are expected to support design live loads.

### **3.04 SCHEDULE**

- A. Contractor shall allow time necessary for Special Inspections as listed above.
- B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

### **3.05 PROCEDURE**

- A. The Special Inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.
- B. Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

## APPENDIX A

### CONCRETE SPECIAL INSPECTION SCHEDULE

(Includes: cast-in-place, precast, prestressed, precast-prestressed, and shotcrete.)

Verification and Inspection	Reference Standard  ACI 318-14 AWS D1.4-11 IBC 2015	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
1. Construction of forms.	ACI 318: 26.13.3.3(c)		●
a. Removal of slab forms and installation of re-shoring	ACI 318: 26.13.3.2(c)		●
2. Inspection of reinforcing steel, including prestressing and post-tensioning tendons.	ACI 318: Ch 20, 25.2, 25.3, 26.5.1-26.5.3, 26.13.3.3(a) IBC: 1908.4		●
a. Reinforcing bar couplers and terminators:	Evaluation Service Reports	●	
b. Inspection of reinforcing steel welding:	AWS D1.4 ACI 318: 26.6.4.1		
3. Verify weldability of reinforcing bars (other than ASTM A706).	ACI 318: 26.6.4.1		●
a. Single pass fillet welds (to 5/16 inch).	IBC: Table 1705.3		●
b. All other welds.	IBC: Table 1705.3	●	
c. Inspect anchors and embedments cast into concrete (prior to and during placement of concrete).	ACI 318: 17.8.2, 26.13.3.3(a)		●
4. Inspection of anchors post-installed in hardened concrete members.			
5. Adhesive anchors installed in horizontal or upwardly inclined orientations.	ACI 318: 17.8.2.4, 26.13.3.2(c). Evaluation Service Reports.	●	
a. Mechanical anchors, and adhesive anchors not included under 4a.	ACI 318: 17.8.2, 26.13.3.3(f)		●
b. Concrete placement:			
6. Verify use of required mix design.	ACI 318: Ch 19, 26.4.3, 26.4.4 IBC: 1904.1, 1904.2, 1908.2, 1908.3	●	

Verification and Inspection	Reference Standard  ACI 318-14 AWS D1.4-11 IBC 2015	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
a. Sampling and preparation of cylinders and specimens for testing.	ACI 318: 26.12 IBC: 1908.10	●	
b. At the time fresh concrete is sampled to fabricate specimens for testing, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172 ASTM C31 ACI 318: 26.12 IBC 1908.10	●	
c. Inspection of concrete placement for proper application and consolidation techniques.	ACI 318: 26.13.3.2(a) IBC: 1908.6, 1908.7, 1908.8	●	
7. Inspection for maintenance of specified curing temperatures, techniques, and duration.	ACI 318: 26.13.3.3(b) IBC: 1908.9		●
8. Inspection of prestressed concrete:			
9. Application of prestressing forces.	ACI 318: 26.13.3.2(b)	●	
a. Grouting of bonded prestressing tendons.	ACI 318: 26.13.3.2(b)	●	
b. Precast concrete members: sequence of erection and connections	ACI 318: 26.13.3.3(d),		●
10. Verification of in-place concrete strength before stressing post-tensioned reinforcement, and before removal of shores and forms from beams and structural slabs.	ACI 318: 26.13.3.3(e)		●
11. Inspect formwork for shape, location, and dimensions of the concrete member being formed.	ACI 318: 26.10.2		●
Notes: (1) The "●" represents a required inspection activity for the project where it occurs.			

## APPENDIX B

### ARCHITECTURAL, PLUMBING, MECHANICAL, AND ELECTRICAL COMPONENTS SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
12. Architectural components:	IBC 2015		
a. Cladding - exterior, weighing more than 5 psf: erection and fastening.	IBC: 1705.12.5		●
b. Exterior insulation and finish system (EIFS): NTS: Review IBC and edit for project.	IBC: 1705.16		
c. Non-bearing walls - exterior: erection and fastening.	IBC: 1705.12.5		●
d. Non-bearing walls - interior, weighing more than 15 psf.	IBC: 1705.12.5		●
e. Veneer, exterior and interior, weighing more than 5 psf: erection and fastening.	IBC: 1705.12.5		●
f. Access floors: erection and anchorage.	IBC: 1705.12.5.1		●
g. Suspended ceiling system: anchorage.			●
h. Storage racks - 8 feet or greater in height: erection and anchorage.	IBC: 1705.12.7		●
13. Plumbing, mechanical, and electrical components:			
a. Anchorage of electrical equipment for emergency and standby power systems.	IBC: 1705.12.6.1		●
b. Anchorage of other electrical and mechanical equipment over 400 lb. on floors or roofs.	IBC: 1705.12.6.2		●
c. Installation and anchorage of pipelines carrying hazardous chemicals and their associated mechanical units.	IBC: 1705.12.6.3		●
d. Installation and anchorage of pipelines greater than 8 inches in diameter.			●
e. Installation and anchorage of ductwork designed to carry hazardous materials.	IBC: 1705.12.6.4		●
f. Installation and anchorage of ductwork greater than 6 sf in cross section.			●

g. Installation and anchorage of vibration isolation systems where contract documents require nominal clearance of 1/4 inch or less between the equipment support frame and its support/restraint.	IBC: 1705.12.6.5		●
14. Fire-resistance elements:			
a. Sprayed fire-resistant coatings:	IBC: 1705.14		
b. Mastic and intumescent coatings:	IBC: 1705.15		
c. Penetration firestops:	IBC: 1705.17, 1705.17.1		
d. Fire-resistant joint systems:	IBC: 1705.17, 1705.17.2		
15. Smoke control systems;	IBC: 1705.18		
Notes:			
(1) The "●" represents a required inspection activity for the project where it occurs.			

## APPENDIX C

### MASONRY SPECIAL INSPECTION SCHEDULE - "LEVEL C"

#### **MINIMUM TESTS**

Verification of Slump flow and Visual Stability Index (VSI) as delivered to the project site as determined by ASTM C1611 for self-consolidating grout.

Verification of proportions of materials in premixed or pre-blended mortar and grout as delivered to the project site.

Verification of  $f_m$ .

MINIMUM SPECIAL INSPECTION - LEVEL C			
Verification and Inspection	Reference Standard  ACI 530-13 ACI 530.1-13	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
1. Verify compliance with the approved submittals.	ACI 530.1: Art. 1.5		●
2. As masonry construction begins, verify that the following are in compliance:			
a. Proportions of site-prepared mortar.	ACI 530.1: Art. 2.1, 2.6A		●
b. Placement of masonry units and construction of mortar joints.	ACI 530.1: Art. 3.3B		●
c. Placement of reinforcement, connectors, and anchors.	ACI 530.1: Art 3.4 ACI 530: Sec 6.1, 6.2.6, 6.2.7	●	
a. Reinforcing bar couplers and terminators.		●	
3. Prior to grouting, verify that the following are in compliance:			
a. Placement of masonry units and construction of mortar joints.	ACI 530.1: Art. 3.3B		●
b. Grout space.	ACI 530.1: Art. 3.2D, 3.2F	●	
c. Grade, type, and size of reinforcement and anchor bolts.	ACI 530.1: Art. 2.4, 3.4 ACI 530: Sec. 6.1		●
d. Placement of reinforcement, connectors, and anchors.	ACI 530.1: Art. 3.2E, 3.4 ACI 530: Sec. 6.1, 6.2.6, 6.2.7	●	

MINIMUM SPECIAL INSPECTION - LEVEL C			
Verification and Inspection	Reference Standard  ACI 530-13 ACI 530.1-13	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
4. Verify during construction:			
a. Size and location of structural elements:	ACI 530.1: Art. 3.3F		●
b. Type, size, and location of anchors, including details of anchorage of masonry to structural members, frames, or other construction.	ACI 530: Sec. 1.2.1(e), 6.1.4.3, 6.2.1	●	
c. Welding of reinforcement.	ACI 530: Sec 8.1.6.7.2, 9.3.3.4(c), 11.3.3.4(b)	●	
d. Preparation, construction, and protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F).	ACI 530.1: Art. 1.8C, 1.8D		●
5. Observe preparation of grout specimens, mortar specimens, and/or prisms.	ACI 530.1: Art. 1.4 B.2.a.3, 1.4 B.2.b.3, 1.4 B.2.c.3, 1.4 B.3, 1.4 B.4	●	
Notes:			
(1) The "●" represents a required inspection activity for the project where it occurs.			



## APPENDIX D

### SOILS VERIFICATION AND SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	IBC: T-1705.6		●
2. Verify excavations are extended to proper depth and have reached proper material.	IBC: T-1705.6		●
3. Perform classification and testing of fill and backfill materials.	IBC: T-1705.6		●
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of fill and backfill.	IBC: T-1705.6	●	
5. Prior to placement of fill, observe subgrade and verify that site has been prepared properly.	IBC: T-1705.6		●
Notes:			
(1) The "●" represents a required inspection activity for the project where it occurs.			



## APPENDIX E

### STRUCTURAL STEEL WELDING SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Referenced Standard	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
<b>Inspection Tasks Prior to Welding</b>	AISC 360, Table N5.4-1		
1. Welding procedure specifications (WPSs) available.		●	
2. Manufacturer certifications for welding consumables available.		●	
3. Material identification (type/grade).			●
4. Welder identification system.			●
5. Fit-up groove welds (including joint geometry): <ul style="list-style-type: none"> <li>Joint preparation.</li> <li>Dimensions (alignment, root opening, root face, bevel).</li> <li>Cleanliness (condition of steel surfaces).</li> <li>Tacking (tack weld quality and location).</li> <li>Backing type and fit (if applicable).</li> </ul>			●
5. Configuration and finish of access holes.			●
6. Fit-up of fillet welds: <ul style="list-style-type: none"> <li>Dimensions (alignment, gaps at root).</li> <li>Cleanliness (condition of steel surfaces).</li> <li>Tacking (tack weld quality and location).</li> </ul>			●
7. Check welding equipment.			●
<b>Inspection Tasks During Welding</b>	AISC 360, Table N5.4-2		
8. Use of qualified welders.			●
9. Control and handling of welding consumables: <ul style="list-style-type: none"> <li>Packaging.</li> <li>Exposure control.</li> </ul>			●
10. No welding over cracked tack welds.			●
11. Environmental conditions: <ul style="list-style-type: none"> <li>Wind speed within limits.</li> <li>Precipitation and temperature.</li> </ul>			●

Verification and Inspection	Referenced Standard	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
12. WPS followed: <ul style="list-style-type: none"> <li>Settings on welding equipment.</li> <li>Travel speed.</li> <li>Selected welding materials.</li> <li>Shielding gas type/flow rate.</li> <li>Preheat applied.</li> <li>Interpass temperature maintained (min/max).</li> <li>Proper position (F, V, H, OH).</li> </ul>	AISC 360-10		●
13. Welding techniques: <ul style="list-style-type: none"> <li>Interpass and final cleaning.</li> <li>Each pass within profile limitations.</li> <li>Each pass meets quality requirements.</li> </ul>			●
<b>Inspection Tasks After Welding</b>	AISC 360, Table N5.4-3		
14. Welds cleaned.			●
15. Size, length, and location of welds.		●	
16. Welds meet visual acceptance criteria: <ul style="list-style-type: none"> <li>Crack prohibition.</li> <li>Weld/base-metal fusion.</li> <li>Crater cross section.</li> <li>Weld profiles.</li> <li>Weld size.</li> <li>Undercut.</li> <li>Porosity.</li> </ul>		●	
17. Arc strikes.		●	
18. k-area.		●	
19. Backing removed and weld tabs removed (if required).		●	
20. Repair activities.		●	
21. Document acceptance or rejection of welded joint or member.		●	
Notes:			
(1) The "●" represents a required inspection activity for the project where it occurs.			

## APPENDIX F

### STRUCTURAL STEEL BOLTING SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Referenced Standard	Frequency of Inspection <sup>(1)</sup> (During Task Listed)	
		Continuous	Periodic
<b>Inspection Tasks Prior to Bolting</b>	AISC 360, Table N5.6-1		
1. Manufacturer's certifications available for fastener materials.		●	
2. Fasteners marked in accordance with ASTM requirements.			●
3. Proper fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane).			●
4. Proper bolting procedure selected for joint detail.			●
5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements.			●
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used.			●
7. Proper storage provided for bolts, nuts, washers and other fastener components.			●
<b>Inspection Tasks During Bolting</b>	AISC 360, Table N5.6-2		
8. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required.			●
9. Joint brought to the snug-tight condition prior to the pretensioning operation.			●
10. Fastener component not turned by the wrench prevented from rotating.			●
11. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges.			●
<b>Inspection Tasks After Bolting</b>	AISC 360, Table N5.6-3		
12. Document acceptance or rejection of bolted connections.		●	
Notes:			
(1) The "●" represents a required inspection activity for the project where it occurs.			



**SECTION 01460**  
**CONTRACTOR QUALITY CONTROL PLAN**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes:
  - 1. Contractor Quality Control Plan.

**1.02 SUBMITTALS**

- A. Qualifications of the Contractor's Quality Control (CQC) Plan Manager.
- B. Contractor's Daily Quality Control Report: Submit to Engineer within 1 day of completion of each inspection.
- C. Daily Inspection Report: Submit to Engineer at the end of each working day or no later than prior to the beginning of the next working day.

**1.03 CONTRACTOR'S INSPECTION OF THE WORK**

- A. Work performed by Contractor shall be inspected by the Contractor's CQC Plan Manager. Non-conforming Work and any safety hazards in the Work area shall be noted and promptly corrected.
- B. No materials or equipment shall be used in Work without inspection and acceptance by Contractor's CQC Plan Manager.

**1.04 QUALIFICATIONS**

- A. Contractor's CQC Plan Manager: Demonstrate having performed similar CQC functions on similar type projects. Submit records of personnel experience, training, and qualifying registrations.
- B. Minimum qualifications: Candidate must have a minimum of 10 years of experience on projects of similar type and size.

**1.05 COVERING WORK**

- A. Whenever Contractor intends to backfill, bury, cast in concrete, or otherwise cover any Work, notify Engineer not less than 24 hours in advance to request inspection before beginning any such Work of covering. Failure of Contractor to notify Engineer in accordance with this requirement shall be resolved according to Article 14 of the General Conditions.

**1.06 CONTRACTOR'S QUALITY CONTROL PROGRAM**

- A. General: Establish and execute a Quality Control (CQC) Plan for Work. The plan shall establish adequate measures for verification and conformance to defined

requirements by Contractor personnel and lower-tier Subcontractors (including Fabricators, Suppliers, and Subcontractors). This program shall be described in a Plan responsive to this Section.

B. CQC personnel:

1. Contractor's CQC Plan Manager shall report to a Senior Project Manager of the Contractor and shall have no supervisory or managerial responsibility over the workforce.
2. The Contractor CQC Plan Manager shall be on-site as often as necessary, but not less than the daily working hours specified in the Contract Documents to remedy and demonstrate that Work is being performed properly and to make multiple observations of Work in progress.
3. The Contractor is to furnish personnel with assigned CQC functions reporting to the CQC Manager. Persons performing CQC functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.

C. CQC Plan:

1. Contractor's CQC Plan shall include a statement by the Senior Project Manager designating the CQC Plan Manager and specifying the authority delegated to the CQC Plan Manager to direct cessation or removal and replacement of defective Work.
2. Describe the CQC program and include procedures, work instructions, and records. Describe methods relating to areas that require special testing and procedures as required by the specifications.
3. Include specific instructions defining procedures for observing Work in process and comparing this Work with the Contract requirements (organized by specifications section).
4. Describe procedures to ensure that equipment or materials that have been accepted at the Site are properly stored, identified, installed and tested.
5. Include procedures to verify that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier Suppliers and/or Subcontractors.
6. Commissioning quality control: Include procedures to verify that the commissioning requirements of the Contract Documents are integrated into the Contractor's CQC Plan and conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to the Contractor and the lower-tier Suppliers and/or Subcontractors.
7. Include instructions for recording inspections and requirements for demonstrating through the Daily Inspection Reports that Work inspected was in compliance or a deficiency was noted and action to be taken.
8. Procedures to preclude the covering of deficient or rejected Work.
9. Procedures for halting or rejecting Work.
10. Procedures for resolution of differences between the CQC Plan Manager and the production personnel.
11. Identify contractual hold/inspection points as well as any Contractor-imposed hold/inspection points.

D. Daily Inspection Report: Include, at a minimum:

1. Inspection of specific work.
2. Quality characteristics in compliance.



3. Quality characteristics not in compliance.
  4. Corrective/remedial actions taken.
  5. Statement of certification.
  6. CQC Manager's signature.
  7. Information provided on the daily report shall not constitute notice of delay or any other notice required by the Contract Documents.
- E. Deficient and Non-conforming Work and Corrective Action: Include procedures for handling deficiencies and non-conforming Work. Deficiencies and non-conforming Work are defined as documentation, drawings, material, equipment, or Work not conforming to the indicated requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent reoccurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documents and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
1. Personnel responsible for identifying deficient and non-complying items within Work.
  2. How and by whom deficient and non-compliant items are documented "in the field."
  3. The personnel and process utilized for logging deficient and non-compliant Work at the end of each day onto a deficiency log.
  4. Tracking processes and tracking documentation for deficient and non-conforming Work.
  5. Personnel responsible for achieving resolution of outstanding deficiencies.
  6. Include detailed procedures for the performance and control of special process (e.g., welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).
- F. Audits: The CQC program shall provide for regularly scheduled documented audits to verify that CQC procedures are being fully implemented by Contractor and its Subcontractors. Audit records shall be made available to Engineer upon request.
- G. Documented control/quality records:
1. Establish methods for control of Contract Documents that describe how Drawings and Specifications are received and distributed to ensure the correct issue of the document being used. Describe how record document/drawing data are documented and furnished to Engineer.
  2. Maintain evidence of activities affecting quality. Including operating logs, records of inspection, audit reports, personnel qualification and certification records, procedures, and document review records.
  3. Maintain quality records in a manner that provides for timely retrieval and traceability. Protect quality records from deterioration, damage and destruction.
  4. Develop a list of specific records as required by the Contract Documents that will be furnished to Engineer at the completion of activities.
- H. Acceptance of CQC Plan: Engineer's acceptance of the CQC Plan shall not relieve Contractor from any of its obligations for performance of Work. Contractor's CQC staffing is subject to Engineer's review and continued acceptance. Owner, at its sole

discretion, and without cause, may direct Contractor to remove and replace the CQC Plan Manager.

1. Acceptance of the CQC Plan by the Engineer is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.
2. After acceptance of the CQC Plan, notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## SECTION 01500

### TEMPORARY FACILITIES AND CONTROLS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes:
  - 1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, standby generators, construction aids, barriers and enclosures, security, temporary controls, project sign, and removal after construction.

##### 1.02 REFERENCE

- A. American National Standards Institute (ANSI).
- B. Occupational Safety and Health Administration (OSHA).

##### 1.03 SUBMITTALS

- A. General: For products specified to be furnished under this Section, submit product data as specified in Section 01330 - Submittal Procedures.
- B. Submit all information at least 28 days prior to when the temporary generators are scheduled to be installed and allow 14 days for review and comment.

##### 1.04 TEMPORARY UTILITIES

- A. Temporary standby generators:
  - 1. Provide temporary standby generators as indicated on the Drawings.
  - 2. Submit layout drawings showing the location of the generators and connections to each automatic transfer switch.
    - a. The installation of the generators shall not interfere with the Owner's access to the facilities.
    - b. All temporary wiring shall be installed in conduit.
  - 3. The Contractor is responsible for fueling the standby generators. Generators shall be fully fueled before each weekend and holiday.
- B. Temporary electrical power:
  - 1. The Owner will provide temporary power for construction.
    - a. Coordinate the connection point with the Owner.
    - b. The Contractor is responsible for providing all breakers, conduit, and cables required to obtain temporary power from these location(s).
      - 1) Coordinate equipment shutdowns to make/remove connections with the Owner.
    - c. The Contractor is responsible for providing all temporary electrical equipment used for construction including transformers, panelboards, cables etc.
    - d. The Owner will pay all charges for construction power.

2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
- C. Temporary electrical lighting:
1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
  2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
    - a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.
- D. Temporary heating, cooling, and ventilating:
1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
  2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.
- E. Temporary water:
1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
  2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
  3. Pay for water used for construction prior to final completion. Owner will provide water for 30-day operational testing.
  4. Development of non-potable water supply:
    - a. Post ample signs throughout the work area warning that plant water is not potable.
    - b. Non-potable water is available from hydrants or hose valves within plant without cost. When combined demand of the Work and plant exceeds plant supply capacity, provide additional temporary supply capacity.
- F. Temporary sanitary facilities:
1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
  2. Existing facility use is not allowed.
  3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.
- G. Temporary fire protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.
- H. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.
- I. Utilities in existing facilities: As specified in Section 01140 - Work Restrictions.

## **1.05 CONSTRUCTION AIDS**

- A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

- B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.
- C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
  - 1. When requested, submit design calculations by professional registered engineer prior to application of loads.
  - 2. Submitted design calculations are for information and record purposes only.
- D. Accident prevention:
  - 1. Exercise precautions throughout construction for protection of persons and property.
  - 2. Observe safety provisions of applicable Laws and Regulations.
  - 3. Guard machinery and equipment, and eliminate other hazards.
  - 4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
  - 5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.
- E. Barricades:
  - 1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
  - 2. Provide barriers with flashing lights after dark.
  - 3. Keep barriers in place until excavations are entirely backfilled and compacted.
  - 4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.
- F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
  - 1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- G. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.
- H. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- I. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.
- J. Fences:
  - 1. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to final completion.
  - 2. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
    - a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.

3. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.

#### **1.06 SECURITY**

- A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

#### **1.07 ACCESS ROADS**

- A. On-site access roads:
  1. Maintain access roads to storage areas and other areas to which frequent access is required.
  2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
  3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
  4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

#### **1.08 TEMPORARY CONTROLS**

- A. Dust control:
  1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
  2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.
- B. Noise control:
  1. Comply with noise and work hours regulations by local jurisdiction.
  2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
  3. In residential areas, take special measures to suppress noise during night hours.
- C. Mud control:
  1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

### **PART 2 PRODUCTS**

Not Used.

### **PART 3 EXECUTION**

Not Used.

END OF SECTION

## **SECTION 01520**

### **SECURITY AND PROCESS SAFETY MANAGEMENT**

#### **PART 1 GENERAL**

##### **1.01 SECURITY PROGRAM**

- A. The Contractor shall:
  - 1. Protect Work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.
  - 2. Maintain program throughout construction period.
  - 3. Require that the workers employed by the Contractor, his Subcontractors and his Vendors shall obey all Rules and Ordinances enacted by the South Valley Water Reclamation Facility (SVWRF) regarding the existence of firearms on SVWRF property. The Contractor shall immediately suspend any such worker who disobeys said Rules and Ordinances and remove such worker from the SVWRF property.

##### **1.02 ENTRY CONTROL**

- A. The Contractor shall:
  - 1. Limit entry of persons and vehicles into project site.
  - 2. Allow entry only to authorized persons.
  - 3. Require that all personal vehicles of the workers employed by the Contractor, his Subcontractors and his Vendors shall park their cars where designated by the Owner.
- B. Owner will control entrance of persons and vehicles related to Owner's operations.

##### **1.03 PERSONNEL IDENTIFICATION**

- A. The Contractor shall:
  - 1. Maintain a list of their authorized employees, subcontractors, vendors and other persons and submit a copy to Owner on request.
  - 2. Require that an identifying badge shall be worn by each of the workers of the Contractor, his subcontractors and vendors on the front of their construction hard hats. Further, the Contractor shall collect the Driver's License of each worker as he first comes on-site and submit them to the Owner's Representative. The Owner will oversee the production of the badges for Contractor key personnel and will return the Driver's Licenses with Badges to the Contractor's Project Superintendent.

##### **1.04 SAFETY PLAN**

- A. At the Preconstruction Conference the Contractor shall submit a Safety, Health, and Environmental Action Plan (SHEAP). SVWRF will review the SHEAP to ensure its compatibility with the safety policies of SVWRF. The Contractor shall address the topics provided on the SVWRF-SHEAP outline (outline is included in the appendix to specification)

- B. Contractor shall be solely responsible for initiating, maintaining and supervising all health safety and environmental issues for his or her employees, including all aspects of on-site construction, operation and activities associated with the contract.
- C. The Contractor shall provide the following insurance and safety data for each of the past three years including the current year to date. See form entitled "Job Related Accident Reports" (form is included in appendix to specification)

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION



## **SECTION 01530**

### **PROTECTION OF EXISTING FACILITIES**

#### **PART 1 GENERAL**

##### **1.01 GENERAL**

- A. The Contractor shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation.

##### **1.02 RIGHTS-OF-WAY**

- A. The Contractor shall not do any Work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electrical transmission line; any fence; or any other structure, nor shall the Contractor enter upon the rights-of-way involved until notified that the Owner has secured authority therefore from the proper party.
- B. After authority has been obtained, the Contractor shall give said party due notice of its intention to begin Work, if required by said party, and shall remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, re replace the same.
- C. Some of the South Valley Water Reclamation Facility (SVWRF) facilities are located on Rocky Mountain Power (RMP) rights-of-way as shown on the Drawings. SVWRF has permanent easements to install remove, repair or replace sewer pipelines and other facilities on these easements. Copies of the easements and conditions for their use may be examined at the office of the SVWRF during regular business hours. The Contractor shall comply with the conditions of each easement. The Contractor shall maintain the minimum clearance mandated by RMP or 6 feet, whichever is greater, between the lowest conductor on the RMP power lines and maximum vertical reach of the equipment booms operated by the Contractor.
- D. When 2 or more contracts are being executed at one time of the same or adjacent land in such manner the Work on 1 contract may interfere with that on another, the Owner shall determine the sequence and order of the Work. When the territory of one contract is necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege may be granted by the Owner to Contractor so desiring, to the extent, amount, in the manner, and at the times permitted, No such decision as to the method or time of conducting the Work or the use of territory shall be made the basis of any claim for delay or damage, except as provided for temporary suspension of the Work in Article of the General Conditions of the Contract.

##### **1.03 PROTECTION OF STREET OR ROADWAY MARKERS**

- A. The Contractor shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other

permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the Contractor shall be accurately restored after street or roadway resurfacing has been complete.

#### **1.04 RESTORATION OF PAVEMENT**

- A. General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner. Pavements which are subject to partial removal shall be neatly saw cut in straight lines.
- B. Permanent resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, the Contractor shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.
- C. Restoration of sidewalks or private driveways: Wherever sidewalks or private roads have been removed for purposes of construction, the Contractor shall place suitable temporary sidewalks or roadways promptly after backfilling and shall maintain them in satisfactory condition until the final restoration thereof has been made.

#### **1.05 EXISTING UTILITIES AND IMPROVEMENTS**

- A. General: The Contractor shall protect underground utilities and other improvements which may be impaired during construction operations, regardless of whether or not the utilities are indicated on the Drawings. The Contractor shall take all possible precautions for the protection of unforeseen utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.
- B. Except where the Drawings indicate utilities have been field located during design or certain utility locations shall be exposed as part of the Work, the Contractor shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Contractor's progress. When such exploratory excavations show the utility location as shown on the Drawings to be in error, the Contractor shall so notify the Resident Project Representative (RPR).
- C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility.
- D. Utilities to be moved: In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the Contractor, be notified by the Owner to move such property within a

specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the RPR a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

- E. Utilities to be removed: Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement which I indicated, the Contractor shall remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to the RPR and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by the Contractor in a manner that will restore or replace the utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal. Permanent relocation of any utility shall be noted on the Contractor's record drawings.
- F. Owner's right of access: The right is reserved to the Owner and to the owners of public utilities and franchises to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.
- G. Underground utilities indicated: Existing utility lines that are indicated or the locations of which are made known to the Contractor prior to excavation and that are to be retained, and all utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and if damaged, shall be immediately repaired or replaced by the Contractor, unless otherwise repaired by the owner of the damaged utility. If the owner of the damaged facility performs its own repairs, the Contractor shall reimburse said owner for the costs of repair.
- H. Underground utilities not indicated: In the event that the Contractor damages existing utility lines that are not indicated or the locations of which are not made known to the Contractor prior to excavation, a verbal report of such damage shall be made immediately to the RPR and a written report thereof shall be made promptly thereafter. The RPR will immediately notify the owner of the damaged utility. If the RPR is not immediately available, the Contractor shall notify the utility owner of the damage. If directed by the RPR, repairs shall be made by the Contractor under the provisions for changes and extra work contained in the General Conditions.
- I. Costs of locating and repairing damage not due to failure of the Contractor to exercise reasonable care, and removing or relocating such utility facilities not indicated in the Contract Documents with reasonable accuracy, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such utility facilities, and which was necessarily idled during such work will be paid for as extra work in accordance with the provisions of Articles 10, 11, and 12 of the General Conditions.
- J. Approval of repairs: All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the utility or improvement owner before being concealed by backfill or other work.
- K. Maintaining in service: Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains,

irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the RPR are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. The Contractor shall be responsible for and shall repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or it not discovered until after completion of the backfilling.

#### **1.06 TREES OR SHURBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS**

- A. General: Except where trees or shrubs are indicated to be removed, the Contractor shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or Owner. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by the Contractor or a certified tree company under permit from the jurisdictional agency and/or the Owner. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.
- B. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other materials injurious to the life of the tree.
- C. Replacement: The Contractor shall immediately notify the jurisdictional agency and/or the Owner if any tree or shrub is damaged by the Contractor's operations. If, in the opinion of said agency or the Owner, the damage is such that replacement is necessary, the Contractor shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, the Contractor shall pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or Owner. The size of the tree or shrub shall be not less than 1-inch diameter nor less than 6 feet in height. Planting of replacement trees and shrubs shall be in accordance with the recommendations of the nursery furnishing the plants. Unless otherwise indicated, the Contractor shall water and maintain the replacements trees and shrubs for 6 months after planting.

#### **1.07 LAWN AREAS**

- A. Lawn or landscaped areas and irrigation systems damaged during construction shall be repaired for by the Owner. The damaged lawn due to trenching shall be replaced with seeding on top of an adequate layer of topsoil by the Contractor. Damaged sprinkler heads shall be replaced with identical heads. Installation details for sprinkler system and sprinkler heads shall match existing.

#### **1.08 NOTIFICATION BY THE CONTRACTOR**

- A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried

electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than 3 days nor more than 7 days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire. The Contractor shall notify RMP three days prior to mobilizing any machinery or equipment within reach of any overhead power lines and shall comply with RMP requirements regarding the operation of such machinery or equipment.

## **PART 2    PRODUCTS**

Not Used.

## **PART 3    EXECUTION**

Not Used.

END OF SECTION



**SECTION 01600**  
**PRODUCT REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Requirements for tangible materials, raw or manufactured, that become part of the project.

**1.02 REFERENCES**

- A. NSF International (NSF):
  - 1. 60 - Technical Requirements.
  - 2. 61 - Drinking Water System Components - Health Effects.

**1.03 DEFINITIONS**

- A. Certificates: Documents that the work is in accordance with the Contract Documents.
- B. Extra stock materials: Extra stock materials provided for the Owner's use in facility operation and maintenance.
- C. Manufacturer's instructions:
  - 1. Stipulations, directions, and/or recommendations issued form by the manufacturer of the product addressing handling, installation, erection, and/or application of the product.
- D. Products:
  - 1. Raw materials, finished goods, equipment, systems, and shop fabrications.
- E. Product data:
  - 1. Public information about the product which is found in the manufacturer's catalogs or on their web site including catalog pages, data sheets, bulletins, layout drawings, exploded views, and brochures.
- F. Samples:
  - 1. As defined in the General Conditions and Supplementary Conditions.
  - 2. Full-size actual products or pieces of products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.
- G. Schedules:
  - 1. Product parts and materials lists.
- H. Shop drawings:
  - 1. As defined in the General Conditions and Supplementary Conditions.

2. Shop drawings are prepared specifically for the project to illustrate details, dimensions, and other data necessary for satisfactory fabrication or construction that are not shown in the contract documents. Shop drawings could include graphic line-type drawings and single-line diagrams.
- I. Spare parts:
  1. Duplicate parts necessary to replace a damaged or worn part of the product.
  2. Consumables such as operating fluids.
- J. Special tools:
  1. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit and that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.
- K. Submittals:
  1. As defined in the General Conditions and Supplementary Conditions.
  2. Samples, product data, shop drawings, and others that demonstrate how Contractor intends to conform to the Contract Documents.

#### **1.04 SUBMITTALS**

- A. Products in contact with drinking water:
  1. Provide certification for by an independent ANSI accredited third party.
    - a. In accordance with NSF 61.
    - b. Weighted average lead content of less than 0.25 percent in accordance with NSF 372.

#### **1.05 GENERAL REQUIREMENTS**

- A. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.
- B. Provide like parts of duplicate units that are interchangeable.
- C. Provide equipment or product that has not been in service prior to delivery, except as required by tests.
- D. Provide products produced by manufacturers regularly engaged in the production of these products.
- E. Provide products that bear approvals and labels as specified.

### **PART 2 PRODUCTS**

#### **2.01 MATERIAL**

- A. Provide corrosion resistance suitable for project conditions as specified in Section 01610 - Project Design Criteria.
  1. Dissimilar metals: Separate contacting surfaces with dielectric material.



- B. Products in contact with drinking water or water in the process of becoming drinking water in accordance with NSF 60 or NSF 61 by an independent ANSI accredited third party.
- C. Dielectric materials for separation of dissimilar metals:
  - 1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.
- D. Edge grinding:
  - 1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence.
- E. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.
- F. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.
- G. Aluminum in contact with concrete or masonry: Apply epoxy mastic, coating system EPX-M-5.
- H. Provide new pipe manufactured for the project, not from manufacturer's inventory, under the following conditions:
  - 1. Pipes 24-inch diameter and larger.
  - 2. Pipe manufactured more than 6 months prior to delivery if the pipe material or its coating is subject to UV degradation.
  - 3. Ductile iron pipe with cement-mortar lining manufactured more than 6 months prior to delivery to the project.
  - 4. Steel pipe 6-inch diameter and larger.
- I. Mark each length of pipe in accordance with applicable standards.

## **2.02 PRODUCT SELECTION**

- A. Provide products with Engineer approved submittals.
- B. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products that meet or exceed reference standard and Specifications.
- C. When products are specified with names of manufacturers but no model numbers or catalog designations, provide Products by one of named manufacturers that meet or exceed Specifications.
- D. When products are specified with names of manufacturers and model numbers or catalog designations, provide Products with model numbers or catalog designations by one of named manufacturers.
- E. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
  - 1. Products specified by brand or trade name, model number, or catalog designation.

2. Products by one of named manufacturers proven, in accordance with requirements for an "or equal", including Engineer's approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
- F. When Products are specified with only one manufacturer followed by "or Equal," provide:
1. Products meeting or exceeding Specifications by specified manufacturer.
  2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

## **2.03 SHIPMENT**

- A. Requirements prior to shipment of equipment:
1. Engineer approved shop drawings.
  2. Engineer approved Manufacturer's Certificate of Source Testing as specified in the Technical Sections.
  3. Draft operations and maintenance manuals, as specified in Section 01782 - Operation and Maintenance Manuals, when required by specifications.
- B. Prepare products for shipment by:
1. Tagging or marking to agree with delivery schedule or shop drawings.
  2. Including complete packing lists and bills of material with each shipment.
  3. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
  4. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
- C. Transport products by methods that avoid product damage.
- D. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

## **2.04 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS**

- A. Provide spare parts and maintenance products as required by Technical Sections.
- B. Provide one set of special tools required to install or service the equipment.
- C. Box, tag, and clearly mark items.
- D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by Owner.
- E. Add product to the Spare Parts, Maintenance Products, and Special Tools Inventory List - form as given in Appendix B.

## **PART 3 EXECUTION**

### **3.01 DELIVERY AND HANDLING**

- A. Handle equipment in accordance with manufacturer's instructions.

- B. Provide construction equipment and personnel to handle products by methods to prevent soiling or damage.
- C. Upon delivery, promptly inspect shipments:
  - 1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
  - 2. Acceptance of shipment does not constitute final acceptance of equipment.
- D. Spare parts, maintenance products, special tools.
  - 1. Immediately store in accordance with the manufacturer's instructions.
  - 2. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period.
    - a. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
  - 3. With Owner's written request for advanced delivery of spare parts, maintenance products, and special tools.
    - a. Deliver requested items and deduct them from the inventory list.
    - b. Provide transmittal documentation.
  - 4. Store large items individually:
    - a. Weight: Greater than 50 pounds.
    - b. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
    - c. Clearly labeled:
      - 1) Equipment tag number.
      - 2) Equipment manufacturer.
      - 3) Subassembly component, if appropriate.
      - 4) Store smaller items in spare parts box:
    - d. Weight: Less than 50 pounds.
    - e. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
    - f. Clearly labeled:
      - 1) Equipment tag number.
      - 2) Equipment manufacturer.
      - 3) Subassembly component, if appropriate.
      - 4) Spare parts and special tools box:
    - g. Box material: Waterproof, corrosion resistant.
    - h. Hinged cover:
      - 1) Locking hasp.
    - i. Spare parts inventory list taped to underside of cover.
    - j. Clearly labeled:
      - 1) The words "Spare Parts and/or Special Tools".
      - 2) Equipment tag number.
      - 3) Equipment manufacturer.
      - 4) Subassembly component, if appropriate.

### **3.02 STORAGE AND PROTECTION**

- A. Immediately store and protect products until installed in Work.
- B. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, architectural items, electrical and instrumentation equipment and special equipment to be incorporated into this project.

1. Storage of equipment shall be in strict accordance with the "instructions for storage" provided by the manufacturer.
    - a. Including connection of heaters, lubrication, rotating shafts, etc.
  2. The Contractor shall furnish a copy of the manufacturer's instructions for storage to the Engineer prior to storage of equipment and materials.
- C. Store products with seals and legible labels intact.
- D. Protect painted or coated surfaces against impact, abrasion, discoloration, and damage.
  1. Repaint or recoat damaged painted or coated surfaces.
- E. Exterior storage of fabricated products:
  1. Place on aboveground supports that allow for drainage.
  2. Cover products subject to deterioration with impervious sheet covering.
  3. Provide ventilation to prevent condensation under covering.
- F. Store moisture sensitive products in watertight enclosures.
- G. Store loose granular materials on solid surfaces in well-drained area.
  1. Prevent materials mixing with foreign matter.
  2. Provide access for inspection.
- H. Payment will not be made for equipment and materials improperly stored or stored without providing Engineer with the manufacturer's instructions for storage.
- I. Provide an equipment log and stored products log with monthly pay applications.
  1. Data includes as a minimum: The storage location, equipment or product identification, date stored, date of inspection/maintenance, date removed from storage, copy of manufacturer's recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

### **3.03 INSTALLATION**

- A. Inspect hardware or fittings prior to product installation.
- B. Use anti-galling compound on stainless steel threads used for field assembly.

### **3.04 PROTECTION AFTER INSTALLATION**

- A. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations.
  1. Remove covering when no longer needed.
  2. Replace corroded, damaged, or deteriorated equipment, product, or parts before acceptance of the project.
- B. Update equipment log with monthly pay applications.
  1. Data includes as a minimum: Description of maintenance activities performed in accordance with the manufacturer's recommendation and industry standards and signature of party performing maintenance.

### **3.05 ATTACHMENTS**

- A. Appendix A - Spare Parts, Maintenance Products, and Special Tools Inventory List.

END OF SECTION

**APPENDIX A**  
**SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST**

Owner: \_\_\_\_\_ Date: \_\_\_\_\_  
Contractor: \_\_\_\_\_ Project  
No.: \_\_\_\_\_  
Project Name: \_\_\_\_\_

Inventory List				
Spec Number: _____ Spec Title _____				
Equipment Tag _____ Equipment No.: _____ Manufacturer: _____				
Quantity	Subassembly Component	Description	Manufacturer's Part Number	Storage Location

## **SECTION 01610**

### **PROJECT DESIGN CRITERIA**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Project design criteria such as temperature and site elevation.

##### **1.02 PROJECT DESIGN CRITERIA**

- A. All equipment and materials for the project are to be suitable for performance in a wastewater treatment plant environment and under following conditions:
  - 1. Design temperatures are:
    - a. Outdoor temperatures: -10 to 110 degrees Fahrenheit.
    - b. Indoor temperatures for the following buildings and areas:
      - 1) Process areas: 50 to 85 degrees Fahrenheit.
      - 2) Electrical rooms: 50 to 85 degrees Fahrenheit.
      - 3) Other: 50 to 85 degrees Fahrenheit.
  - 2. Design groundwater elevation: varies (6 feet below grade adjacent to bioreactors, 17 feet below grade at new Grit Handling Facility).
  - 3. Freeze-thaw conditions.
  - 4. Moisture conditions: Defined in individual equipment sections.
  - 5. Site elevation: Approximately 4,300 feet above mean sea level.

#### **PART 2 PRODUCTS**

Not Used.

#### **PART 3 EXECUTION**

Not Used.

END OF SECTION





## SECTION 01612

### SEISMIC DESIGN CRITERIA

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes: Seismic design criteria for the following:
  - 1. Anchorage of mechanical and electrical equipment.
  - 2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
  - 3. Other structures or items as specified or indicated on the Drawings.

##### 1.02 REFERENCES

- A. American Society of Civil Engineers (ASCE):
  - 1. 7-10 - Minimum Design Loads for Buildings and Other Structures.

##### 1.03 SYSTEM DESCRIPTION

- A. Design in accordance with the requirements of the building code as specified in Section 01410 - Regulatory Requirements.
- B. Design spectral acceleration at short period,  $S_{DS}$ : 0.918.
- C. Design of non-structural components and their connections to structures:
  - 1. Component amplification factor,  $a_p$ : In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
  - 2. Component response modification factor,  $R_p$ : In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
  - 3. Component importance factor,  $I_p$ :

Table 1: Component Importance Factor, $I_p$		
Component	Description	$I_p$
Electrical	Equipment and appurtenances provided and installed under Division 26.	1.5
All Other Equipment	Equipment and appurtenances provided and installed under any other Divisions.	Per ASCE 7-10, Section 13.1.3

- D. Seismic Design Category (SDC):
  - 1. Seismic Design Category (SDC) for certification of mechanical and electrical equipment as required by ASCE 7: Seismic Design Category D.
- E. Design requirements: Anchorage of equipment to structures.
  - 1. Do not use friction to resist sliding due to seismic forces. Do not design or provide connections that use friction to resist seismic loads. Resist seismic forces through direct tension and/or shear on anchors and fasteners.

2. Anchoring and fastening to concrete and masonry:
  - a. Provide anchors specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods.

#### **1.04 SUBMITTALS**

- A. Shop drawings and calculations: Complete shop drawings and seismic calculations.
- B. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state of Utah.

#### **PART 2 PRODUCTS**

Not Used.

#### **PART 3 EXECUTION**

Not Used.

END OF SECTION

**SECTION 01614**  
**WIND DESIGN CRITERIA**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Wind design criteria.

**1.02 SYSTEM DESCRIPTION**

- A. Design requirements:
1. Building code criteria: Design for wind in accordance with building code as specified in Section 01410 - Regulatory Requirements:
    - a. Risk category: III.
    - b. Wind speed,  $V_{ult}$ : 120 miles per hour.
    - c. Wind speed,  $V_{asd}$ : 93 miles per hour.
    - d. Exposure category: C.
    - e. Topographic factor,  $K_{zt}$ : 1.0.
  2. Resist wind forces through direct bearing on anchors and fasteners. Do not design or provide connections that use friction to resist wind loads.
  3. Anchoring and fastening to concrete and masonry:
    - a. Provide anchors specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All-Thread Rods and 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

**1.03 SUBMITTALS**

- A. Shop drawings and calculations: Complete shop drawings and wind design calculations.
- B. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state of Utah.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

Not Used.

END OF SECTION



**SECTION 01722**  
**FIELD ENGINEERING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Field engineering to establish lines and grades for the Work.

**1.02 SUBMITTALS**

- A. Submit as specified in Section 01330 - Submittal Procedures.
- B. Qualifications of the professional land surveyor or registered civil engineer in Utah that will be performing the field engineering.
- C. Pre-Excavation Report.

**1.03 PRE-EXCAVATION REPORT**

- A. Prior to the start of the Work, create a report confirming the verification of the following data:
  - 1. Site elevation.
  - 2. Existing structures including but not limited to buildings, manholes (sanitary, storm, electrical, and other), drainage inlets:
    - a. Location coordinates.
    - b. Top of wall elevation and coordinates.
    - c. Floor elevations.
    - d. Invert elevations.
  - 3. Existing utilities as specified in Section 01353 - Special Procedures for Locating and Verifying. Concealed Existing Utilities.
  - 4. Proposed building corners, tank, and equipment locations.
  - 5. Verify existing electrical, instrumentation, and phone utilities.
- B. Incorporate information from Pre-Excavation Report into the record drawings.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

**3.01 SURVEY REFERENCE POINTS**

- A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided by Owner.

- B. From these reference points, establish other control and reference points as required to properly lay out the Work.
- C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
  - 1. Make no changes or relocations without prior written notice.
  - 2. Replace Project control point, when lost or destroyed, in accordance with original survey control.
- D. Set monuments for principal control points and protect them from being disturbed and displaced:
  - 1. Re-establish disturbed monuments.
  - 2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

### **3.02 PROJECT SITE SURVEY REQUIREMENTS**

- A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.
- B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.
- C. Perform verifications and checking in accordance with standard surveying practice.
- D. Maintain complete, accurate log of control points and survey.
- E. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

### **3.03 CONSTRUCTION STAKES, LINES, AND GRADES**

- A. Execute the Work in accordance with the lines and grades indicated.
- B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

### **3.04 QUALITY CONTROL**

- A. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
  - 1. Notice of when checking will be conducted will be given.
  - 2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
  - 3. Engineer's check does not substitute or complement required field quality control procedures.

### **3.05 RECORD DOCUMENTS**

- A. Prepare and submit Record Documents as specified in Section 01770 - Closeout Procedures.

- B. Provide certified site survey including buildings, benchmarks, and appurtenances sealed and signed by professional land surveyor or registered civil engineer.
  - 1. File with permitting agency, as required.

END OF SECTION





## **SECTION 01738**

### **SELECTIVE ALTERATIONS AND DEMOLITION**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Cutting or modifying of existing and new work.
  - 2. Partial demolition of structures.
  - 3. In-place abandonment of pipe.

##### **1.02 REFERENCES**

- A. American National Standards Institute (ANSI):
  - 1. A10.6 - Safety and Health Program Requirements for Demolition Operations.
- B. International Concrete Repair Institute (ICRI):
  - 1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
  - 2. Guideline No. 310.3R - Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods.

##### **1.03 DEFINITIONS**

- A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.
- B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.
- C. Coring equipment: Non-impact rotary drill with diamond cutting edges.
- D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

##### **1.04 DESCRIPTION OF WORK**

- A. The work includes partial demolition, cutting, and modifying of existing facilities, utilities, and/or structures.
- B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and

structures that are to remain in place and that are damaged by demolition or removal operations.

## **1.05 SUBMITTALS**

- A. General:
  - 1. Submit specified in Section 01330 - Submittal Procedures.
- B. Shop drawings: Include:
  - 1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.
- C. Submittals for information only:
  - 1. Permits and notices authorizing demolition.
  - 2. Certificates of severance of utility services.
  - 3. Permit for transport and disposal of debris.
  - 4. Selective Demolition Plan.
  - 5. Pipe Abandonment Plan.
- D. Quality assurance submittals:
  - 1. Qualifications of non-destructive testing agency/agencies.
- E. Project record documents.
- F. Drawings and/or other media documenting locations of service lines and capped utilities.

## **1.06 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
  - 2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

## **1.07 SEQUENCING**

- A. Perform Work in sequences and within times specified in Section 01140 - Work Restrictions.
- B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.
- C. Coordinate the Work with operation of the facility:
  - 1. Do not begin alterations of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
  - 2. Engineer will coordinate the planned procedure with facility manager.

3. Complete Work as quickly and with as little delay as possible.
- D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.
- E. Owner will cooperate in every way practicable to assist in expediting the Work.
- F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

#### **1.08 REGULATORY REQUIREMENTS**

- A. Dispose of debris in accordance with governing regulatory agencies.
- B. Comply with applicable air pollution control regulations.
- C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

#### **1.09 PREPARATION**

- A. Non-destructive evaluation of existing concrete and masonry:
  1. Prior to cutting, drilling, coring, and/or any other procedure that penetrates existing concrete or masonry, retain and pay for the services of a qualified non-destructive testing agency to perform investigations to determine the location of existing steel reinforcement, plumbing, conduit, and/or other embedments in the concrete.
  2. Submit documentation of the investigations to the Engineer for review and approval as specified in Section 01330 - Submittal Procedures before any work involving penetration of existing concrete is initiated.
- B. Obtain permission from adjacent property owners when outriggers, swinging cranes, and other equipment may have to traverse or extend into adjacent property.

#### **1.10 PROJECT CONDITIONS**

- A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.
- B. Provide erect and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
  1. Do not close or obstruct roadways without permits.
  2. Conduct operations with minimum interference to public or private roadways.
- C. Prevent movement, settlement, or collapse of structures adjacent services, sidewalks, driveways and trees:
  1. Provide and place bracing or shoring.
  2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.

3. Assume liability for movement, settlement, or collapse. Promptly repair damage.
- D. Arrange and pay for capping and plugging utility services. Disconnect and stub off.
  1. Notify affected utility company in advance and obtain approval before starting demolition.
  2. Place markers to indicate location of disconnected services.
- E. Unknown conditions:
  1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
  2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other surface fixtures.
  3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the Work until written instructions are received from the Engineer.

## **PART 2 PRODUCTS**

### **2.01 SALVAGE MATERIALS**

- A. Salvage materials: Materials removed from existing facility.
- B. Materials designated for salvage:
  1. As indicated on the drawings.
- C. Handling and storage:
  1. Prevent damage to salvaged materials during removal, handling, and transportation of salvaged materials.
  2. Prepare salvaged materials for storage:
  3. Store salvaged materials in the following locations:
    - a. On-site area will be identified by Owner.
- D. Pay costs associated with salvaging materials, including handling, transporting, and storage.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Prior to beginning selective demolition operations, perform a thorough inspection of the facility and site, and report to the Engineer defects and structural damage to or deterioration of existing construction to remain.
- B. Examine areas affected by the Work and verify the following conditions prior to commencing demolition:
  1. Disconnection of utilities as required.

2. That utilities serving occupied or active portions of surrounding facilities will not be disturbed, except as otherwise indicated.
- C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition operations until such conditions have been corrected.

### **3.02 PREPARATION**

- A. Selective Demolition Plan:
1. Prepare and submit a comprehensive selective demolition plan for the Work including the following elements, at a minimum:
    - a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
    - b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
  2. Plan shall be signed and sealed by a Professional Structural Engineer registered in the state where Project is located.
  3. Submit plan a minimum 4 weeks before demolition is scheduled to begin.
- B. Pipe Abandonment Plan:
1. Prepare and submit a comprehensive Pipe Abandonment Plan for the Work to demonstrate and verify with camera inspection that all solids have been removed and pipe is free of residual.
  2. At a minimum, define the following elements:
    - a. Proposed sequence, methods, cleaning procedures, or demolition, removal, and disposal of contents of the piping.
    - b. Method of verification of final pipe condition.
    - c. Detailed drawings showing treatment of pipe ends.
  3. Submit plan a minimum 4 weeks before abandonment is scheduled to begin.
- C. Protection:
1. Erect weatherproof closures to protect the interior of facilities and elements or equipment that are not designed for exposure to the weather. Provide temporary heat, cooling, and humidity control as necessary to prevent damage to existing and new construction. Maintain existing exiting paths and/or provide new paths in compliance with Building Code requirements.
  2. Erect and maintain dustproof partitions as required to prevent spread of dust, to other parts of building. Maintain negative pressure in the area where the Work is being performed to prevent the accidental spread of dust and to minimize the spread of fumes related to the Work.
  3. Upon completion of Work, remove weatherproof closures and dustproof partitions, and repair damaged surfaces to match adjacent surfaces.
  4. Provide and maintain protective devices to prevent injury from falling objects.
  5. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
  6. Cause as little inconvenience to adjacent building areas as possible.
  7. Protect landscaping, benchmarks, and existing construction to remain from damage or displacement.
  8. Carefully remove designated materials and equipment to be salvaged by Owner or reinstalled.
  9. Store and protect materials and equipment to be reinstalled.

- D. Layout:
1. The limits of selective demolition are indicated on the Drawings. Confine demolition operations within the limits indicated on the Drawings.
  2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.
  3. Arrange for Engineer's inspection of the lay out extents.
  4. Do not begin demolition/removal operations until the lay out markings have been reviewed by the Engineer.

### 3.03 DEMOLITION

- A. General:
1. Perform demolition work in accordance with ANSI A10.6.
  2. Demolish designated portions of structures and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.
  3. Conduct demolition and removal work in a manner that will minimize dust and flying particles.
    - a. Use water or dust palliative when necessary to prevent airborne dust.
    - b. Provide and maintain hoses and connections to water main or hydrant.
  4. Demolish concrete and masonry in small sections. Perform demolition with small tools as much as possible. Blasting with explosive charges is not permitted.
  5. Sawcut concrete to establish the edges of demolition, wherever possible.
    - a. Do not use a concrete breaker within 6 inches of reinforcing or structural metals that are designated to remain.
    - b. At edges that are not sawcut, remove the final 6 inches of material with a chipping hammer as defined herein. At surfaces where material is removed with a chipping hammer, follow with a heavy abrasive blast to remove all loose material and microcracking.
    - c. Alternate techniques to remove concrete may be used if acceptable to the Engineer; however, techniques other than those deemed by ICRI Guideline No. 310.2R to provide a low risk of introducing microcracking will require a subsequent procedure to remove loose material.
    - d. Provide final surface preparation for repairs as specified.
  6. At locations indicated on the Drawings that the existing reinforcing is to be preserved, remove concrete using methods that do not damage the reinforcing. Use one of the following techniques:
    - a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
    - b. Chipping hammer, as defined herein, followed by heavy abrasive blast to remove all loose material and microcracking at remaining surfaces impacted by the chipping hammer.
    - c. Alternate methods may be used, only if acceptable to the Engineer.
    - d. For all methods, provide a small, completed area for Engineer's review and acceptance. If the proposed method, in the opinion of the Engineer, damages the reinforcing, revise the removal method to remove the concrete with a less aggressive technique to protect the reinforcing.
  7. Remove materials carefully, to the extent indicated and as required.
    - a. Provide neat and orderly junctions between existing and new materials.
    - b. Use methods that terminate surfaces in straight lines at natural points of division.

8. Do not remove anything beyond the limits of Work indicated without prior written authorization of the Engineer. If in doubt about whether to remove an item, obtain written authorization of the Engineer prior to proceeding.
  9. Perform work so as to provide the least interference and most protection to existing facilities to remain.
  10. Assume possession of demolished materials, unless otherwise indicated on the Drawings or specified.
    - a. Remove demolished materials from site at least weekly and dispose of in accordance with Laws and Regulations.
    - b. Do not burn materials on site.
- B. In-place Abandonment of Pipe:
1. Abandoned pipe in-place as indicated on the Drawings.
  2. Clean buried or exposed solids service piping to a condition free of residual.
    - a. Solids service piping includes: raw wastewater (RAW WW), primary sludge or scum (PS), mixed liquor (ML), return activated sludge (RAS), waste active sludge (WAS), surface waste activated sludge (SWAS), thickened waste activated sludge (TWAS), digested sludge (DS), centrate, or other similar solids service subject to biological degradation, etc.
  3. Provide closure of abandoned pipe cut ends as indicated on the Drawings using one of the following methods:
    - a. Install cap.
    - b. Install plug.
    - c. Install drain valves, pressure relief valves, vents, etc.
- C. Sizing of openings in existing concrete or masonry:
1. Make openings large enough to permit final alignment of pipe and fittings without deflections, but without oversizing.
  2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
  3. If the Engineer deems the opening to be insufficient in size to accomplish this criteria, remove additional material using the procedures outlined in this Section.
- D. Cutting openings in existing concrete or masonry:
1. Do not allow saw cuts to extend beyond limits of openings.
  2. Create openings by the following method or other means acceptable to the Engineer that prevents over-cutting of member at corners:
    - a. Core-drill through slab or wall at corners, being careful not to damage materials beyond the area to be removed.
    - b. Saw cut completely through the member, between the core holes at the corners.
    - c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth on both surfaces (when accessible).
      - 1) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
      - 2) Remove the remaining material with a chipping hammer.
    - d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.
  3. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

- E. Fill tanks with sand or fine gravel and cover with fill.
- F. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.
- G. Rough grade areas affected by demolition.
- H. Remove demolished materials, tools, and equipment upon completion of demolition.

### **3.04 RESTORATION**

- A. General:
  - 1. Repair damage caused by demolition to a conditions equal to those that existing prior to beginning of demolition.
    - a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored with matching material. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface.
    - b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
  - 2. The cost of repairs shall be at the Contractor's expense at no increase in the Contract Price.
  - 3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
  - 4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.
  - 5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
  - 6. Where changes of plane exceed 2 inches, request instructions for making transition.
  - 7. Trim and refinish existing doors as necessary to clear new floors.
  - 8. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
  - 9. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.
- B. Restore existing concrete reinforcement as follows:
  - 1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
  - 2. Where existing reinforcement is not to be retained, cut off as follows:
    - a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
    - b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.



- C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
  - 1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit, and fasteners with non-shrink grout and finish smooth.
  - 2. Remove concrete bases for equipment and supports by:
    - a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface.
      - 1) Do not cut existing reinforcement on floors.
    - b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
    - c. Patch with non-shrink grout to match adjacent grade and finish.
  - 3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.

### **3.05 FIELD QUALITY CONTROL**

- A. Do not proceed with demolition without Engineer's inspection of lay out.
- B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION



## SECTION 01756

### COMMISSIONING

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes: Requirements for each Commissioning phase of the Project, equipment/system, and/or facility.

##### 1.02 DEFINITIONS

- A. Commissioning - The process of planning, testing, and process start-up of the installation for compliance with contract requirements and demonstrating, through documented verification, that the project has successfully met the Contractual requirements. It includes training the Owner's staff to operate the facility.
- B. Commissioning Phases - The work activities of facility commissioning are grouped into the phases defined in the table below.

<b><u>Commissioning</u></b>	
<b><u>Planning Phase</u></b>	<b><u>Testing and Training Phase</u></b>
Owner Training Plan and Schedule	Source Testing
Commissioning Schedule	Owner Training
Subsystem Testing Plan	Installation Testing
	Closeout Documentation

- C. Component - A basic building block of equipment, subsystems, and systems that requires installation or functional testing but does not have an electrical connection or internal electronics. (Examples: filter effluent piping and manual isolation valves).
- D. Device - A basic building block of equipment, subsystems, and systems that requires installation or functional testing and does have an electrical connection or internal electronics. (Examples: filter level transmitter or water pump pressure transmitter).
- E. Equipment - An assembly of component(s) and device(s) that requires installation or functional testing. (Examples: Pump, motor, VFD, Ozone Generator, UV Disinfection System, etc.).
- F. Facility - A grouping of process areas, systems, subsystems, equipment, components, and devices (Examples: treatment plant, pump station, etc.).
- G. Functional Testing - Testing performed on a completed subsystem to demonstrate that equipment/system meets manufacturers' calibration and adjustment requirements and other requirements as specified. Functional testing includes

operating equipment/system manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).

- H. Installation Testing - Testing to demonstrate that subsystem component (piping, power, networks, devices, etc.) is ready and meets the project requirements in advance of functional testing. Installation testing also includes manufacturers' certification of installation and other requirements as specified to prepare equipment/system for Functional Testing. Also referred to as Field Acceptance Testing.
- I. Manufacturer's Certificate of Source Testing - When applicable, the form is used during Source Testing for the manufacturer to confirm that the applicable source tests have been performed and results conform to the Contract Documents. The form is provided at the end of this Section.
- J. Manufacturer's Certificate of Installation and Functionality Compliance - The form is used during Installation Testing and Functional Testing. It is submitted at the end of Functional Testing to confirm that the equipment/system is installed in conformance with the Contract Documents and that it meets the Functional Testing requirements defined in the Contract Documents. The form is provided at the end of this Section.
- K. Process Area - A grouping of systems, subsystems, equipment, components, and devices that divide a facility into functional areas. (Examples: Filter Process Area or Chemical Area).
- L. Product - A system, subsystem or component.
- M. Subsystem - A building block of systems made up from a grouping of components, devices, and equipment that perform a definable function. (Examples: Filter No. 1 Backwash Subsystem, Sedimentation Basin No. 1 Hoseless Sludge Removal Subsystem).
- N. System - A grouping of subsystems, equipment, components, and devices that perform a definable function. (Examples: Filter No. 1, Sedimentation Basin).

### **1.03 COMMISSIONING COORDINATOR (CC)**

- A. Designate and provide a CC for this project.
- B. Submit summary of the CC's qualifications within 30 days of NTP:
  - 1. Include description of previous experience as a CC on similar projects for the designated CC with a list of references including phone numbers for review and Owner approval.
- C. CC responsibilities include the following:
  - 1. Lead efforts relating to Commissioning.
  - 2. Be thoroughly familiar with commissioning requirements in the Contract Documents.
  - 3. Be regularly engaged and experienced in all aspects of commissioning.
  - 4. Provide technical instruction for commissioning.
  - 5. Provide primary interface with Engineer and Owner for efforts relating to Commissioning of Project facilities.
  - 6. Coordinate training efforts.

- D. CC on-site:
  - 1. NTP to 30 percent milestone: 2 hours per week.
  - 2. 30-percent milestone to 70-percent milestone: 1 day per week.
  - 3. Testing and Training Phase: Full-time.
  - 4. Process Start-up Phase: Full-time.

E. Designate and provide CC assistants, as needed.

#### **1.04 SERVICES OF MANUFACTURER'S REPRESENTATIVES**

- A. Qualification of manufacturer's representative as specified in the Contract Documents technical sections include the following:
  - 1. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.
  - 2. Competent, experienced technical representative of equipment/system manufacturer for assembly, installation, testing guidance, and training.
  - 3. Additional qualifications may be specified in the individual sections.
  - 4. Submit qualifications of the manufacturer's representative no later than 30 days in advance of required observations.
  - 5. Representative subject to approval by Owner and Engineer.
  - 6. No substitute representatives will be allowed until written approval by Owner and Engineer has been obtained.
- B. Completion of manufacturer on-site services: Engineer approval required.
- C. Manufacturer is responsible for determining the time required to perform the specified services.
  - 1. Minimum times specified in the Contract Documents are estimates.
  - 2. No additional costs associated with performing the required services will be approved.
  - 3. Manufacturer required to schedule services in accordance with the Contractor's project schedule up to and including making multiple trips to project site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.
- D. Manufacturer's on-site services as specified in the Contract Documents include the following:
  - 1. Assistance during Commissioning Phase and Process Start-Up Phase.
  - 2. Provide daily copies of manufacturer's representative's field notes and data to Engineer.
  - 3. Other requirements as specified in the Contract Documents.

#### **1.05 PLANNING PHASE**

- A. Overview of Planning Phase:
  - 1. Define approach and timing for Commissioning.

- B. Owner training plan and schedule:
1. Training outcomes:
    - a. Owner's operations, maintenance, and engineering staff have the information needed to safely operate, maintain, and repair the equipment/systems provided in the Contract Documents.
  2. Training objectives:
    - a. To instruct personnel in the operation and maintenance of the equipment/system. Instruction shall include step-by-step troubleshooting procedures with all necessary test equipment/system.
    - b. To instruct personnel in the removal, inspection, and cleaning of equipment/system as needed.
    - c. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).
    - d. Provide supporting documentation, such as vendor operation and maintenance manuals.
  3. Training schedule:
    - a. Schedule Owner's staff training within the constraints of their workloads. Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative. Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.
  4. Training plan:
    - a. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
    - b. Conduct classroom training at location designated by Owner.
    - c. Scope and sequence:
      - 1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
        - a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
  5. Training scheduling coordination:
    - a. CC is responsible for the following:
      - 1) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).
    - b. Complete Owner training no sooner than 15 calendar days prior to start of process start-up of each system.
  6. Meetings:
    - a. CC is responsible for setting commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
    - b. CC shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 90 calendar days prior to commissioning of equipment/system.
    - c. CC shall conduct commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.
      - 1) Frequency: Monthly minimum. Increase frequency as needed based on complexity and quantity of commissioning activities.

7. Submittals:
  - a. Submit Training Plan Schedule 90 calendar days before the first scheduled training session, including but not limited to lesson plans, participant materials, instructor's resumes, and training delivery schedules.
  - b. Submit training documentation including the following:
    - 1) Training plan:
      - a) Training modules.
      - b) Scope and sequence statement.
      - c) Contact information for manufacturer's instructors including name, phone, and e-mail address.
      - d) Instructor qualifications.
    - 2) Training program schedule:
      - a) Format: Bar chart:
        - (1) Additionally include in the Project Progress Schedule.
      - b) Contents:
        - (1) Training modules and classes.
8. Training sessions:
  - a. Provide training sessions for equipment/system as specified in the individual equipment/system section.

C. Commissioning Schedule:

1. Commissioning overview:
  - a. Comply with Commissioning Roles and Responsibilities Matrix specified at the end of this Section.
2. Submittal due date:
  - a. Submit Commissioning Schedule not less than 90 calendar days prior to planned initial commissioning of each subsystem or system.
3. Schedule requirements:
  - a. Schedule durations and float for commissioning activities to ensure Work does not fall behind schedule due to complications or delays during commissioning.
  - b. Time-scaled network diagram detailing the work to take place in the period between 210 calendar days prior to planned initial commissioning of equipment and systems, and prior to the date of Substantial Completion, together with supporting narrative.
  - c. Provide detailed schedule of commissioning activities including durations and sequencing requirements.
    - 1) Identify the following activities:
      - a) Testing and Training Phase:
        - (1) Source Testing.
        - (2) Owner Training.
        - (3) Installation Testing.
        - (4) Functional Testing.
        - (5) Closeout Documentation.
  - d. Schedule manufacturer's services to avoid conflict with other on-site testing or other manufacturers' on-site services.
  - e. Verify that conditions necessary to allow successful testing have been met before scheduling services.

- D. Subsystem testing plans:
1. Provide separate testing plans for each individual subsystem and system that include the following:
    - a. Approach to testing including procedures, schedule, and recirculation requirements.
    - b. Test objective: Demonstrate subsystem meets the design requirements as specified in the technical sections.
    - c. Test descriptions, forms, temporary systems (pumps, piping, etc.), shutdown requirements for existing systems, test forms, test logs, witness forms, and checklists to be used to control and document the required tests.
    - d. Test forms: Include, but not limited to, the following information:
      - 1) Tag and name of equipment/system to be tested.
      - 2) Test date.
      - 3) Names of persons conducting the test.
      - 4) Names of persons witnessing the test, where applicable.
      - 5) Test data.
      - 6) Applicable project requirements.
      - 7) Check offs for each completed test or test step.
      - 8) Place for signature of person conducting tests and for the witnessing person, as applicable.
    - e. Define start-up sequencing of unit processes:
      - 1) Include testing of alarms, interlocks, permissives, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
      - 2) Provide detailed test procedures setting forth step-by-step descriptions of the procedures for systematic testing of equipment/system.
      - 3) Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration.
        - a) Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
      - 4) Demonstrate proper operation of each control loop function including mechanical, electrical, alarms, local and remote controls, instrumentation, and other equipment/system functions.
        - a) Generate signals with test equipment/system to simulate operating conditions in each control mode.
  2. Engineer approval of test plan is required prior to performing test.
    - a. Revise and update test plans based on review comments, actual progress, or to accommodate changes in the sequence of activities.
    - b. Submit test reports for each phase of testing for each equipment/system.
    - c. Engineer approval of preceding test reports is required prior to start of next test.
    - d. Tests will be rescheduled if test plan is not approved by the required deadline.
      - 1) Contractor is responsible for any resulting delay.
  3. Contractor is responsible to reproduce and distribute final test procedures.
    - a. Provide 3 copies for Engineer.
  4. Tests may commence only after Engineer has received approved test plan copies.



5. Submittals:
  - a. Submit test plans not less than 60 calendar days prior to planned installation testing of subsystem or system.
  - b. Completed Manufacturer's Certificate of Installation and Functionality Compliance.
  - c. Test procedures and forms: Provide signed-off copy of test forms and test reports upon completion of the test.
  - d. Test reports:
    - 1) Submit preliminary copies within 1 day after testing completion.
    - 2) Submit final copies and report within 14 days after testing completion.

## **1.06 TESTING AND TRAINING PHASE**

- A. Overview of Testing and Training Phase:
  1. General:
    - a. Include specified Source Testing, Owner Training, Installation Testing, Functional Testing, and Closeout Documentation required by this Section and the technical sections.
  2. Contractor responsibilities:
    - a. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
    - b. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.
    - c. Acceptable tests: Demonstrate the equipment/system performance meets the requirements stated in the Contract Documents.
      - 1) When the equipment/system fails to meet the specified requirements, perform additional, more detailed, testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.
- B. Source testing:
  1. Also referred to as factory testing or factory acceptance testing (FAT).
  2. Test components, devices, and equipment/system for proper performance at point of manufacture or assembly as specified in the technical sections.
  3. Notify the Engineer in writing when the equipment/system is ready for source inspection and testing.
  4. Source Test Plan:
    - a. As specified in this Section and other technical sections.
    - b. Source testing requirements as specified in technical sections.
      - 1) Non-witnessed: Provide Manufacturer's Certificate of Source Testing.
      - 2) Witnessed: 1 Owner's representative and 1 Engineer's representative present during testing, unless otherwise specified, and provide Manufacturer's Certificate of Source Testing.
    - c. Prepared by Contractor as a result of discussions and planning emerging from regularly conducted commissioning meetings for source tests as specified in the Contract Documents.
    - d. Provide the following items for each Source Test:
      - 1) Purpose and goals of the test.
      - 2) Identification of each item of equipment/system, including system designation, location, tag number, control loop identifier, etc.

- 3) Description of the pass/fail criteria that will be used.
- 4) Listing of pertinent reference documents (Contract Documents and industry standards or sections applicable to the testing).
- 5) Complete description, including drawings or photographs, of test stands and/or test apparatus.
- 6) Credentials of test personnel.
- 7) Descriptions of test equipment to be used, product information, and all appropriate calibration records for the test equipment.
- 8) Test set-up procedures.
- 9) Detailed step-by-step test procedures.
  - a) The level of detail shall be sufficient for any witness with a rudimentary technical aptitude to be able to follow the steps and develop confidence that the tests were being performed as planned.
  - b) All steps are significant, and all steps shall be included in the procedures.
- 10) Sample data logs and data recording forms.
- 11) Sample computations or analyses with the results in the same format as the final report to demonstrate how data collected will be used to generate final results.
  - a) Complete disclosure of the calculation methodologies.
  - b) Include a sample for each type of computation required for the test and analysis of the results.
- 12) Detailed outline of the Source Test report.
- 13) Sample test reports.
- e. Submit Source Test Plan and forms as specified in the technical sections.
  - 1) Submit a copy of the Source Test Plan at least 30 days before any scheduled test date.
  - 2) Engineer approval of Source Test Plan required prior to beginning source testing.
  - 3) Schedule the testing after approval of the test procedures submittal.
- f. Indicate the desired dates for source inspection and testing.
  - 1) Notify the Engineer of the scheduled tests a minimum of 30 days before the date of the test.
5. Test results:
  - a. Prepare and submit test results with collected data attached.
6. Contractor is responsible for costs associated with Owner's representatives and Engineer's representative witnessing Source Tests.
  - a. Include costs for at least the following:
    - 1) Transportation:
      - a) Travel 1 day on commercial airline to site including air flight costs and \$1,600 allowance per person per day.
      - b) Travel 1 day on commercial airline from site including air flight costs and \$1,600 allowance per person per day.
      - c) Rental car from hotel to and from the test site.
    - 2) Hotel costs at a facility with an American Automobile Association 4-star rating or equivalent for single occupancy room per person per day.
    - 3) Meal allowance of \$60 per person per day.
    - 4) On-site time: 1 day at the site, unless specified otherwise, including \$1,600 allowance per person per day.

- b. If Source Test is not ready when the witnesses arrive or if the Source Test fails, the witnesses will return home with Contractor responsible for costs associated with the trip including costs described above. Contractor is responsible for rescheduling the Source Test and witnesses' costs associated with the second trip including costs described above.
  - c. Contractor is responsible for witnesses' costs associated with retests including costs described above.
7. Contractor is responsible for providing fuel, chemicals, and other consumables needed for Source Testing.

C. Owner training:

- 1. Training instruction format:
  - a. The training for operations and maintenance personnel shall be provided as one entity.
  - b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
  - c. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture.
  - d. Visual aids and hands-on practice sessions must support training objectives.
  - e. Lecturing should be less than 30 percent of class time.
  - f. Conduct hands-on instruction according to the following descriptions:
    - 1) Present hands-on demonstrations of at least the following tasks:
      - a) Proper start-up, shutdown, and normal and alternative operating strategies.
      - b) Common corrective maintenance repairs for each group.
      - c) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
    - 2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
      - a) Submit requests for supplemental assistance and facilities with the Contractor's proposed lesson plans.
    - 3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel.
      - a) Provide written certification of proper equipment/system operation to Engineer after completion of hands-on training.
- 2. Class agenda:
  - a. Include the following information in the agenda:
    - 1) Instructor name.
    - 2) Listing of subjects to be discussed.
    - 3) Time estimated for each subject.
    - 4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
    - 5) List of documentation to be used or provided to support training.
  - b. Owner may request that particular subjects be emphasized, and the agenda be adjusted to accommodate these requests.
  - c. Distribute copies of the agenda to each student at the beginning of each training class.
- 3. Number of students:
  - a. Estimated maximum class size: 5 persons.
    - 1) Owner will determine the actual number of students.

- 2) Engineer will provide an estimated headcount 1 week prior to the class, so that the instructor can provide the correct number of training aids for students.
4. Instructor qualifications:
  - a. Provide instructors completely knowledgeable in the equipment/system for which they are training.
  - b. Provide instructors experienced in conducting classes.
  - c. Provide instructor's technical preparation and instructional technology skills and experience.
  - d. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
  - e. If, in the opinion of the Owner, an appropriately knowledgeable person did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor.
5. Training aids:
  - a. Instructors are encouraged to use audio-visual devices, P&IDs, models, charts, etc. to increase the transfer of knowledge.
  - b. Instructors shall provide such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, etc. for each class.
  - c. Instructor is responsible for confirming with Engineer and Owner in advance of each class that the classroom will be appropriate for the types of audiovisual equipment to be employed.
6. Classroom documentation:
  - a. Trainees will keep training materials and documentation after the session.
  - b. Operations and maintenance manuals, as specified in technical sections:
    - 1) Provide a minimum of 2 copies of final Engineer-approved operations and maintenance manuals as specified in Section 01782 - Operation and Maintenance Data for use during the classroom instruction.
    - 2) Owner reserves the right to delay training for a particular equipment item if the operations and maintenance manuals for that equipment are incomplete, inaccurate, or otherwise unsuitable for use by the Owner's staff.
    - 3) No contract extensions or extra costs will be allowed for training delays due to operations and maintenance manual submittal delays.
  - c. Provide supplemental documentation handouts to support instruction.
  - d. Digitally record audio and video of each training session.
    - 1) Include classroom and field instruction with question and answering periods.
    - 2) Engineer approval required for producer of video materials from one of the following options:
      - a) Qualified, professional video production company.
      - b) Contractor demonstrates satisfactory skill.
    - 3) Record in digital format and recording shall become property of the Owner.
      - a) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.
    - 4) Video files shall be file format and delivery medium as directed and approved by Owner.

- 5) Provide 2 complete sets of video materials fully indexed and cataloged with printed labels stating session content and dates recorded.
- 6) The Contractor shall provide a written release from all claims to the recorded training material produced, if required.
- e. Training modules:
  - 1) Provide a training module for each equipment category.
  - 2) Divide each training module's instructional content into discrete lesson plans.
- f. Lesson plans:
  - 1) Provide performance-based learning objectives.
  - 2) State learning objectives in terms of what the trainees will be able to do at the end of the lesson.
  - 3) Define student conditions of performance and criteria for evaluating instructional success.
  - 4) Instruction lesson plan outlines for each trade.
    - a) Provide specific components and procedures.
  - 5) Minimum requirements:
    - a) Hands-on demonstrations planned for the instructions.
    - b) Cross-reference training aids.
    - c) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
    - d) Attach handouts cross-referenced by section or topic in the lesson plan.
    - e) Indicate duration of outlined training segments.
  - 6) Provide maintenance instruction lesson plans including mechanical, HVAC, instrumentation, and electrical aspects:
    - a) Equipment operation:
      - (1) Describe equipment's operating (process) function and system theory.
      - (2) Describe equipment's fundamental operating principles and dynamics.
      - (3) Identify equipment's mechanical, electrical, and electronic components and features.
      - (4) Identify support equipment associated with the operation of subject equipment.
      - (5) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
      - (6) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
      - (7) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.
    - b) Detailed component description:
      - (1) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).
        - (a) Review preventive maintenance frequency and task analysis table.

- (2) Identify each component function and describe in detail.
    - (3) Where applicable, group relative components into subsystems.
    - (4) Identify and describe in detail equipment safety features, permissive and controls interlocks.
  - 7) Provide the following information in equipment troubleshooting lesson plans:
    - a) Define recommended systematic troubleshooting procedures as they relate to specific craft problems.
    - b) Provide component specific troubleshooting checklists as they relate to specific craft problems.
  - 8) Provide the following information in equipment Corrective Maintenance (CM) troubleshooting lesson:
    - a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
    - b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.
    - c) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
    - d) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
      - (1) Additional demonstrations may be required by the Owner.
    - e) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
7. Class logistics:
- a. Delivery time minimum: 2 hours.
  - b. Delivery time maximum: 4 hours.
    - 1) Longer time requires Engineer approval.
  - c. Class agenda:
    - 1) Refreshment break: One 10-minute break.
    - 2) Meal break: One 45-minute break, unless otherwise specified.
    - 3) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.
  - d. Schedule specific sessions:
    - 1) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
    - 2) At the times requested by the Owner, within the period 7 a.m. to 7 p.m. Monday through Friday.
      - a) Times scheduled will be at Owner's discretion.
    - 3) Owner approval and confirmation required for session schedules.
    - 4) Provide minimum of 2 sessions for each class unless otherwise noted.
      - a) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.
8. Distribute Training Evaluation Form following each training session.
- a. Training Evaluation Form is included in this Section.
  - b. Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.

- c. Revise training sessions judged "Unsatisfactory" by a majority of attendees.
  - 1) Conduct training sessions again until a satisfactory rating is achieved at no additional cost to Owner.
- 9. Submittals:
  - a. Prior to the training session:
    - 1) Instructor qualifications: Due 30 calendar days prior to initial training session.
    - 2) Training course materials: Due 14 calendar days prior to initial training session.
      - a) Training agenda, lesson plan, presentation, and handouts.
      - b) Other audio-visual aids utilized during each training course.
      - c) Format: 2 electronic copies and 3 hard copies organized in notebooks.
  - b. Post training session:
    - 1) Training course materials: Due 14 calendar days after class completion.
      - a) Video recordings.
      - b) Class attendance sheet.
      - c) Training agenda, final lesson plan, presentation, and handouts.
      - d) Other audio-visual aids utilized during each training course.
      - e) Provide materials for all sessions of the class in a single transmittal.
      - f) Format: 2 electronic copies and 3 hard copies organized in notebooks.

D. Installation Testing:

- 1. Perform subsystem testing according to approved Subsystem Testing Plans.
- 2. Initiate the Manufacturer's Certificate of Installation and Functionality Compliance for all equipment.
  - a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
  - b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment meets the following requirements:
    - 1) Has been properly installed, adjusted, aligned, and lubricated.
    - 2) Is free of any stresses imposed by connecting piping or anchor bolts.
    - 3) Is able to be operated as necessary for Functional Testing.
  - c. Form shall be submitted after completion of Functional Testing, as specified in this Section.
- 3. Coordinate Installation Testing with restrictions and requirements as specified in Section 01140 - Work Restrictions.
- 4. Perform coating holiday testing as specified in Section 09960 - High-Performance Coatings.
- 5. Perform mechanical equipment Installation Testing: As specified below and in individual equipment sections:
  - a. Remove rust preventatives and oils applied to protect equipment during construction.
  - b. Flush lubrication systems and dispose of flushing oils.
    - 1) Recharge lubrication system with lubricant recommended by manufacturer.
  - c. Flush fuel system and provide fuel for testing and start-up.

- d. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
  - e. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
  - f. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
  - g. Perform cold alignment and hot alignment to manufacturer's tolerances.
  - h. Adjust V-belt tension and variable pitch sheaves.
  - i. Inspect hand and motorized valves for proper adjustment.
    - 1) Tighten packing glands to ensure no leakage, but permit valve stems to rotate without galling.
    - 2) Verify valve seats are positioned for proper flow direction.
  - j. Tighten leaking flanges or replace flange gasket.
    - 1) Inspect screwed joints for leakage.
  - k. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.
6. Electrical devices and subsystems Installation Testing: As specified below, in Section 16950 - Field Electrical Acceptance Tests, and the technical sections.
- a. Perform insulation resistance tests on all wiring except wiring and control wiring inside electrical panels.
  - b. Perform grounding resistance tests on grounding systems.
  - c. Test and set relays and circuit breaker trip units for proper operation.
    - 1) Settings as documented in approved electrical studies.
  - d. Perform direct-current high-potential tests on all cables that will operate at more than 2,000 volts.
  - e. Motors:
    - 1) Windings energized to 1,000 volts DC for 1 minute.
      - a) Motor resistance measured at the end of the test and recorded.
    - 2) Check motors for actual full-load amperage draw and proper rotation.
7. Instrumentation devices and subsystems Installation Testing: As specified below, in Section 17950 - Testing, Calibration, and Commissioning, and technical sections.
8. Heating, ventilating, and air conditioning systems Installation Testing: As specified below and technical sections.
- a. Perform testing of heating, ventilating, and air conditioning equipment, balancing of distribution systems, and adjusting of ductwork accessories.
  - b. Test hydronic systems, if required by technical sections.
- E. Functional Testing:
- 1. Perform subsystem testing according to approved Subsystem Testing Plan.
  - 2. Notify the Engineer 5 days prior to when the Work is ready for Functional Testing.
    - a. Perform testing in the presence of the Engineer.
  - 3. Determine Functional Testing durations with Owner's input.
    - a. Target minimum Functional Test duration: 8 hours.
      - 1) Identify equipment/system that cannot be tested for a minimum of 8 hours as specified in technical sections.
  - 4. Perform Functional Testing as specified in technical sections.
    - a. Perform Functional Testing in addition to the other tests specified in the technical sections.
    - b. Perform Functional Testing to demonstrate that the component equipment functions as an entire system in accordance with the design requirements.



- c. Perform Functional Testing to demonstrate that the unit process has operated in a manner necessary to demonstrate equipment/system functions manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).
- d. Repair or replace parts that operate improperly and retest.
- e. Submit testing results as specified in the technical sections to the Owner and Engineer for approval of Functional Testing results.
- 5. Provide completed Manufacturer's Certificate of Installation and Functionality Compliance forms for all equipment.
  - a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
  - b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment/system meets the following requirements:
    - 1) Is suitable for satisfactory full-time operation under full-load conditions.
    - 2) Operates within the allowable limits for vibration and noise.
    - 3) Electrical and instrumentation requirements:
      - a) Electrical equipment, instrumentation, and control panels are properly installed, calibrated, and functioning.
      - b) Electrical Installation Testing is complete, and test results have been approved by the Engineer.
        - (1) Noted deficiencies have been corrected.
        - (2) Relays, circuit breakers, and other protective devices are set.
      - c) Control logic for start-up, shutdown, sequencing, interlocks, control, and emergency shutdown has been tested and is properly functioning.
      - d) Motor control is calibrated and tested.

F. Closeout documentation:

- 1. Submittals:
  - a. Provide records generated during Commissioning Phase of Project.
    - 1) Required documents include but are not limited to:
      - a) Training documentation.
      - b) Manufacturer's Certificate of Source Testing.
      - c) Manufacturer's Certificate of Installation and Functionality Compliance.
      - d) Daily logs of equipment/system testing identifying tests conducted and outcome.
      - e) Test forms and documentation.
      - f) Functional Testing results.
      - g) Logs of time spent by manufacturer's representatives performing services on the job site.
      - h) Equipment lubrication records.
      - i) Electrical phase, voltage, and amperage measurements.
      - j) Insulation resistance measurements.
      - k) Bearing temperature measurements.
    - 2) Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints. Format: 2 electronic copies and 3 hard copies organized in notebooks.
    - 3) Due date: Within 14 calendar days of Substantial Completion.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER \_\_\_\_\_ EQPT/SYSTEM \_\_\_\_\_  
PROJECT NAME \_\_\_\_\_ EQPT TAG NO. \_\_\_\_\_  
PROJECT NO. \_\_\_\_\_ EQPT SERIAL NO. \_\_\_\_\_  
SPECIFICATION NO. \_\_\_\_\_  
SPECIFICATION TITLE \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract Documents, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: \_\_\_\_\_, 20\_\_\_\_

Manufacturer: \_\_\_\_\_

Manufacturer's Authorized Representative Name (*print*): \_\_\_\_\_

\_\_\_\_\_  
(Authorized Signature)

If applicable, Witness Name (*print*): \_\_\_\_\_

\_\_\_\_\_  
(Witness Signature)

**MANUFACTURER'S CERTIFICATE OF  
INSTALLATION AND FUNCTIONALITY COMPLIANCE**

OWNER \_\_\_\_\_ EQPT/SYSTEM \_\_\_\_\_  
PROJECT NAME \_\_\_\_\_ EQPT TAG NO. \_\_\_\_\_  
PROJECT NO. \_\_\_\_\_ EQPT SERIAL NO. \_\_\_\_\_  
SPECIFICATION NO. \_\_\_\_\_  
SPECIFICATION TITLE \_\_\_\_\_

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/instrumentation and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functionally tested.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements.

**NOTES:**

Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

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 this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system 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: \_\_\_\_\_

Manufacturer's Authorized Representative Name (*print*): \_\_\_\_\_

By Manufacturer's Authorized Representative: \_\_\_\_\_  
(Authorized Signature)

## COMMISSIONING

## TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM:

VENDOR/MANUFACTURER:

DATE: \_\_\_\_\_ NAME OF REPRESENTATIVE: \_\_\_\_\_

- |     |   |            |              |    |     |
|-----|---|------------|--------------|----|-----|
| 1.  | Was representative prepared?  | Acceptable | Unacceptable | or | N/A |
| 2.  | Was an overview description presented?  | Acceptable | Unacceptable | or | N/A |
| 3.  | Were specific details presented for system components?                              | Acceptable | Unacceptable | or | N/A |
| 4.  | Were alarm and shutdown conditions clearly presented?                               | Acceptable | Unacceptable | or | N/A |
| 5.  | Were step-by-step procedures for starting, stopping, and troubleshooting presented? | Acceptable | Unacceptable | or | N/A |
| 6.  | Were routine/preventative maintenance items clearly identified?                     | Acceptable | Unacceptable | or | N/A |
| 7.  | Was the lubrication schedule (if any) discussed?                                    | Acceptable | Unacceptable | or | N/A |
| 8.  | Was the representative able to answer all questions?                                | Acceptable | Unacceptable | or | N/A |
| 9.  | Did the representative agree to research and answer unanswered questions?           | Acceptable | Unacceptable | or | N/A |
| 10. | Comments:   |            |              |    |     |

10. Comments: \_\_\_\_\_

---

11. Overall Rating: Satisfactory Unsatisfactory

Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

## COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
<b>Testing and Training Phase</b>				
<b>Source Testing</b>				
1	Source Testing	Witness	Lead	Witness, Review
<b>Installation Testing</b>				
2	Electrical Conductor Testing	No Action	Lead	Witness
3	Electrical Field Acceptance Tests	No Action	Lead	Witness
4	Instrument Field Calibration	No Action	Lead	Witness
5	Network Installation Testing	Witness	Lead	Witness
6	Loop Testing	Witness	Lead	Witness
7	Pressure Testing	No Action	Lead	Witness
8	Leak Testing	No Action	Lead	Witness
9	Holiday Testing	No Action	Lead	Witness
10	HVAC Testing	No Action	Lead	Witness
11	Motor Electrical Testing	No Action	Lead	Witness
<b>Functional Testing</b>				
12	Network Operational Testing	Witness	Lead	Review
13	Preliminary Run Testing Local/Manual Control	Witness	Lead	Review
14	PCIS Functional Demonstration Testing - Local/Auto Control Testing - Remote/Manual Contact Testing - Alarm Testing - Control Loop Testing	No Action	Lead	Review
15	Subsystem Start-Up and Testing	Witness	Lead	Review
16	Equipment/System Start-Up and Testing	Witness	Lead	Review
17	HVAC Start-Up and Testing	Witness	Lead	Review
18	Corrosion Control Start-Up and Testing	Witness	Lead	Review
19	Wide Area Network Communications Testing	Support	Lead	Witness
20	Manufacturer's Certificate of Installation and Functionality Compliance	No Action	Lead	Witness, Review
26	HVAC Functionality Check	No Action	Lead	Witness
27	Start-Up Sequence Review	Support	Lead	Review
28	Temporary Testing Arrangement Finalization	Support	Lead	Support
29	Start-Up Forms Finalization	Support	Lead	Support
30	Operation Testing Plan Finalization	Review	Support	Lead
32	System Testing	Support	Lead	Witness
33	Control Loop Tuning	Support	Lead	Witness
34	Process Area Start-Ups	Support	Lead	Witness
35	Facility-Wide Start-Up	Support	Lead	Witness

Commissioning

01756-20

pw://Carollo/Documents/Client/UT/SVWRF/10548A10/Specifications/P2/01756 (Bid)

10548A10

March 2021

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
<b>Testing and Training Phase</b>				
36	Process Control Systems Testing	Support	Lead	Witness
38	HVAC Final Testing, Adjust, and Balancing	Witness	Lead	Witness, Review
<b>Process Operational Period</b>				
39	Operational Testing	Support	Lead	Witness, Review
40	Final Testing Reports	Support	Lead	Review
<b>Instrumentation and Controls Reliability Phase</b>				
<b>Instrumentation and Controls Reliability Period</b>				
42	As specified in Section 17950 - Testing, Calibration, and Commissioning			
<b>Legend:</b> <b>Lead:</b> Primarily responsible for organization, coordination, and execution of task work product or result. <b>Support:</b> Assist the lead with organization, coordination, and execution of task work product or result. <b>Witness:</b> Observe and document completion of task work product or result. <b>Review:</b> As necessary to accept task work product result. <b>No Action:</b> Limited or no involvement.				





**SECTION 01770**  
**CLOSEOUT PROCEDURES**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes: Contract closeout requirements including:
  - 1. Final cleaning.
  - 2. Waste disposal.
  - 3. Touch-up and repair.
  - 4. Disinfection of systems.
  - 5. Preparation and submittal of closeout documents.
  - 6. Certificate of Substantial Completion.

**1.02 REFERENCES**

- A. American Water Works Association (AWWA).

**1.03 FINAL CLEANING**

- A. Perform final cleaning prior to inspections for Final Completion.
- B. Employ skilled workers who are experienced in cleaning operations.
- C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.
- D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.
- E. Clean roofs, gutters, downspouts, and drainage systems.
- F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
  - 1. Police yards and grounds to keep clean.
- G. Remove dust, cobwebs, and traces of insects and dirt.
- H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.
- I. Remove non-permanent protection and labels.
- J. Polish waxed woodwork and finish hardware.
- K. Wash tile.
- L. Wax and buff hard floors, as applicable.
- M. Wash and polish glass, inside and outside.

- N. Wash and shine mirrors.
- O. Polish glossy surfaces to clear shine.
- P. Vacuum carpeted and soft surfaces.
- Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.
- R. Clean ducts, blowers, and coils when units were operated without filters during construction.
- S. Clean light fixtures and replace burned-out or dim lamps.
- T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

#### **1.04 WASTE DISPOSAL**

- A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
  - 1. Prior to making disposal on private property, obtain written permission from Owner of such property.
- B. Do not fill ditches, washes, or drainage ways which may create drainage problems.
- C. Do not create unsightly or unsanitary nuisances during disposal operations.
- D. Maintain disposal site in safe condition and good appearance.
- E. Complete leveling and cleanup prior to Final Completion of the Work.

#### **1.05 TOUCH-UP AND REPAIR**

- A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Final Completion.
- B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

#### **1.06 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF PLANT FACILITIES**

- A. Clean channels, pipe, basins, reservoirs, and tanks
- B. Wash, wherever practicable, or broom sweep channels, pipe, basins, reservoirs, and tanks.
- C. Disinfect piping intended to carry potable water as follows or in accordance with AWWA Standards.
- D. Provide ample sampling outlets in pipe for testing.
- E. Fill pipe and other plant facilities with chlorine solution of sufficient strength to retain residual of not less than 10 parts per million at end of 24 hours.

- F. When reservoirs and basins are too large to be economically disinfected by filling with chlorine solution, spray reservoirs and basins with solution containing 100 parts per million of chlorine.
- G. After disinfection, rinse entire potable water system with potable water sufficient to reduce chlorine residual to not more than 0.6 parts per million throughout system before system is put into service.

#### **1.07 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF POTABLE WATER MAINS**

- A. Clean interior of pipe and fittings.
- B. When pipe contains dirt that cannot be removed by flushing, swab pipe interiors with solution containing not less than 500 parts per million of chlorine until clean.
- C. Flush 12-inch in diameter and smaller pipe as thoroughly as available water sources will permit.
- D. Fill pipe with chlorine solution of sufficient strength to provide 10 parts per million chlorine residual at end of 24 hours.
- E. Flush pipes with potable water until chlorine residual is less than 0.6 parts per million before pipe are put into service.

#### **1.08 CLOSEOUT DOCUMENTS**

- A. Submit following Closeout Submittals before Substantial Completion:
  - 1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
  - 2. Evidence of Compliance with Requirements of Governing Authorities.
  - 3. Project Record Documents.
  - 4. Approved Operation and Maintenance Manuals.
  - 5. Approved Warranties and Bonds.
  - 6. Keys and Keying Schedule.
  - 7. Completed contract requirements for commissioning and process start-up.
- B. Submit following Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
  - 1. Punch list of items have been completed and Engineer and Owner are satisfied that all deficiencies are corrected.
  - 2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
  - 3. Release of claims as outlined in Conditions of the Contract.
  - 4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
  - 5. Final statement of accounting.

#### **1.09 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES**

- A. Submit the following:
  - 1. Certificate of Occupancy.

2. Certificates of Inspection:
  - a. Elevators.
  - b. Mechanical:
    - 1) Form U-1 "Manufacturer's Data Report for Unfired Pressure Vessels" for each pressure vessel furnished and installed.
  - c. Electrical.

## 1.10 PROJECT RECORD DOCUMENTS

- A. Maintain at Project site, available to Owner and Engineer, 1 copy of the Contract Documents, shop drawings, and other submittals in good order:
  1. Mark and record field changes and detailed information contained in submittals and change orders.
  2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
  3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
  4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
  5. Provide schedules, lists, layout drawings, and wiring diagrams.
  6. Make annotations in hard copy format with erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Graphite

- B. Maintain documents separate from those used for construction:
  1. Label documents "RECORD DOCUMENTS."
- C. Keep documents current:
  1. Record required information at the time the material and equipment is installed and before permanently concealing.
  2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.
- D. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.
- E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.
- F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.
- G. Updated Record Documents are a condition for Engineer's recommendation for progress payment.

- H. Final Schedule Submittal as specified in Section 01321 - Schedules and Reports.

#### **1.11 MAINTENANCE SERVICE**

- A. Maintenance service as specified in technical specifications.

#### **1.12 SUBSTANTIAL COMPLETION**

- A. Obtain Certificate of Substantial Completion.

#### **1.13 FINAL COMPLETION**

- A. When Contractor considers the Work is complete, submit written certification that:
  - 1. Work has been completed in accordance with the Contract Document:
  - 2. Punch list items have been completed or corrected.
  - 3. Work is ready for final inspection.
- B. Engineer will make an inspection to verify the status of completion with reasonable promptness.
- C. Should the Engineer consider that the Work is incomplete or defective:
  - 1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
  - 2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the Engineer that the Work is complete.
  - 3. Engineer shall re-inspect the Work.

#### **1.14 FINAL ADJUSTMENT OF ACCOUNTS**

- A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.
- B. Statement shall reflect all adjustments to the Contract amount.
  - 1. The original Contract amount.
  - 2. Additions and deductions resulting from:
    - a. Change Orders.
    - b. Units installed and unit prices.
    - c. Set-offs for uncorrected or incomplete Work.
    - d. Set-offs for liquidated damages.
    - e. Set-offs for reinspection payments.
    - f. Extended engineering and/or inspection services and inspection overtime.
    - g. Excessive shop drawings review cost by the Engineer.
    - h. Other adjustments.
  - 3. Total Contract amount, as adjusted.
  - 4. Previous payments.
  - 5. Remaining payment due.
- C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

## **1.15 FINAL APPLICATION FOR PAYMENT**

- A. Contractor shall submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## **SECTION 01782**

### **OPERATION AND MAINTENANCE DATA**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Preparation and submittal of Operation and Maintenance Manuals.

##### **1.02 GENERAL**

- A. Submit Operation and Maintenance Manuals as specified in technical sections.
- B. Make approved manuals available at project site for use by construction personnel and Owner.

##### **1.03 SUBMITTALS**

- A. Draft Operation and Maintenance Manuals:
  - 1. Submit prior to shipment of equipment or system to site.
  - 2. Shipment will be considered incomplete without the draft Operation and Maintenance Manuals.
  - 3. Quantity:
    - a. Hard copy: 2 sets.
    - b. Electronic: 2 CD-ROM or DVD.
- B. Final Operation and Maintenance Manuals:
  - 1. Make additions and revisions in accordance with Owner's and Engineer's review comments on draft manuals.
  - 2. Submit approved Operation and Maintenance Manuals at least 30 days prior to Functional Testing and at least 60 days prior to Owner Training.
  - 3. Quantity:
    - a. Hard copy: 3 sets.
    - b. Electronic: 2 CD-ROM or DVD.

##### **1.04 PREPARATION**

- A. General requirements:
  - 1. Provide dimensions in English units.
  - 2. Assemble material, where possible, in the same order within each volume.
  - 3. Reduce drawings and diagrams to 8 1/2 by 11-inch size, if possible unless otherwise specified.
  - 4. Complete forms on computer, handwriting not acceptable.
  - 5. Delete items or options not provided in the supplied equipment or system.
  - 6. Provide package control system annotated ladder logic for PLC, if applicable.
- B. Hard copy requirements:
  - 1. Binders: 3-ring with rigid covers.
    - a. Break into separate binders as needed to accommodate large size.

2. Utilize numbered tab sheets to organize information.
  3. Provide original and clear text on reproducible non-colored paper, 8 1/2 by 11-inch size, 24-pound paper.
  4. Drawings larger than 8 1/2 by 11 inch:
    - a. Fold drawings separately and place in envelope bound into the manual.
    - b. Label each drawing envelope on the outside regarding contents.
- C. Electronic requirements:
1. File format:
    - a. Entire manual in PDF format.
      - 1) Include text and drawing information.
      - 2) Provide a single PDF file even if the hard copy version is broken into separate binders due to being large.
      - 3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.).
        - a) If material is not available in native format and only available in paper format, remove smudges, fingerprints, and other extraneous marks before scanning to PDF format.
        - b) Hard copy record drawing requirements:
          - (1) Provide a single multipage PDF file of each set of the scanned drawings.
          - (2) Page 1 shall be the cover of the drawing set.
        - c) At file opening, display the entire cover.
          - (1) Scan drawings at 200 to 300 dots per inch (DPI), black and white, Group IV Compression, unless otherwise specified.
          - (2) Scan drawings with photos in the background at 400 dots per inch (DPI), black and white, Group IV Compression.
      - 4) Pagination and appearance to match hard copy.
      - 5) Searchable.
      - 6) Scanned images are not acceptable.
      - 7) Bookmarks:
        - a) Bookmarks shall match the table of contents.
        - b) Bookmark each section (tab) and heading.
        - c) Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
        - d) At file opening, display all levels of bookmarks as expanded.
      - 8) Thumbnails optimized for fast web viewing.
    - b. Drawing requirements:
      - 1) Provide additional copy of drawings in most current version of Microstation format.
      - 2) Drawings shall have a white background.
      - 3) Drawing shapes shall not degrade when closely zoomed.
      - 4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
      - 5) Delete items or options not provided in the supplied equipment or system.
  2. Media:
    - a. CD-ROM or DVD-ROM compatible with Microsoft Windows.
    - b. Flash drive.
    - c. Secure Electronic File Transfer (SEFT).
  3. Label media with the following information:
    - a. Operation and Maintenance Manual.



- b. Equipment name.
  - c. Specification Section Number
  - d. Equipment tag number.
  - e. Owner's name.
  - f. Project number and name.
  - g. Date.
4. If multiple submittals are made together, each submittal must have its own subdirectory that is named and numbered based on the submittal number.

## **1.05 CONTENTS**

- A. Label the spines:
  - 1. Equipment name.
  - 2. Tag number.
  - 3. Project name.
  - 4. Owner name.
- B. Cover page:
  - 1. Operation and Maintenance Manual.
  - 2. Equipment name.
  - 3. Specification Section Number
  - 4. Equipment tag number.
  - 5. Owner's name.
  - 6. Project number and name.
  - 7. Date.
- C. Table of Contents: General description of information provided within each tab section.
- D. Equipment Summary Form: Completed form as specified in Appendix A of this Section.
- E. Equipment Maintenance Summary Form: Completed form as specified in Appendix B of this Section.
- F. Electric Motor Technical Data Form: Completed form as specified in Appendix C of this Section.
- G. Description of equipment function, normal operating characteristics, and limiting conditions.
- H. Manufacturer's product data sheets:
  - 1. Where printed material covers more than 1 specific model, indicate the model number, calibrated range, and other special features.
- I. Assembly, installation, alignment, adjustment, and checking instructions.
- J. Storage instructions: Control diagrams:
  - 1. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer-based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
  - 2. Complete set of 11-inch by 17-inch drawings of the control system.

3. Complete set of control schematics.
- K. Programming: Copies of Contractor furnished programming.
- L. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.
- M. Operating procedures:
1. Step-by-step instructions including but not limited to the following:
    - a. Safety precautions.
    - b. Guidelines.
    - c. Manual keyboard entries.
    - d. Entry codes.
    - e. System responses.
    - f. Other information as needed for safe system operation and maintenance.
  2. Modes:
    - a. Startup.
    - b. Routine and normal operation.
    - c. Regulation and control.
    - d. Shutdown under specified modes of operation.
    - e. Emergency operating shutdown.
- N. Preventative maintenance procedures:
1. Recommended steps and schedules for maintaining equipment.
  2. Troubleshooting.
- O. Lubrication information: Required lubricants and lubrication schedules.
- P. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.
- Q. Parts list:
1. Complete parts list for equipment including but not limited to the following information:
  2. Catalog data: Generic title and identification number of each component part of equipment.
  3. Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
  4. Availability.
  5. Service locations.
- R. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.
- S. Engineering data:
1. Drawings: Complete set of 11-inch by 17-inch equipment drawings.
  2. Exploded view or plan and section views with detailed callouts.
  3. Outline, cross-section, and assembly drawings.
  4. System drawings: Provide interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.

5. Packaged equipment system drawings: Provide instrumentation loop drawing, control schematic diagrams, interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.
  6. System drawings and data sheets: Include drawings and data furnished by the Engineer and the Supplier; provide "as installed" version.
  7. Provide electrical and instrumentation schematic record drawings.
- T. Test data and performance curves, when applicable.
- U. Manufacturer's technical reference manuals.
- V. Source (factory) Test results: Provide copies of Source Tests reports as specified in technical sections.
- W. Functional Test results: After Functional Tests are completed, insert Functional Test reports as specified in technical sections.

#### **1.06 ARCHIVAL DOCUMENTATION**

- A. Typically does not require updating to remain valid and should be stored in a format that preserves the document and limits one's ability to make changes.
- B. Types of archival documents include the following:
1. Record drawings.
  2. Reports.
  3. Specifications.
  4. Shop drawings.
  5. Vendor Equipment O&M Manuals.
  6. Photos.
  7. Demonstration and training videos.
  8. Other.

#### **1.07 LIVING DOCUMENTATION**

- A. Requires periodic updates to remain valid and should be stored in formats that are easy to update.
- B. Types of living documents include the following:
1. Facility O&M Manuals.
  2. Standard Operating Procedures.
  3. Other.

## **PART 2    PRODUCTS**

Not Used.

## **PART 3    EXECUTION**

Not Used.

END OF SECTION

APPENDIX A  
EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM \_\_\_\_\_
2. MANUFACTURER \_\_\_\_\_
3. EQUIPMENT IDENTIFICATION NUMBER(S) \_\_\_\_\_  
(maps equipment number)
4. LOCATION OF EQUIPMENT \_\_\_\_\_
5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- NAMEPLATE DATA -
  - Horsepower \_\_\_\_\_
  - Amperage \_\_\_\_\_
  - Voltage \_\_\_\_\_
  - Service Factor (S.F.) \_\_\_\_\_
  - Speed \_\_\_\_\_
  - ENC Type \_\_\_\_\_
  - Capacity \_\_\_\_\_
  - Other \_\_\_\_\_
7. MANUFACTURER'S LOCAL REPRESENTATIVE  
Name \_\_\_\_\_  
Address \_\_\_\_\_  
Telephone Number \_\_\_\_\_
8. MAINTENANCE REQUIREMENTS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
9. LUBRICANT LIST \_\_\_\_\_  
\_\_\_\_\_
10. SPARE PARTS (recommendations) \_\_\_\_\_  
\_\_\_\_\_
11. COMMENTS \_\_\_\_\_



APPENDIX B  
**EQUIPMENT MAINTENANCE SUMMARY**

1. Equipment Item: \_\_\_\_\_
2. Manufacturer: \_\_\_\_\_
3. Serial No. (if applicable): \_\_\_\_\_
4. Manufacturer's Order No. (if applicable): \_\_\_\_\_
5. Nameplate Data (horsepower, voltage, speed, etc.): \_\_\_\_\_  
\_\_\_\_\_

6. Manufacturer's Local Representative:

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone: \_\_\_\_\_

7. Maintenance Requirements:

Maintenance Operation	Frequency	Lubricant (if applicable)	Comments
(List each operation required. Refer to specific information in Manufacturer's Manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

8. Lubricant List:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 7 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

9. Spare Parts: (Include recommendation on what spare parts should be kept on the job):

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APPENDIX C  
ELECTRIC MOTOR TECHNICAL DATA

Technical Data for Each Motor:

Application: \_\_\_\_\_

Manufacturer: \_\_\_\_\_

Frame No.: \_\_\_\_\_ Type: \_\_\_\_\_

Code Letter: \_\_\_\_\_ Design Letter: \_\_\_\_\_

Rating:

Horsepower: \_\_\_\_\_ Voltage: \_\_\_\_\_ Phase: \_\_\_\_\_

Cycles: \_\_\_\_\_ Full Load rpm: \_\_\_\_\_  
(wound rotor secondary)

Volts: \_\_\_\_\_ Amperes: \_\_\_\_\_

Full Load Current: \_\_\_\_\_ amperes

Locked Rotor Current: \_\_\_\_\_ amperes

Locked Rotor or Starting Torque (percent of full load): \_\_\_\_\_ percent

Full Load Torque: \_\_\_\_\_ ft-lb

Breakdown Torque: \_\_\_\_\_ percent

Efficiency:

Full Load: \_\_\_\_\_ percent

3/4 Load: \_\_\_\_\_ percent

1/2 Load: \_\_\_\_\_ percent

Power Factor:

Full Load \_\_\_\_\_ percent

3/4 Load: \_\_\_\_\_ percent

1/2 Load: \_\_\_\_\_ percent

Insulation:

Type: \_\_\_\_\_

Class: \_\_\_\_\_

Temperature Rise: \_\_\_\_\_ Above Ambient: \_\_\_\_\_

Enclosure: \_\_\_\_\_

Net Weight: \_\_\_\_\_ lbs

Wk<sup>2</sup>: \_\_\_\_\_ lbs/sq ft

Type of Bearings: \_\_\_\_\_

Service Factor: \_\_\_\_\_

Noise Level in Decibels: \_\_\_\_\_

Heaters: \_\_\_\_\_ kW, \_\_\_\_\_ Phase, \_\_\_\_\_ volts

Altitude: \_\_\_\_\_



## **SECTION 01783**

### **WARRANTIES AND BONDS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Warranty and bonds requirements.

##### **1.02 SUBMITTALS**

- A. For each item of material or equipment furnished under the Contract:
  - 1. Submit form of manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
  - 2. Submit form of manufacturer's special warranty when specified.
- B. Provide consolidated warranties and bonds within 15 calendar days of Substantial Completion.
  - 1. Contents:
    - a. Organize warranty and bond documents:
      - 1) Include Table of Contents organized by specification section number and the name of the product or work item.
    - b. Include each required warranty and bond in proper form, with full information, are certified manufacturer as required, and are properly executed by Contractor, or subcontractor, supplier, or manufacturer.
    - c. Provide name, address, phone number, and point of contact of manufacturer, supplier, and installer, as applicable.
  - 2. Hardcopy format:
    - a. Submit 2 copies.
    - b. Assemble in 3 D-side ring binders with durable cover.
    - c. Identify each binder on the front and spine with typed or printed title "Warranties and Bonds"; Project Name or Title, and the Name Address and Telephone Number of the Contractor.
  - 3. Electronic copy in PDF format:
    - a. Submit 1 copy.

##### **1.03 OWNER'S RIGHTS**

- A. Owner reserves the right to reject warranties.
- B. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

##### **1.04 RELATIONSHIP TO GENERAL WARRANTY AND CORRECTION PERIOD**

- A. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both Contractor's general warranty and the correction period requirements.

- B. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor's general warranty, nor does such affect or limit Contractor's performance obligations under the correction period.

#### **1.05 MANUFACTURER'S WARRANTY MINIMUM REQUIREMENTS**

- A. Written warranty issued by item's manufacturer.
- B. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner.
- C. Covers all costs associated with the correction of the defect, including but not limited to removal of defective parts, new parts, labor, and shipping.
  - 1. When correcting warranted Work that has failed, remove and replace other Work that had been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- D. Provides a timely response to correct the defect.
  - 1. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.
  - 2. In the case that Owner has to provide temporary equipment to replace function of warranted item requiring repair or replacement, manufacturer shall reimburse Owner for such costs associated with the temporary equipment.
- E. Warranty commence running on the date of substantial completion.
  - 1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.
- F. Duration of Warranty: 1 year.

#### **1.06 MANUFACTURER'S SPECIAL WARRANTY**

- A. Manufacturer's special warranty is a written warranty published by the manufacturer which includes the requirements specified in the section where the item is specified.
  - 1. Includes Project-specific information and requirements, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner. Technical sections indicate Project-specific requirements that differ from the minimum warranty requirements for that item.
    - a. Examples include extending the duration of manufacturer's warranty or to provide increased rights to Owner.

#### **1.07 WARRANTY WORK**

- A. Contractor's responsibilities:
  - 1. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the product, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

- B. Replacement cost:
  - 1. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of the Contract Documents.
    - a. Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.
- C. Related damages and losses:
  - 1. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
- D. Owner's recourse:
  - 1. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.
- E. Reinstatement of warranty:
  - 1. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
    - a. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

## **1.08 IMPLIED WARRANTIES**

- A. Warranty of title and intellectual rights:
  - 1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
  - 2. Provisions on intellectual rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.
- B. Implied warranties: Duration in accordance with Laws and Regulations.

## **1.09 BONDS**

- A. Bond requirements as specified in the technical sections.
- B. Bonds commence running on the date of substantial completion.
  - 1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of bond period.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## **SECTION 03055**

### **ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives.

##### **1.02 REFERENCES**

- A. American Concrete Institute (ACI).
  - 1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.
- B. American National Standards Institute (ANSI):
  - 1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.
- C. ASTM international (ASTM):
  - 1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- D. Concrete Reinforcing Steel Institute (CRSI).
- E. ICC Evaluation Service, Inc. (ICC-ES):
  - 1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- F. Society for Protective Coatings (SSPC):
  - 1. SP-1 - Solvent Cleaning.

##### **1.03 DEFINITIONS**

- A. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

##### **1.04 SUBMITTALS**

- A. Product data: Technical data for adhesives, including:
  - 1. Manufacturer's printed installation instructions (MPII).
  - 2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
  - 3. Handling and storage instructions.

- B. Quality control submittals:
  - 1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01410 - Regulatory Requirements.
  - 2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
  - 3. Installer qualifications:
    - a. Submit evidence of successful completion of adhesive manufacturer's installation training program.
    - b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.
- C. Inspection and testing reports:
  - 1. Inspections: Field quality control: Reports of inspections and tests.
    - a. Inspections: Field quality assurance: Reports of special inspections and tests.

## **1.05 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. Installation requirements:
    - a. Have available at the site, and install anchors in accordance with, the adhesive manufacturer's printed installation instructions.
  - 2. Installer qualifications:
    - a. Demonstrating successful completion of adhesive manufacturer's onsite training program for installation of adhesive-bonded anchors.
    - b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the Building Official.
      - 1) Organizations/certification programs deemed to be qualified are:
        - a) ACI-CRSI Adhesive Anchor Installer Certification Program.
        - b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the Building Official.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
  - 1. Store adhesives and adhesive components on pallets or shelving in a covered storage area protected from weather.
  - 2. Control temperature to maintain storage within manufacturer's recommended temperature range.
    - a. If products have been stored at temperatures outside manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
  - 3. Dispose of products that have passed their expiration date.

## **1.07 PROJECT CONDITIONS**

- A. As specified in Section 01610 - Project Design Criteria.
- B. Seismic Design Category (SDC) for structures is indicated on the Drawings.



## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.
- B. Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements of ACI 308.4 and of ICC-ES ECR-1090 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.
- C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

### **2.02 EPOXY ADHESIVE**

- A. Materials:
  - 1. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
  - 2. 2-component, 100 percent solids, insensitive to moisture.
  - 3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.
- B. Packaging:
  - 1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
    - a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
    - b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
  - 2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- C. Manufacturers: One of the following or equal:
  - 1. Hilti, Inc., HIT-RE 500-V3.
  - 2. Simpson Strong-Tie Co., Inc., SET-XP.

### **2.03 ACRYLIC AND HYBRID ADHESIVE**

- A. Materials:
  - 1. 2-component, high-solids, acrylic-based or hybrid acrylic and epoxy-based adhesive.
  - 2. Approved by the manufacturer for installation at substrate temperatures of 0 degrees Fahrenheit and above.

- B. Packaging:
  - 1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
  - 2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- C. Manufacturers: One of the following or equal:
  - 1. Hilti, Inc., HIT-HY-200.
  - 2. Simpson Strong-Tie Co., Inc., AT-XP.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official.
  - 1. Do not install holes or adhesive until training is complete.
- B. Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.
- C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
  - 1. If embedment depth is not indicated, contact Engineer for requirements.
  - 2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by Engineer.

### **3.02 PREPARATION**

- A. Do not begin installation of adhesive bonded anchors until:
  - 1. Concrete has achieved an age of at least 21 days after placement.
  - 2. On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.
- B. Review manufacturer's printed installation instructions (MPII) and "conditions of use" stipulated in the Evaluation Report before beginning work.
  - 1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents, and resolve before proceeding with installation.
- C. Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed

manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

- D. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions, and will remain so during the curing time for the product.

### **3.03 HOLE SIZING AND INSTALLATION**

- A. Drilling holes:
  - 1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
  - 2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by Engineer.
- B. Hole drilling equipment:
  - 1. Electric or pneumatic rotary impact type with medium or light impact.
    - a. Installation of anchors in cored holes is not permitted.
    - b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.
    - c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
  - 2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a "condition of use" in the Evaluation Report.
    - a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
- C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.
- D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.
- E. Obstructions in drill path:
  - 1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
    - a. Obtain Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
    - b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
    - c. Epoxy grout may be substituted for dry-pack mortar when accepted by Engineer.
  - 2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.

3. When existing reinforcing steel is encountered during drilling and when specifically accepted by Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
  4. Bent bar reinforcing bars: Where edge distances are critical, and interference with existing reinforcing steel is likely, if acceptable to Engineer, drill hole at 10-degree (or less) angle from axis of reinforcing bar or all thread rod being installed.
- F. Cleaning holes:
1. Insert air nozzle to bottom of hole and blow out loose dust.
    - a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
    - b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
  2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
    - a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
    - b. Repeat at least 4 times.
  3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
  4. Leave prepared holes clean and dry.
  5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
  6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

### **3.04 INSTALLATION OF ADHESIVE AND INSERTS**

- A. Clean and prepare inserts reinforcing bars and all thread rods:
1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
  2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.
- B. Fill holes with adhesive:
1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
  2. Fill hole as nozzle is withdrawn without creating air voids.
  3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
  4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.
- C. Installing reinforcing bars and all thread rods.

1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
  2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer's recommended procedures.
  3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
  4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
  5. Clean excess adhesive from the mouth of the hole.
- D. Curing and loading.
1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
  2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

### **3.05 POST-INSTALLATION ACTIVITIES**

- A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.
- B. Attachments to all thread rods:
1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.

### **3.06 FIELD QUALITY CONTROL**

- A. Provide field quality control over the Work of this Section as specified in Section 01450 - Quality Control.
- B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.
- C. Manufacturer's services:
1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
    - a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
  2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.
- D. Field inspections and testing:
1. Hole drilling and preparation.
  2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

### 3.07 FIELD QUALITY ASSURANCE

- A. Provide field quality assurance over the Work of this Section as specified in Section 01450 - Quality Control.
- B. Special inspections, special tests, and structural observation:
  - 1. Provide as specified in Section 01455B - Special Tests and Inspections Provided by Owner.
  - 2. Frequency of inspections:
    - a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
    - b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
    - c. Provide continuous inspection of all drilling, cleaning and bonding activities for bars and rods installed in horizontal and upwardly inclined positions.
  - 3. Preparation:
    - a. Review Drawings and Specifications for the Work to be observed.
    - b. Review adhesive manufacturer's MPII and recommended installation procedures.
    - c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
  - 4. Inspection: Periodic:
    - a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
      - 1) Concrete: Class (minimum specified compressive strength) and thickness.
      - 2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
      - 3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "conditions of use" listed in the Evaluation Report.
      - 4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
      - 5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
    - b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
      - 1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.

- 2) For ongoing installations, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.
5. Inspection: Continuous.
  - a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.
6. Records of inspections:
  - a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.  
Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION





## **SECTION 04055**

### **ADHESIVE BONDED REINFORCING BARS AND ALL THREAD RODS IN MASONRY**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: Bonding reinforcing bars and all thread rods in masonry using injectable, 2-component adhesive.

##### **1.02 REFERENCES**

- A. American National Standards Institute (ANSI):
  - 1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.
- B. ICC Evaluation Service, Inc. (ICC-ES):
  - 1. AC58 - Acceptance Criteria for Adhesive Anchors in Masonry Elements.
- C. Society for Protective Coatings (SSPC):
  - 1. Surface Preparation Standards (SP).
    - a. SP-1 - Solvent Cleaning.

##### **1.03 DEFINITIONS**

- A. Evaluation Report: Report prepared by ICC-ES, or by other testing agency acceptable to the Engineer and to the Authority Having Jurisdiction, that documents testing and review of the adhesive product to confirm that it conforms to the requirements of ICC-ES AC58.

##### **1.04 SUBMITTALS**

- A. Product data: Furnish technical data for adhesives, including:
  - 1. Independent testing laboratory results indicating allowable loads in tension and shear for masonry walls of the types included in the Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
  - 2. Handling and storage instructions.
  - 3. Installation instructions.
- B. Quality control submittals:
  - 1. Special inspection: Detailed instructions for special inspection to comply with the building code specified in Section 01410 - Regulatory Requirements.
  - 2. Evaluation Report confirming that the product complies with the requirements of ICC-ES AC58.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect as follows, unless manufacturer has more stringent requirements:
  - 1. Store adhesive components on pallets or shelving in a covered-storage area protected from weather.
  - 2. Control temperature to maintain storage within manufacturer's recommended temperature range.
    - a. If products are stored at temperatures outside manufacturer's recommended range, test components prior to use by methods acceptable to the Engineer to determine if the products still meet specified requirements.
  - 3. Dispose of products that have passed their expiration date.

## **1.06 PROJECT CONDITIONS**

- A. Seismic design category: As specified in Section 01610 - Project Design Criteria.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. Like items of materials: Use end products of one manufacturer to achieve structural compatibility and single-source responsibility.

### **2.02 ADHESIVE FOR SELF-CONTAINED CARTRIDGE SYSTEM**

- A. Adhesive shall have a current Evaluation Report demonstrating compliance with the requirements of ICC-ES AC58.
- B. Materials:
  - 1. 2-component structural adhesive, insensitive to moisture, and gray in color.
  - 2. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.
- C. Packaging:
  - 1. Furnished in disposable, side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
    - a. Nozzle designed to thoroughly blend the components, in the proper mixing ratio, for injection from the nozzle directly into prepared hole.
    - b. Provide nozzle extensions as required to allow full-depth insertion and filling from the bottom of the hole.
  - 2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- D. For installation in solid masonry and solid-grouted masonry (concrete or brick):
  - 1. Manufacturers: One of the following or equal:
    - a. Hilti, Inc., HY-270 Adhesive Anchor System.
    - b. Simpson Strong-Tie Co., Inc., ET-HP Anchoring Adhesive.
    - c. USP Structural Connectors, CIA-GEL 7000 Masonry Epoxy Adhesive.

- E. For installation in un-grouted and partially grouted masonry (concrete or brick) and in masonry containing voids or holes (concrete or brick):
  - 1. Manufacturers: The following or equal:
    - a. Hilti, Inc., HY-270 Adhesive Anchor System.
      - 1) Provide manufacturer's plastic mesh sleeve for bonding reinforcing bar(s) or all thread rod(s) of the size and embedment indicated on the Drawings.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Unless otherwise required for "conditions of use" in the Evaluation Report submitted, prepare and install holes, adhesive, and inserts (all thread rods or reinforcing bars) in accordance with the manufacturer's recommendations and this Section.
  - 1. In the event of conflicts, the more restrictive provisions shall govern.
- B. Do not install adhesive-bonded all-thread rods or reinforcing bars in upwardly inclined and overhead applications.

### **3.02 PREPARATION**

- A. Prior to completing manufacturer's on-site training specified in this Section, do not:
  - 1. Drill holes for reinforcing bars or all thread rods.
  - 2. Mix or install adhesive in holes.
- B. Review manufacturer's installation instructions and "conditions of use" stipulated in the Evaluation Report before beginning work.
- C. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended temperature range, and will remain so during the cure time for the product.

### **3.03 HOLE LAYOUT AND INSTALLATION**

- A. Drilling holes:
  - 1. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device. Mark locations with on the surface of the masonry using removable construction crayon, or other method acceptable to the Engineer.
  - 2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the masonry without prior acceptance by Engineer.
- B. Hole drilling equipment:
  - 1. Electric or pneumatic rotary impact type.
    - a. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with manufacturer's installation instructions and the requirements of the Evaluation Report.
  - 2. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and spalling from drilling.

3. Drill bits: Carbide-tipped in accordance with ANSI B212-15.
  4. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
- C. Hole diameter: As recommend in the manufacturer's installation instructions and the Evaluation Report.
- D. Hole depth: As recommended by the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.
- E. Obstructions in drill path:
1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill to the required depth.
    - a. Allow dry-pack mortar to cure to strength equal to that of the surrounding masonry before resuming drilling in that area.
    - b. Epoxy grout may be substituted for dry-pack mortar when acceptable to the Engineer.
  2. Avoid drilling an excessive number of adjacent holes that would weaken the structural member and endanger the stability of the structure. Obtain Engineer's acceptance of distance between abandoned and relocated holes.
- F. Cleaning holes:
1. Insert air nozzle to bottom of hole and blow out loose dust.
    - a. Use compressed air that is free of oil, water, or other contaminants.
    - b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
  2. Using a stiff bristle brush of diameter that provides contact around the full perimeter of the hole, vigorously brush the hole to dislodge compacted drilling dust.
    - a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
    - b. Repeat at least 4 times.
  3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and as required by the manufacturer and the Evaluation Report.
  4. Leave prepared hole clean and dry.

### **3.04 INSTALLATION OF ADHESIVE AND INSERTS**

- A. Clean and prepare inserts:
1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. The inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
  2. Solvent-clean prepared reinforcing bars and all thread rods over their embedment length in accordance with SSPC SP-1. Provide an oil and grease-free surface for bonding of adhesive to steel.
- B. Fill holes with adhesive: Solid or solid-grouted masonry:
1. Starting at the bottom of the hole, fill hole with adhesive before inserting the reinforcing bar or all thread rod.
  2. Fill hole without creating air voids as nozzle is withdrawn.

3. Fill hole with sufficient adhesive so that excess is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole.
  4. Where metal or plastic screens are required for use in masonry (units with hollow cells or holes, and multi-wythe brick walls), fill screen with adhesive and insert into hole in accordance with manufacturer's recommendations.
- C. Fill holes with adhesive: Masonry with holes or un-grouted cells.
1. Provide manufacturer's mesh screen tubes (steel or plastic mesh), fill with adhesive, and install in compliance with manufacturer's instructions.
- D. Install reinforcing bars and all thread rods:
1. Install to depth, spacing, and locations as indicated on the Drawings.
  2. Insert bars and all thread rods into hole in accordance with manufacturer's recommended procedures. Confirm that insert has reached the designated embedment in the hole and that adhesive completely surrounds the embedded portion.
  3. Clean excess adhesive from the mouth of the hole.
- E. Curing and loading:
1. Provide curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the actual temperature of the masonry.
  2. Do not disturb or load anchors until manufacturer's recommended cure time has elapsed.

### **3.05 FIELD QUALITY CONTROL**

- A. Contractor shall provide field quality control as specified in Section 01450 - Quality Control.
- B. Manufacturers' services:
1. Before beginning installation, furnish adhesive manufacturer's representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
    - a. Provide notice of training to Engineer and Special Inspector not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
  2. Submit record, signed by the Engineer, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.
  3. Do not install holes or adhesive until training is complete.

### **3.06 FIELD QUALITY ASSURANCE**

- A. Owner will provide on-site inspection and field quality assurance.
- B. Special inspection:
1. As specified in Section 01455B - Special Tests and Inspections Provided by Owner.
  2. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the "Conditions of Use" in the Evaluation Report for the product installed.

3. Provide a written record of each inspection using form acceptable to the Engineer and the Authority Having Jurisdiction.
4. Preparation:
  - a. Review drawings and specifications for the Work being observed.
  - b. Review adhesive manufacturer's recommended installation and evaluation report's special inspection procedures.
5. Provide an initial inspection by for each combination of masonry type and reinforcing bar or all thread rod being installed. During initial inspection, observe the following for compliance with installation requirements. Furnish report of inspection that includes the following items.
  - a. Masonry construction: Type and thickness; whether fully or partially grouted; locations and types of voids and holes in units.
  - b. Environment: Temperature and moisture conditions of masonry base material and work area.
  - c. Holes: Locations, spacing, edge distances; verification of drill bit compliance with ANSI B212.15; cleaning equipment and procedures; cleanliness of hole. Before placing adhesive, confirm that depth and preparation of holes conforms to requirements of the Contract Documents, installation recommendations of the manufacturer, and "conditions of use" specified in the Evaluation Report.
  - d. Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedures. Note initial set times observed during installation.
  - e. Embedded reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment.
6. Subsequent installations of the same reinforcing bars or threaded rods in the same masonry may be performed without the presence of the special inspector, provided that:
  - a. There is no change in the personnel performing the installation, the type or details of the masonry receiving the insert, the adhesive or the reinforcing bars and all thread rods being used. Changes in any of these items shall require a new initial inspection.
  - b. For ongoing installations over a period of time, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.

END OF SECTION

## SECTION 05190

### MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

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## **PART 1    GENERAL**

### **1.01    SUMMARY**

- A. Section includes:
  - 1. Cast-in anchors and fasteners:
    - a. Anchor bolts.
    - b. Anchor rods.
    - c. Concrete inserts.
  - 2. Post-installed steel anchors and fasteners:
    - a. Concrete anchors.
    - b. Screw anchors.
    - c. Undercut concrete anchors.
  - 3. Appurtenances for anchoring and fastening:
    - a. Anchor bolt sleeves.
    - b. Isolating sleeves and washers.
    - c. Thread coating for threaded stainless steel fasteners.

### **1.02    REFERENCES**

- A. American Concrete Institute (ACI):
  - 1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.
- B. American National Standards Institute (ANSI):
  - 1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.
- C. American Welding Society (AWS):
  - 1. D1.1 - Structural Welding Code - Steel.
  - 2. D1.6 - Structural Welding Code - Stainless Steel.
- D. ASTM International (ASTM):
  - 1. A29 - Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for.
  - 2. A36 - Standard Specification for Carbon Structural Steel.
  - 3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 4. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
  - 5. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 6. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 7. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  - 8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
  - 9. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
  - 10. A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.



11. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
  12. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
  13. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
  14. F436 - Standard Specification for Hardened Steel Washers.
  15. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
  16. F594 - Standard Specification for Stainless Steel Nuts.
  17. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
  18. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
- E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
  2. AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry.
  3. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

### 1.03 DEFINITIONS

- A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.
- B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.
- C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.
- D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.
- E. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.
- F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
  1. Corrosive locations: Describes interior and exterior locations as follows:
    - a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
    - b. Exterior and interior locations at the following treatment structures:
      - 1) Wastewater treatment facilities: Liquids stream:
        - a) Raw wastewater delivery and holding structures.
        - b) Headworks and grit facilities.
        - c) Primary clarifiers and primary clarifier flow splitting boxes.
        - d) Chlorine contact structures.

- 2) Wastewater treatment facilities: Solids stream:
  - a) Sludge holding and thickening tanks.
  - b) Digesters.
  - c) Dewatering facilities.
2. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
  - a. Exterior portions of buildings and structures.
  - b. Liquid-containing structures:
    - 1) Locations at and below the maximum operating liquid surface elevation.
    - 2) Locations above the maximum operating liquid surface elevation and:
      - a) Below the top of the walls containing the liquid.
      - b) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).
  - c. Liquid handling equipment:
    - 1) Bases of pumps and other equipment that handles liquids.
  - d. Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
  - e. Other locations indicated on the Drawings.
3. Other locations:
  - a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

#### 1.04 SUBMITTALS

- A. General:
  1. Submit as specified in Section 01330 - Submittal Procedures.
  2. Submit information listed for each type of anchor or fastener to be used.
- B. Action submittals:
  1. Product data:
    - a. Cast-in anchors:
      - 1) Manufacturer's data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
    - b. Post-installed anchors:
      - 1) For each anchor type, manufacturer's data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
  2. Samples:
    - a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.
  3. Certificates:
    - a. Cast-in anchors:
      - 1) Mill certificates for steel anchors that will be supplied to the site.
    - b. Post-installed anchors:
      - 1) Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.

4. Test reports:
  - a. Post-installed anchors: For each anchor type used for the Work:
    - 1) Current ICC-ES Report (ESR) demonstrating:
      - a) Acceptance of that anchor for use under the building code specified in Section 01410 - Regulatory Requirements.
      - b) That testing of the concrete anchor included the simulated seismic tension and shear tests of AC193, and that the anchor is accepted for use in Seismic Design Categories C, D, E, or F and with cracked concrete.
5. Manufacturer's instructions:
  - a. Requirements for storage and handling.
  - b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
  - c. Requirements for inspection or observation during installation.
6. Qualification statements:
  - a. Post-installed anchors: Installer qualifications:
    - 1) Submit list of personnel performing installations and include date of manufacturer's training for each.

## **1.05 QUALITY ASSURANCE**

- A. Qualifications:
  1. Post installed anchors shall be in accordance with building code specified in Section 01410 - Regulatory Requirements.
  2. Installers: Post-installed mechanical anchors:
    - a. Conduct a training session with the manufacturer's authorized technical representative for the project on-site:
      - 1) Training shall cover the complete installation process for each type of anchor to be used and shall include, but not be limited to, hole drilling procedures and techniques, hole preparation and cleaning, bolt installation, and bolt proof loading and torquing.
      - 2) Use only trained and qualified personnel for anchor installation.
- B. Special inspection:
  1. Provide special inspection of post-installed anchors as specified in Section 01455B - Special Tests and Inspections Provided by Owner and this Section.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.
- B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.
- C. Protect anchors from weather and moisture until installation.

## **1.07 PROJECT CONDITIONS**

- A. As specified in Section 01610 - Project Design Criteria.

- B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURED UNITS**

- A. General:
1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
    - a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
    - b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
  2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact Engineer for clarification.
  3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
- B. Materials:
1. Provide and install anchors of materials as in this Section.

### **2.02 CAST-IN ANCHORS AND FASTENERS**

- A. Anchor bolts:
1. Description:
    - a. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
    - b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer.
      - 1) Rods or bars with angle bend for embedment in concrete (i.e., "L" or "J" shaped anchor bolts) are not permitted in the Work.
  2. Materials:
    - a. Ship anchor bolts with properly fitting nuts attached.
    - b. Type 316 stainless steel:
      - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
      - 2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
      - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
      - 4) Washers: Type 316 stainless steel.
    - c. Type 304 stainless steel:
      - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
      - 2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
      - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.

- 4) Washers: Type 304 stainless steel.
- d. Galvanized steel:
  - 1) Hot-dip galvanized coating in accordance with ASTM F2329.
  - 2) Bolt: ASTM F1554, Grade 36, Grade 55, heavy hex, coarse thread.
  - 3) Nuts: ASTM A563, Grade A, heavy hex, threads to match bolt.
  - 4) Washers: ASTM F436, Type 1.

B. Anchor rods:

- 1. Description: Straight steel rod having threads on each end or continuously threaded from end to end. One threaded end is fitted with nuts or plates and embedded in concrete to the effective depth indicated on the Drawings, leaving the opposite threaded end to project clear of the concrete face as required for the connection to be made at that location.
- 2. Materials:
  - a. Stainless steel: Type 316:
    - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
    - 2) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
    - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
    - 4) Washers: Type 316 stainless steel.
    - 5) Plates (embedded): ASTM A240.
  - b. Stainless steel: Type 304:
    - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
    - 2) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
    - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads or rods.
    - 4) Washers: Type 304 stainless steel.
    - 5) Plates (embedded): ASTM A240.
  - c. Galvanized: steel:
    - 1) Hot-dip galvanized with coating in accordance with ASTM F2329.
    - 2) Rod: ASTM F1554, Grade 36, Grade 55, coarse thread.
    - 3) Nuts: ASTM A563, Grade A, threads to match rod.
    - 4) Washers: ASTM F436, Type 1.
    - 5) Plates (embedded): ASTM A36.

C. Concrete insert: Ductile embed:

- 1. Description: 1-piece, integrally hot forged sleeve for embedment in concrete. Provided with flange for nailing to forms and female threaded coupler at the exposed concrete face, and washer-faced hex headed foot to resist pullout from concrete at the embedded end.
- 2. Manufacturers: The following or equal:
  - a. Dayton Superior, F-54 Ductile Embed Insert.
- 3. Materials:
  - a. Stainless steel: Not available.
  - b. Galvanized steel:
    - 1) Hot-dip galvanized coating in accordance with ASTM A123 or A153.
    - 2) Steel: ASTM A29 hot rolled, Grade 1045.

## **2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE**

- A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete:  
As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.
- B. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in masonry:  
As specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

## **2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL**

- A. General:
  - 1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410 - Regulatory Requirements.
    - a. Conditions of use: The acceptance report shall indicate acceptance of the product for use under the following conditions:
      - 1) In regions of concrete where cracking has occurred or may occur.
      - 2) To resist short-term loads due to wind forces.
      - 3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.
  - 2. Substitutions: When requesting product substitutions, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section.
    - a. Calculations shall be prepared by and shall bear the signature and seal of a Civil or Structural Engineer licensed in the State of Utah.
    - b. Decisions regarding the acceptability of proposed substitutions shall be at the discretion of the Engineer.
- B. Concrete anchors:
  - 1. Description. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. (Sometimes referred to as "expansion anchors" or "wedge anchors.")
    - a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
  - 2. Concrete anchors for anchorage to concrete:
    - a. Acceptance criteria:
      - 1) Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      - 2) Concrete anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.

- b. Manufacturers: One of the following or equal:
    - 1) Hilti, Kwik Bolt TZ Expansion Anchor.
    - 2) DEWALT/Powers, PowerStud.
    - 3) Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.
  - c. Materials. Integrally threaded stud, wedge, washer, and nut:
    - 1) Stainless steel: Type 316.
      - a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
    - 2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
3. Concrete anchors for anchorage to concrete masonry (fully grouted cells):
- a. Acceptance criteria: Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified in accordance with ICC-ES AC01, including all mandatory tests and optional seismic tests.
  - b. Manufacturers: One of the following or equal:
    - 1) Hilti, Kwik Bolt 3 Expansion Anchor.
    - 2) DEWALT/Powers, Power-Stud+ SD1.
    - 3) Simpson Strong-Tie, Wedge-All Anchor.
  - c. Materials. Integrally threaded stud, wedge, washer, and nut:
    - 1) Stainless steel: Type 316.
      - a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
    - 2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or mechanically galvanized in accordance with ASTM B695, Class 55, Type 1.

C. Flush shells:

- 1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
- 2. Flush shell anchors are not permitted in the Work.

D. Screw anchors:

- 1. Description: Post-installed concrete anchor that develops tensile strength from mechanical interlock provided by creating a helical "key" that is larger than the diameter of the bolt itself along the length of the anchor shaft.
- 2. Screw anchors for anchorage to concrete:
  - a. Acceptance criteria:
    - 1) Screw anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and ICC ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
    - 2) Screw anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.

- b. Manufacturers: Screw anchor: One of the following or equal:
      - 1) Hilti, Hex head, HUS-EZ Screw Anchor:
        - a) With internally threaded head: HUS-EZ I Hanger Anchor.
      - 2) DEWALT/Powers, Screwbolt+ Screw Anchor:
        - a) With internally threaded head: Vertigo+ Rod Hanging System.
      - 3) Simpson Strong-Tie, Titen® HD Screw Anchor:
        - a) With internally threaded head: Titen® HD Rod Hanger.
    - c. Materials:
      - 1) Stainless steel: Not available.
      - 2) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or equal.
  - 3. Screw anchors for anchorage to concrete masonry (fully grouted only):
    - a. Acceptance criteria:
      - 1) Acceptance criteria. Screw anchors shall have a current ICC-ES Report demonstrating that anchors have been tested and qualified for performance in masonry, including short-term loading due to wind and seismic forces in accordance with ICC-ES AC106.
    - b. Manufacturers: One of the following or equal:
      - 1) Hilti, HUS-EZ Screw Anchor.
      - 2) Simpson Strong-Tie, Titen® HD Screw Anchor.
      - 3) DEWALT/Powers: Screwbolt+ Screw Anchor.
    - c. Materials:
      - 1) Stainless steel: Not available.
      - 2) Galvanized steel: Carbon steel. Zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5); or mechanically galvanized in accordance with ASTM B695; Class 55, Type I.
- E. Undercut concrete anchors:
  - 1. Description: Post-installed concrete anchor that develops tensile strength from mechanical interlock provided by creation of an undercut “key” at the embedded end of the anchor. The undercut may be achieved with a special drill before anchor installation, or by the anchor itself during installation.
  - 2. Acceptance criteria:
    - a. Acceptance criteria:
      - 1) Undercut concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and ICC ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      - 2) Undercut anchor performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
    - b. Use pre-setting units. Through-setting units are not allowed unless prior written acceptance for specific locations is obtained from the Engineer.
  - 3. Manufacturers: One of the following or equal:
    - a. Hilti, HDA (carbon steel) or HDA-R (stainless steel) Undercut Anchor.
    - b. Powers Fasteners, Atomic+ Undercut Anchor.
    - c. Simpson Strong-Tie, Torq-Cut Anchor.
    - d. USP Structural Connectors, DUC-L Undercut Anchors.
  - 4. Materials:
    - a. Stainless steel: Corrosive, wet, and moist and locations: Type 316.



- b. Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

## 2.05 APPURTENANCES FOR ANCHORING AND FASTENING

- A. Anchor bolt sleeves:
  - 1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
  - 2. Plastic sleeves:
    - a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
    - b. Manufacturers: The following or equal:
      - 1) Portland Bolt & Manufacturing Co.
    - c.
  - 3. Fabricated steel sleeves:
    - a. Fabricate to the following dimensions unless otherwise indicated on the Drawings:
      - 1) Inside diameter: At least 2 inches greater than bolt diameter.
      - 2) Inside length: Not less than 10 bolt diameters.
      - 3) Bottom plate:
        - a) Square plate with dimensions equal to the outside diameter of the sleeve plus 1/2 inch each side.
        - b) Thickness equal to or greater than one-half of the anchor bolt diameter.
    - b. Carbon steel anchor bolts:
      - 1) Fabricated from ASTM A36 plate and ASTM A53, Grade B pipe.
      - 2) Welded connections: Conform to requirements of AWS D1.1.
      - 3) Hot dip galvanized in accordance with ASTM A153.
    - c. Stainless steel anchor bolts:
      - 1) Fabricated from ASTM A240 plate and pipe. Type 304L or Type 316L to match Type of the anchor bolt.
      - 2) Welded connections: In accordance with AWS D1.6.
- B. Isolating sleeves and washers:
  - 1. Manufacturers: One of the following or equal:
    - a. Central Plastics Co.
    - b. Allied Corrosion Industries.
  - 2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
  - 3. One sleeve required for each bolt.
  - 4. Washers: The inside diameter of all washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter.
    - a. Proper size to fit bolts.
    - b. Two 1/8-inch thick steel washers for each bolt.
    - c. G3 Phenolic: 2 insulating washers are required for each bolt:
      - 1) Thickness: 1/8 inch.
      - 2) Base material: Glass.
      - 3) Resin: Phenolic.
      - 4) Water absorption: 2 percent.
      - 5) Hardness (Rockwell): 100.
      - 6) Dielectric strength: 450 volts per mil.

- 7) Compression strength: 50,000 pounds per square inch.
- 8) Tensile strength: 20,000 pounds per square inch.
- 9) Maximum operating temperature: 350 degrees Fahrenheit.
- C. Coating for repair of galvanized surfaces:
  - 1. Manufacturers: The following or equal:
    - a. Jelt, Galvinox.
- D. Thread coating: For use with threaded stainless steel fasteners:
  - 1. Manufacturers: One of the following or equal:
    - a. Bostik, Never-Seez.
    - b. Oil Research, Inc., WLR No. 111.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

### **3.02 INSTALLATION: GENERAL**

- A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.
- B. Substitution of anchor types:
  - 1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
  - 2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.
- C. Protect products from damage during installation. Take special care to protect threads and threaded ends.
- D. Accurately locate and position anchors and fasteners:
  - 1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
  - 2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.
- E. Interface with other products:
  - 1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
  - 2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

### 3.03 INSTALLATION: CAST-IN ANCHORS

#### A. General:

1. Accurately locate cast-in and built-in anchors.
  - a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
  - b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
  - c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not "stab" anchors into plastic concrete, mortar, or grout.
  - d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

#### B. Anchor bolts:

1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
2. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment. Seal top of sleeve to prevent grout from filling sleeve.

#### C. Anchor rods:

1. Install as specified for anchor bolts.

#### D. Concrete inserts:

1. Provide inserts with minimum clear concrete cover not less than that specified for reinforcing bars.

#### E. Deformed bar anchors:

1. Butt weld to steel fabrications with automatic stud welding gun as recommended by manufacturer.
2. Ensure that butt weld develops the full strength of the anchor.

#### F. Welded studs:

1. Butt weld to steel fabrications with automatic stud welding gun as recommended by the manufacturer.
2. Ensure that butt weld develops full strength of the stud.

### 3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

- #### A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

- B. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in masonry: As specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

### 3.05 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

- A. General:
1. Install anchors in accordance with the manufacturer's instructions, ACI 355.2, the anchor's ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
  2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
  3. After anchors have been positioned and inserted into concrete or masonry, do not:
    - a. Remove and reuse/reinstall anchors.
    - b. Loosen or remove bolts or studs.
- B. Holes drilled into concrete and masonry:
1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength ( $f'_c$  or  $f'_m$ ).
  2. Accurately locate holes:
    - a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
    - b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
  3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
    - a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.
  4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
  5. Drill using anchor manufacturer's recommended equipment and procedures:
    - a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
      - 1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
      - 2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.
  6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
  7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
    - a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
    - b. Repeat cleaning process as required by the manufacturer's installation instructions.

- c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

- C. Insert and tighten (or torque) anchors in full compliance with the manufacturer's installation instructions.
  1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

- D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
Nominal Diameter	Minimum Effective Embedment Length		Minimum Member Thickness
	In Concrete	In Grouted Masonry	
3/8 inch	2 1/2 inch	2 5/8 inch	8 inch
1/2 inch	3 1/2 inch	3 1/2 inch	8 inch
5/8 inch	4 1/2 inch	4 1/2 inch	10 inch
3/4 inch	5 inch	5 1/4 inch	12 inch

- E. Flush shell anchors:
  1. Flush shell anchors are not permitted in the Work.
  2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.

- F. Screw anchors:
  1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Screw Anchors			
Nominal Diameter	Minimum Effective Embedment Length		Minimum Member Thickness
	In Concrete	In Grouted Masonry	
3/8 inch	2 1/2 inch	3 1/4 inch	8 inch
1/2 inch	3 1/4 inch	4 1/2 inch	8 inch
5/8 inch	4 inch	5 inch	10 inch
3/4 inch	5 1/2 inch	6 1/4 inch	12 inch

1. Install screw anchors using equipment and methods recommended by the manufacturer. Continue driving into hole until the washer head is flush against the item being fastened.

G. Undercut concrete anchors:

1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Undercut Anchors			
Nominal Diameter (bolt)	Minimum Effective Embedment Length		Minimum Member Thickness <sup>(1)</sup>
	In Concrete	In Grouted Masonry	
M10 (3/8 inch)	100 mm (4 inch)	Not accepted	200 mm (8 inch)
M12 (1/2 inch)	125 mm (5 inch)	Not accepted	350 mm (14 inch)
M16 (5/8 inch)	190 mm (7 1/2 inch)	Not accepted	460 mm (18 inch)
M20 (7/8 inch)	250 mm (10 inch)	Not accepted	510 mm (20 inch)
Notes: (1) Thickness indicated is for pre-set units. If through-set units are accepted, obtain minimum member thickness requirements from the Engineer.			

2. Installations of undercut anchors shall not be allowed where edge distances are less than 12 times the nominal diameter of the anchor stud.
3. Undercut bottom of hole using cutting tools manufactured for this purpose by the manufacturer of the undercut anchors being placed.

### 3.06 FIELD QUALITY CONTROL

- A. Contractor shall provide quality control over the Work of this Section as specified in Section 01450 - Quality Control.
  1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.
- B. Post-installed anchors:
  1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
  2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
  3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

### 3.07 FIELD QUALITY ASSURANCE

- A. Owner will provide on-site observation and field quality assurance for the Work of this Section.
  1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.
- B. Field inspections and special inspections:
  1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer's installation instructions for the products used.

2. Record of inspections:
    - a. Maintain record of each inspection.
    - b. Submit copies to Engineer upon request.
  3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.
- C. Special inspections: Anchors cast into concrete and built into masonry.
1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
    - a. Anchor bolts.
    - b. Anchor rods.
    - c. Concrete inserts (all types).
  2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
    - a. Anchor:
      - 1) Type and dimensions.
      - 2) Material: Galvanized steel, Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
      - 3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
      - 4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
  3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
    - a. Base material (concrete or grouted masonry):
      - 1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
      - 2) Material encapsulating embedment is dense and well-consolidated.
- D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
1. Provide special inspection during installation of the following anchors:
    - a. Concrete anchors.
    - b. Screw anchors.
    - c. Undercut concrete anchors.
  2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors.
    - a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.
  3. Requirements for periodic special inspection:
    - a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.

- 1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new "initial inspection."
  - b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor's rated strength.
  - c. Anchor:
    - 1) Manufacturer, type, and dimensions (diameter and length).
    - 2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
  - d. Hole:
    - 1) Positioning: Spacing and edge distances.
    - 2) Drill bit type and diameter.
    - 3) Diameter, and depth.
    - 4) Hole cleaned in accordance with manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
    - 5) Anchor's minimum effective embedment.
    - 6) Anchor tightening/installation torque.
4. Requirements for continuous special inspection:
  - a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:

1. Owner may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
  - a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
  - b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.
2. Field testing Post-installed anchors:
  - a. Proof load testing:
    - 1) In addition to performing special inspections, the Owner may select up to 10 percent of each type and size of post-installed mechanical anchor for proof-load testing for pullout or shear. Tests shall be non-destructive whenever possible.
    - 2) Perform tension testing in accordance with ASTM E488. Apply proof loads using a calibrated hydraulic ram.
  - b. Torque load testing:
    - 1) Using a calibrated torque wrench, apply manufacturer's recommended installation torque.
  - c. Acceptance criteria:
    - 1) Minimum anchor embedment, proof load for pullout and shear, and torque shall be as specified in this Section.
    - 2) Anchors that fail to resist their designated proof load or installation torque requirements shall be regarded as non-performing.
    - 3) Remediate non-performing anchors as specified in "non-conforming work."



### 3.08 NON-CONFORMING WORK

- A. Remove misaligned or non-performing anchors.
- B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.
- C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

### 3.09 SCHEDULES

- A. Provide and install anchor materials as scheduled in the following Table.

Table - Required Anchoring Materials by Location			
Location/Exposure		Materials	Notes
1.	<b>Anchors into concrete and grouted masonry for attachment of carbon steel, including structural steel and other steel fabrications:</b>		
a)	Interior dry areas	Carbon steel - galvanized	
b)	Locations with galvanized steel structures or fabrications	Stainless steel - Type 304 or 316	1
c)	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
d)	Corrosive locations	Stainless steel - Type 316	1
2.	<b>Anchors into concrete and grouted masonry for attachment of aluminum, stainless steel, or fiber-reinforced plastic (FRP) shapes and fabrications:</b>		
a)	Interior dry areas	Stainless steel - Type 304 or 316	1
b)	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
c)	Corrosive locations	Stainless steel - Type 316	1
3.	<b>Anchors for attaching equipment and its appurtenances:</b>		
a)	All locations	Stainless steel - Type 316 (unless Type 304 is specifically indicated in the specifications for the equipment.)	1
<u>Notes:</u> (1) Where anchors are in contact with a metal that differs from that of the anchor, provide isolation sleeves and washers.			

END OF SECTION



## SECTION 09960

### HIGH-PERFORMANCE COATINGS

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## **PART 1 GENERAL**

### **1.01 SUMMARY**

- A. Section includes: Coatings, including coating systems, surface preparation, application requirements, and quality control requirements.

### **1.02 REFERENCES**

- A. ASTM International (ASTM):
  - 1. D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
  - 2. D2200 – Standard Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces.
  - 3. D3359 - Standard Test Methods for Rating Adhesion by Tape Test.
  - 4. D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
  - 5. D4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
  - 6. D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
  - 7. D4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.
  - 8. D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
  - 9. D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast-Cleaned Steel.
  - 10. D4541 - Standard Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
  - 11. D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
  - 12. D5162 - Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.
  - 13. D7234 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
  - 14. E337 - Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
  - 15. F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
  - 16. F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-situ Probes.
- B. International Concrete Repair Institute (ICRI):
  - 1. 310.2 - Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

- C. NACE International (NACE):
  - 1. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
  - 2. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
- D. National Association of Pipe Fabricators (NAPF):
  - 1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.
- E. NSF International (NSF):
  - 1. 61 - Drinking Water System Components - Health Effects.
- F. Occupational Safety and Health Administration (OSHA).
- G. Society of Protective Coatings (SSPC):
  - 1. Glossary - SSPC Protective Coatings Glossary.
  - 2. Guide 6 - Guide for Containing Surface Preparation Debris Generated during Paint Removal Operations.
  - 3. Guide 15 - Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
  - 4. PA 1 - Shop, Field, and Maintenance Painting of Steel.
  - 5. PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
  - 6. PA 9 - Measurement of Dry Coating Thickness Using Ultrasonic Gages.
  - 7. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
  - 8. SP 1 - Solvent Cleaning.
  - 9. SP 3 - Power Tool Cleaning.
  - 10. SP 5 - White Metal Blast Cleaning.
  - 11. SP 10 - Near-White Metal Blast Cleaning.
  - 12. SP 11 - Power Tools Cleaning to Bare Metal.
  - 13. SP 13 - Surface Preparation of Concrete.
  - 14. SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
  - 15. SP COM - Surface Preparation Commentary.
  - 16. SP VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
  - 17. SP WJ-1 - Waterjet Cleaning of Metals -- Clean to Bare Substrate.
  - 18. SP WJ-2 - Waterjet Cleaning of Metals -- Very Thorough Cleaning.
  - 19. SP WJ-3 - Waterjet Cleaning of Metals -- Thorough Cleaning.
  - 20. SP WJ-4 - Waterjet Cleaning of Metals -- Light Cleaning.

### **1.03 DEFINITIONS**

- A. Definitions used in this Section are in accordance with definitions referenced in ASTM D16, ASTM D3960, and SSPC Glossary of Definitions.
- B. Specific definitions:
  - 1. Abrasive: Material used for blast cleaning, such as sand, grit, or shot.
  - 2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.

3. Anchor Pattern: Profile or texture of prepared surface(s).
4. Biogenic Sulfide Corrosion: Corrosion caused by sulfuric acid formed when *Thiobacillus* bacteria metabolizes hydrogen sulfide.
5. Bug Holes: Small cavities resulting when air bubbles are entrapped in the surface of formed concrete during placement and consolidation.
6. System: Protective film with 1 or more coats applied in a predetermined order, including surface preparation and quality control requirements.
7. Coating/Paint/Lining Thickness: Total thickness of primer, intermediate, and/or finish coats after drying or curing.
8. Dew point: Temperature a given air/water vapor mixture starts to condense.
9. Drying Time: Time interval between application and material curing.
10. Dry to Recoat: Time interval between material application and its ability to receive the next coat.
11. Dry to Touch: Time interval between material application and its ability to tolerate a light touch without coating damage.
12. Exposed Surface: Any indoor or outdoor surface not buried or encased.
13. Feather Edging: Reducing coating thickness at its edge to blend with existing surrounding coating.
14. Feathering: Tapering off a wet edge with a comparatively dry brush.
15. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
16. Field Coat: Application of a surface coating system at the work site.
17. Finish Coat: Final coat in a paint system, including texture, color, smoothness of surface, and other properties affecting appearance.
18. Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
19. Holiday: A discontinuity, skip, void, or pinhole in coating or coating system film that exposes the substrate.
20. Honeycomb: Segregated and porous surface of hardened concrete due to insufficient consolidation.
21. Hydroblast: High or ultra-high pressure water jet surface preparation.
22. Incompatibility: One coating's inability to overlay another coating or surface as evidenced by bleeding, poor bonding, or lifting of old coating; inability of a coating to bond to a substrate.
23. Immersed/Immersion: A service condition in which substrate is submerged, is immediately above liquids, or is subject to frequent wetting, splashing, or washdown.
24. Laitance: A thin, weak, brittle layer of cement and aggregate fines on a concrete surface.
25. Mil: 0.001 inch.
26. Overspray: Dry spray, particularly paint bonded to an unintended surface.
27. Pinhole: A small diameter discontinuity in a coating or coating system film, created by offgassing from a void in a concrete or masonry substrate causing a void between coats or exposing the substrate. Usually caused by coating application while temperature is rising.
28. Pot Life: Time interval after components are mixed and coating can be satisfactorily applied.
29. Prime Coat: First full paint coat applied to a surface when using a multicoat system. Primers adhere to a new substrate, protect the substrate, and promote adhesion of subsequent coats of paint. The prime coat on metal surfaces is the first full coat and does not include solvent wash, grease emulsifiers, or other pretreatment applications.

30. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-based material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
31. Shelf Life: Maximum storage time a material may be stored without losing its usefulness.
32. Shop Coat: 1 or more coats applied in an off-site shop or plant before shipment to work site where field or finishing coat(s) are applied.
33. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
34. Stripe Coat: A separate brush coat of paint applied to all weld seams, pits, nuts/bolts/washers, and edges. This coat shall not be applied until previous coats have cured. Once applied, the coat shall be allowed to cure before subsequent coats are applied.
35. Tie Coat: An intermediate coat that bonds different types of paint material, improving succeeding coat adhesion.
36. Thick Film Coating System: A coating system applied with a minimum dry film thickness of 25 mils.
37. Touch-Up Painting: Application of paint on previously painted surfaces to repair marks, scratches, and deteriorated or damaged areas to restore the appearance and performance of the coating.
38. Water Blast: An alternative to air abrasive blast cleaning that can be used with or without abrasive injection. Water cleaning at pressures up to 5,000 pounds per square inch is called low-pressure water cleaning or power washing. High-pressure water cleaning uses water pressures between 5,000 and 10,000 pounds per square inch. Water jetting is water blasting with added abrasive at pressures between 10,000 and 25,000 pounds per square inch. Ultra-high-pressure water jetting is water blasting at pressures above 25,000 pounds per square inch.
39. Weld Splatter: Beads of non-structural weld metal that adhere to the surrounding surface, removed as part of surface preparation.

#### **1.04 ABBREVIATIONS**

- A. CSM - Coating System Manufacturer.
- B. CMU - Concrete Masonry Units.
- C. CSA - Coating System Applicator. Specialty subcontractor retained by the Contractor to install the coating systems specified in this Section.
- D. CTR - Coating System Manufacturer's Technical Representative.
- E. DFT - Dry-Film Thickness. Thickness of cured film, usually expressed in mils (0.001 inch).
- F. SSD - Surface Saturated Dry. Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
- G. TPC - Technical Practice Committee.
- H. VOC - Volatile Organic Compound. Portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing; expressed in grams per liter (g/l) or pounds per gallon (lb/gal). VOC is determined by EPA Method 24.

- I. WFT - Wet Film Thickness. Coating thickness as measured immediately after application. Usually expressed in mils (0.001 inch).

## 1.05 SUBMITTALS

- A. As specified in Section 01330 - Submittal Procedures, submit the following:
1. Schedule of proposed coating materials.
  2. Schedule of surfaces to be coated with each coating material.
  3. Dehumidification and heating plan.
  4. Product data:
    - a. Physical properties of coatings, including the following:
      - 1) Solids content.
      - 2) Ingredient analysis.
      - 3) VOC content.
      - 4) Temperature resistance.
      - 5) Typical exposures and limitations.
      - 6) Manufacturer's standard color chips.
    - b. Compliance with regulatory requirements:
      - 1) VOC limitations.
      - 2) Lead compounds and polychlorinated biphenyls.
      - 3) Abrasives and abrasive blast cleaning techniques and disposal.
      - 4) Methods for tenting blasting areas and methods to protect existing equipment from dust and debris.
      - 5) NSF certification of coatings for potable water supply systems.
    - c. CSM's current printed recommendations and product data sheets for coating systems, including:
      - 1) Surface preparation recommendations.
      - 2) Primer type.
      - 3) Maximum dry and wet-mil thickness per coat and number of coats.
        - a) Coating Coverage Worksheets.
      - 4) Minimum and maximum curing time between coats, including atmospheric conditions for each.
      - 5) Curing time before submergence in liquid.
      - 6) Thinner to be used for each coating.
      - 7) Ventilation requirements.
      - 8) Minimum and maximum atmospheric conditions during which the paint shall be applied.
      - 9) Allowable application methods.
      - 10) Maximum allowable substrate moisture content.
      - 11) Maximum shelf life.
      - 12) Requirements for transportation and storage.
      - 13) Mixing instructions.
      - 14) Shelf life.
      - 15) Material Pot life.
      - 16) Precautions for applications free of defects.
      - 17) Method of application.
      - 18) Drying time of each coat, including prime coat.
      - 19) Compatible prime coats.
      - 20) Limits of ambient conditions during and after application.
      - 21) Required protection from sun, wind, and other conditions.
      - 22) Touch-up requirements and limitations.



- 23) Minimum adhesion of each system submitted in accordance with ASTM D4541 and ASTM D7234.
- d. Samples: Include 8-inch square drawdowns or brushouts of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.
- e. Affidavits signed by an officer of the CSM's corporation attesting to full compliance of each coating system component with current federal, state, and local air pollution control regulations and requirements.
- f. List of cleaning and thinner solutions allowed by the CSMs.
- g. Storage requirements, including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
- h. Thick film coating systems (greater than 25 mils):
  - 1) CSM's detailed written instructions for coating system treatment and graphic details for coating system terminations in coated structures, including pipe penetrations, metal embedments, gate frames, and other terminations encountered.
  - 2) Include detail treatment for coating system at concrete joints.
  - 3) Manufacturer's Representative's (CTR) Field Reports.
- 5. Quality assurance submittals:
  - a. Quality assurance plan.
  - b. Qualifications of CSA, including:
    - 1) List of Similar Projects.
      - a) Name and address of project.
      - b) Year of installation.
      - c) Year placed in operation.
      - d) Point of contact: Name and phone number.
    - 2) Provide a minimum of 5 project references, each including contact name, address, and telephone number where similar coating work has been performed by their company in the past 5 years.
  - c. CSA Reports:
    - 1) Written daily quality control inspection reports.
  - d. CTR Reports:
    - 1) Reports on visits to project site to view and approve surface preparation of structures to be coated.
    - 2) Reports on visits to project site to observe and approve coating application procedures.
    - 3) Reports on visits to coating plants to observe and approve surface preparation and coating application on shop-coated items.

## 1.06 QUALITY ASSURANCE

- A. CSA qualifications:
  - 1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
    - a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 5 years.
  - 2. SSPC QP 1 certified.
  - 3. Manufacturer-approved applicator when manufacturer has approved applicator program or when required in these specifications.

- B. CTR qualifications:
  - 1. Certification, one of the following:
    - a. NACE Level 2 or 3 Certified Coating Inspector.
    - b. SSPC Level 3 Protective Coatings Inspector.
  - 2. Minimum of 5 years of experience evaluating application of manufacturer's coatings under conditions similar to those of the Work:
    - a. Provide CTR qualifications and references listing 5 similar projects completed in the past 5 years.
- C. Regulatory requirements: Comply with governing agencies' regulations by using coatings conforming to their VOC limits.
  - 1. Lead-based coatings are not permitted.
  - 2. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.
- D. Certification:
  - 1. Certify that applicable pigments resist deterioration when exposed to hydrogen sulfide and other sewage gases.
  - 2. Product data shall designate coating as being suitable for wastewater service.
- E. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.
  - 1. Coordinate Hold Point schedule.
- F. Field samples:
  - 1. Prepare and coat a minimum 25-square-foot area of each system between corners or limits such as control or construction joints.
  - 2. Approved field sample may be part of the Work.
- G. Obtain approval before coating other surfaces. Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.
- H. CSM services:
  - 1. CSA shall arrange for CTR to attend pre-installation conferences.
  - 2. Visit the project site periodically to consult on and inspect specified surface preparation and application Hold Points.
  - 3. Visit coating plants to observe and approve surface preparation procedures and coating application of items to be shop primed and coated.
  - 4. CTR shall provide written inspection reports.
- I. Quality control requirements:
  - 1. Contractor shall be responsible for the workmanship and quality of the coating system installation.
    - a. Inspections by Owner, Engineer, CSA, or CTR will not relieve or limit Contractor's responsibilities.
  - 2. Conform to this specification's requirements and the standards referenced in this Section. Changes in the coating system application requirements will be allowed only with the Engineer's written acceptance.
  - 3. Specially trained crews with experience applying the specified coating system coating are required for:
    - a. Coating application using plural component spray equipment or other specialty equipment.

- b. Coating with specialty linings for severe service conditions, including floor coatings, and with linings for corrosive headspaces or secondary containment areas.
- 4. CTR shall specially train personnel for coating systems as specified in Appendix B Coating Detail Sheets.
  - a. CSM shall approve personnel in writing applying the coating system.
- 5. Do not use contaminated, outdated, diluted materials, and/or materials from previously opened containers.
- 6. Identify inspection access points used by Owners or Engineers.
- 7. Provide ventilation, ingress, egress, or other means as necessary for Owner's or Engineer's personnel to safely access the work areas.
- 8. Conduct and continually inspect work so the coating system is installed as specified. The CSM shall provide written directions to correct coating work not conforming to the specifications or is otherwise unacceptable.
- 9. Provide written daily reports summarizing test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system application.
  - a. Determine relative humidity in accordance with ASTM E337. Confirm other conditions, such as proper protective measures for surfaces not to be coated and safety requirements for personnel.
    - 1) Measure daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
    - 2) Determine the acceptability of weather and/or environmental conditions within the structure in accordance with the CSM's requirements.
  - b. Monitoring surface preparation: Spot check cleanliness, surface profile, and surface pH testing at least 3 times daily. Check each surface at least once. In accordance with:
    - 1) ASTM D4262.
    - 2) ASTM D4263.
    - 3) ASTM D4417.
    - 4) ICRI 310.2 requirements.
    - 5) SSPC Surface Preparation Standards.
  - c. Confirm that compressed air used for surface preparation or blow-down cleaning is free of oil and moisture.
  - d. Monitor surface preparation daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
  - e. Do not apply coatings when environmental conditions are outside of the CSM's published limits.
  - f. Monitoring coatings application: Continuously inspect, measure, and record the wet film thickness and general film quality (visual inspection) for runs, sags, pinholes, holidays, etc. during coating.
    - 1) Perform WFT measurements in accordance with ASTM D4414.
  - g. Post cure evaluation: Measure and inspect the overall dry film thickness on all surfaces. Conduct a DFT survey and perform adhesion testing, holiday detection, or cure testing as required in this Section and/or the CSM's written instructions. Perform all applicable tests in accordance with ASTM D4541, ASTM D4787, ASTM D5162, ASTM D7234, SSPC-PA 1, SSPC-PA 2, SSPC-PA 9, and other pertinent standards and recommended practices.

- J. Inspection at Hold Points:
1. Conduct inspections at Hold Points during the coating system application and record the results.
  2. Coordinate Hold Points with the Engineer so the Engineer can observe Contractor's inspections on a scheduled basis.
  3. Provide the Engineer a minimum of 24 hours of notice before conducting Hold Point Inspections.
  4. Hold Points shall be as follows:
    - a. Conditions before surface preparation: Before starting surface preparation, observe, record, and confirm that oil, grease, and/or soluble salts are gone from the surface.
    - b. Post surface preparation: After completing surface preparation, measure and inspect for cleanliness and proper surface profile as specified in this Section and in the CSM's written instructions.
    - c. Coatings application: At the beginning of any coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
    - d. Coatings application: At the beginning of coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
      - 1) Observe conditions during the Pre-application Meeting.

## **1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products as specified in Section 01600 - Product Requirements.
- B. Immediately remove unspecified and unapproved coatings from Project site.
- C. Deliver new labeled, unopened containers:
1. Do not deliver materials after manufacturer's expiration date or over 12 months from manufacturing date, whichever is more stringent. Store materials in well-ventilated enclosed structures and protect from weather and excessive heat or cold in accordance with the CSM's recommendations.
    - a. Store flammable materials in accordance with federal, state, and local requirements.
    - b. Store rags and cleanup materials appropriately to prevent fire and spontaneous combustion.
  2. Store and dispose of hazardous waste in accordance with federal, state, and local requirements. This requirement specifically applies to waste solvents and coatings.
  3. Container labels shall show the following:
    - a. Brand name or product title.
    - b. CSM's batch number.
    - c. CSM's manufacture date.
    - d. CSM's name.
    - e. Generic material type.
    - f. Application and mixing instructions.
    - g. Hazardous material identification label.
    - h. Shelf life expiration date.

- i. Color.
  - j. Mixing and reducing instructions.
- 4. Clearly mark containers to indicate safety hazards associated with the use of or exposure to materials.

## 1.08 PROJECT CONDITIONS

- A. Apply coatings to dry surfaces.
  - 1. Surface moisture: Comply with manufacturer's requirements or as specified in this Section.
    - a. Plaster and gypsum wallboard: 12 percent.
    - b. Masonry and concrete block: 12 percent.
    - c. Interior located wood: 15 percent.
    - d. Concrete floors: Moisture vapor transmission rate of no more than 3.0 pounds per 1,000 square feet per 24 hours in accordance with ASTM F1869 or relative humidity no greater than 80 percent if tested in accordance with ASTM F2170 unless the CSM's recommendations are more restrictive.
    - e. Concrete structures: Negative results from Plastic Sheet Test in accordance with ASTM D4263, and maximum of 80 percent relative humidity in accordance with ASTM F2170.
- B. Do not apply coatings when the following conditions exist. If such conditions exist, provide containment, covers, environmental controls, and other necessary measures.
  - 1. During rainy, misty, or damp weather, or to surfaces with frost or condensation.
  - 2. When the surface temperature is below 10 degrees Fahrenheit above the dew point.
  - 3. When ambient or surface temperature:
    - a. Is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
    - b. Is less than 65 degrees Fahrenheit for clear finishes, unless manufacturer allows a lower temperature.
    - c. Exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
    - d. Exceeds manufacturer's recommendation.
  - 4. When relative humidity is higher than 85 percent.
  - 5. Under dusty or adverse environmental conditions.
  - 6. When light on surfaces measures less than 15 foot-candles.
  - 7. When wind speed exceeds 15 miles per hour.
- C. Apply coating only under evaporation conditions rather than condensation.
  - 1. Use dehumidification equipment, fans, and/or heaters inside enclosed areas to maintain required atmospheric and surface temperature requirements for proper coating application and cure.
  - 2. Measure and record relative humidity and air and surface temperatures at the start and end of each shift to confirm proper humidity and temperature levels inside the work area.
    - a. Submit test results.

- D. Continuously ventilate, dehumidify, and heat enclosed spaces with high humidity during surface preparation, coating application, and curing.
1. Maintain minimum air temperature of 55 degrees Fahrenheit and 10 degrees Fahrenheit above the dew point.
  2. Maintain dew point of at least 10 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is performed.
  3. Reduce dew point temperature in conditioned space by at least 10 degrees Fahrenheit within 20 minutes.
  4. Seal work areas and maintain positive pressure per dehumidification equipment supplier's recommendations.
  5. Maintain these conditions before, during, and after application to ensure proper adhesion and cure of coatings for no less than:
    - a. Entire curing period.
    - b. 8 hours after coating.
- E. Systems:
1. Site electrical power availability as specified in Section 01500 - Temporary Facilities and Controls.
  2. Internal combustion engine generators may be used.
    - a. Obtain required permits and provide air pollution and noise control devices on equipment as required by permitting agencies require.
    - b. Comply with state, federal, and local fire and explosion protection measures when locating and operating generator.
    - c. Locate engine generator outside hazardous classified areas per NFPA 820.
    - d. Provide daily fuel service for generator for duration of use.
  3. Dehumidification:
    - a. Provide desiccant or refrigeration drying.
    - b. Use only desiccant types with a rotary desiccant wheel capable of continuous operation.
    - c. Liquid, granular, or loose lithium chloride drying systems are not acceptable.
  4. Heating:
    - a. Use electric, indirect combustion, or steam coil.
    - b. Direct-fired combustion heaters are not acceptable heat sources during abrasive blasting, coating application, or coating cure.
  5. Filters:
    - a. Use a filtration system for dust removal designed to not interfere with dehumidification equipment's ability to control dew point and relative humidity inside the reservoir.
    - b. Do not allow air from the working area or dust filtration equipment to recirculate through their dehumidifier during coating application or when solvent vapors are present.
  6. Design and submittals:
    - a. Prepare and submit dehumidification and heating plan, including all equipment and operating procedures.
    - b. Suppliers of services and equipment shall have at least 3 years of experience in similar applications.
- F. Provide containment and ventilation system components in accordance with SSPC-Guide 6, Level 3 and as required for hazardous materials.

## **1.09 MAINTENANCE**

- A. Provide table of products applied organized by surface type. List coating manufacturer, color, color formulation, distributor name, telephone number, and address.

## **1.10 CTR RESPONSIBILITIES**

- A. General:
  - 1. Attend pre-installation conference.
  - 2. Perform onsite application training.
  - 3. Periodically inspect coating system application.
- B. Coating system installation training:
  - 1. Provide a minimum of 8 hours of classroom and off-site training for application personnel and supervisory personnel in one of the following ways:
    - a. Train a minimum of 2 supervisory personnel and 2 application personnel.
    - b. Submit a letter from the CSM stating that CSM approves the supervisory and application personnel, listed by name and responsibility, and no additional training is required.
  - 2. CTR can train up to 14 application personnel and 3 supervisory personnel at a time.
  - 3. Minimum training requirements:
    - a. Explain in detail the mixing, application, curing, and termination requirements.
    - b. Provide hands-on demonstration of coating system mixing.
    - c. Explain in detail the ambient condition requirements for temperature and humidity.
    - d. Explain in detail the surface preparation requirements.
    - e. Explain in detail the re-coat times, cure times, and related ambient condition requirements.
    - f. Write a letter stating that training was satisfactorily completed by the personnel, listed by name and responsibility.
  - 4. Provide special training as specified in the Coating Detail Sheets.
- C. Coating system inspection:
  - 1. CTR inspection is in addition to the CSA's inspection as specified in this Section.
  - 2. Be on-site to oversee:
    - a. Coating application at least once a week.
    - b. End of surface preparation.
    - c. During coating application.
    - d. Post-cure inspection.
  - 3. Routinely inspect and verify in writing that application personnel have successfully performed surface preparation, filler/surfacer application, coating system application, and Quality Control Inspection in accordance with this Section and to warrantable quality.
  - 4. Perform the following activities to confirm conformance with the specifications:
    - a. Inspect ambient conditions during coating system installation at Hold Points for conformance with the specified requirements.

- b. Inspect each coated surface type and coating system applied to verify the following:
  - 1) Cleanliness.
  - 2) Surface pH for concrete substrates.
  - 3) Confirm surface preparation of substrates where coating system will terminate or will be applied for conformance to the specified application criteria.
- c. Verify surface profile of substrates by completing the following:
  - 1) Inspect preparation and application of coating detail treatment at terminations, transitions, metal embedments in concrete, and joints and cracks in substrates.
  - 2) Inspect application of filler/surfacer materials for concrete and masonry substrates.
  - 3) Verify proper mixing of coating materials.
  - 4) Inspect application of primers and finish coats, including wet and dry film thickness.
  - 5) Inspect coating systems for proper cure times and conditions.
- d. Review adhesion testing of cured coating systems.
- e. Review coating system continuity testing.
- f. Inspect and record representative-localized repairs.
- g. Conduct final review of completed coating system installation.
- h. Prepare and submit site visit reports after each site visit to document that the coating work is in accordance with the CSM's Recommendations.

## **PART 2 PRODUCTS**

### **2.01 DESIGN AND PERFORMANCE CRITERIA**

- A. Coating materials shall be formulated for environments encountered in water and wastewater treatment processes.
- B. Coating materials that come in contact with water distributed as potable water shall be certified in accordance with NSF 61.

### **2.02 MATERIALS**

- A. General:
  1. Product requirements as specified in Section 01600 - Product Requirements.

### **2.03 COATING SYSTEMS IDENTIFICATION**

- A. Naming Conventions: Coating Systems Identifications contain the elements defined in Table 1.

<b>Table 1 - Coating System Identification Elements</b>					
First Element	-	Second Element	-	Third Element	- Fourth Element (optional)
3 or 4 alpha characters		1-3 alpha characters		1 number	3 or 4 alpha characters
Coating Type		Substrate		System Number	Additional Substrate or Special Condition



<b>Table 1 - Coating System Identification Elements</b>						
Example: EPX	-	C	-	6	-	BSC

- 1) First element identifies the coating type using the following abbreviations:
  - a) ACR: acrylic.
  - b) CTE: coal tar epoxy.
  - c) ELA: elastomeric acrylic.
  - d) EPU: epoxy-polyurethane.
  - e) EPX: epoxy.
  - f) POL: polyurethane.
  - g) SIL: silicone.
  - h) SILX: siloxane or silane.
  - i) VE: vinyl ester.
- 2) Second element identifies the substrate using the following abbreviations:
  - a) C: concrete or masonry.
  - b) F: concrete flooring.
  - c) FRP: fiber-reinforced plastic.
  - d) GM: galvanized metal.
  - e) M: metal.
  - f) PVC: polyvinyl chloride, chlorinated polyvinyl chloride.
- 3) Third element identifies the sequential system number.
  - a) For example, EPX-C-2 is the second standard epoxy coating system for concrete substrates.
- 4) Fourth element is optional and identifies the additional substrate or special condition with the following abbreviations:
  - a) PWS: Potable water service applications (NSF-61 approved).
  - b) BSC: Biogenic sulfide corrosion-resistant applications in wastewater.
  - c) BG: Below grade or buried.
  - d) OZ: Organic zinc primer, epoxy polyurethane system.
  - e) SC: Secondary containment.

## 2.04 PRODUCTS FOR COATING SYSTEMS

- A. Products: As specified in Appendix B Coating Detail Sheets.
- B. Cleaning solvents:
  1. Requirements for solvent wash, solvent wipe, or cleaner used, including, but not limited to, those used for surface preparation in accordance with SSPC-SP 1:
    - a. Emulsifying type.
    - b. Containing no phosphates.
    - c. Biodegradable.
    - d. Does not damage zinc.
    - e. Compatible with the specified primer.
    - f. Complying with applicable air-quality control board requirements.
  2. Use clean white cloths and clean fluids in solvent cleaning.

## **PART 3 EXECUTION**

### **3.01 GENERAL PROTECTION REQUIREMENTS**

- A. Protect adjacent coated surfaces from coatings and damage associated with coating work. Repair damage resulting from inadequate or unsuitable protection.
- B. Use drop cloths and other coverings to protect adjacent surfaces not to be coated against spatter and droppings.
- C. Mask off surfaces of items not to be coated or remove items from area.
- D. Furnish and deploy sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.
- E. Place coating waste, cloths, and material that may pose a fire hazard in closed metal containers and remove daily from site.
- F. Remove electrical plates, surface hardware, fittings, and fasteners before coating application. Carefully store, clean, and replace items after completing coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finishes.
- G. Erect and maintain protective enclosures in accordance with SSPC- Guide 6.
- H. Protect the following surfaces from abrasive blasting by masking or by other means:
  - 1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
  - 2. Machined surfaces for sliding contact.
  - 3. Surfaces to be assembled against gaskets.
  - 4. Surfaces of shafting where sprockets will be fit.
  - 5. Surfaces of shafting where bearings will be fit.
  - 6. Machined bronze surfaces, including slide gates.
  - 7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used to assemble equipment requiring abrasive blasting.
  - 8. Galvanized items, unless scheduled to be coated.
- I. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by spent abrasive blast media, dust, or dirt entering such equipment.
- J. Schedule cleaning and coating to keep dust and spray from the cleaning process from falling on wet, newly coated surfaces.
  - 1. Whenever possible, coordinate with other trades and complete surface preparation and coating work before installing hardware, hardware accessories, nameplates, data tags, electrical fixtures, and similar uncoated items that will be in contact with coated surfaces. Mask machined surfaces, sprinkler heads, and other small items that will not be coated.
  - 2. After completing coating, reinstall removed items.
  - 3. Disconnect and move equipment adjacent to walls to clean and coat equipment and walls. Replace and reconnect equipment after coating.

### **3.02 GENERAL SURFACE PREPARATION REQUIREMENTS**

- A. Prepare surfaces in accordance with CSM's instructions unless more stringent requirements are specified in this Section.
- B. Coating detail sheets in Appendix B include additional surface preparation requirements.
- C. Follow more stringent requirement if information conflicts.
- D. Where required by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before applying a coating.
  - 1. CSA shall coordinate coating inspections.
    - a. Identify coating inspection Hold Points during the pre-installation conference.
    - b. Provide at least 2 days' notice before inspection.
  - 2. Contractor shall correct surface defects identified by the inspector at no additional cost to Owner.

### **3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION**

- A. Identify equipment, ducting, piping, and conduit as specified in Section 16075 - Identification for Electrical Systems.
- B. Remove grilles, covers, and access panels for mechanical and electrical system and coat separately.
- C. Prepare and finish coat equipment primed by the manufacturer using specified intermediate and top coats, as applicable, and color selected by the Owner.
- D. Prepare, prime, and coat both insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with material not requiring coating, or with a prefinished coating.
- E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.
- F. Prepare and coat interior surfaces of air ducts and convactor and baseboard heating cabinets visible through grilles and louvers with 1 coat of flat black paint to limit of sight line.
- G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convactor and baseboard heating cabinets to match face panels.
- H. Prepare and coat exposed conduit and appurtenances occurring in finished areas with color and texture to match adjacent surfaces.
- I. Prepare and coat sides' front, back, and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

- J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

### **3.04 CLEANING OF NEW AND PREVIOUSLY COATED OR NEW SURFACES**

- A. Utilize cleaning agent to remove soluble salts, such as chlorides, from concrete and metal surfaces:
  - 1. Cleaning agent: Biodegradable non-flammable and containing no VOC.
  - 2. Manufacturers: The following or equal:
    - a. CHLOR\*RID International, Inc.
      - 1) Complete soluble salt removal with steam or warm water cleaning.
  - 3. Steam clean and degrease surfaces to be coated to remove oils and grease.
  - 4. Clean surfaces with decontamination agent in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing, as approved by the CTR and the Engineer.
  - 5. Test cleaned surfaces to ensure removal of soluble salts. Carry out additional cleaning as needed.
  - 6. Complete final surface preparation before applying new coating system in strict accordance with CSM's printed instructions.

### **3.05 BLAST CLEANING**

- A. Surface preparation requirements:
  - 1. Do not reuse spent blast abrasive.
  - 2. Ensure that filter compressed air used for blast cleaning is free of condensed water and oil. Clean moisture traps at least once every 4 hours or more frequently, as required, to prevent moisture from entering the abrasive blasting equipment air supply. Check blast air for moisture and oil after each cleaning in accordance with ASTM D4285.
  - 3. Install oil separators just downstream of compressor discharge valves and at the discharge point of blast pot discharges. Check separators on the same frequency as the moisture traps.
  - 4. Keep regulators, gauges, filters, and separators on compressor air lines to blasting nozzles operational at all times.
  - 5. Install an air dryer or desiccant filter drying unit to dry the compressed air before blast pot connections. Use and maintain the dryer throughout surface preparation work.
  - 6. Use a venturi-type, or other high velocity-type, abrasive blast nozzles supplied with at least 100 pounds per square inch gauge air pressure at the nozzle and enough volume to obtain appropriate blast cleaning production rates and surface cleanliness.
  - 7. Provide airborne particulate evacuation and filtering that meets OSHA safety standards. Maintain optimal visibility both to clean and provide the specified surface profile and to allow inspection of the substrate during surface preparation work.
  - 8. If prepared and cleaned metallic substrates become contaminated between final surface preparation work and coating system application, or if the prepared substrate darkens or changes color, re-clean by water blasting, or abrasive blast cleaning as appropriate until the specified degree of cleanliness is restored.

- B. Water jetting or water blasting:
  - 1. Use water jetting or water blasting for recoating or relining where an adequate surface profile exists.
  - 2. Perform water jetting or water blasting in accordance with SP 13 and SSPC-WJ-1, WJ-2, WJ-3, WJ-4.

### **3.06 PREPARATION REQUIREMENTS FOR CONCRETE SURFACES**

- A. Cure for at least 28 days before coating.
- B. Remove degraded concrete using abrasive blast cleaning or high or ultrahigh pressure water jetting, chipping, or other abrading tools until achieving a sound, clean substrate. Remove all bruised or cracked concrete.
- C. Prepare substrate cracks and areas requiring resurfacing; perform detail treatment, including, but not limited to, terminating edges per the CSM's recommendations and as indicated on the Drawings.
  - 1. Prepare concrete surfaces in accordance with SSPC-SP 13.
- D. Prepare concrete surfaces in accordance with SSPC-SP 13.
  - 1. Inspect concrete surfaces to select appropriate surface preparation method to provide a suitable substrate for the specified coating system.
  - 2. Use blast cleaning or other means to expose the complete perimeter of air voids or bug holes. Do not leave shelled over, hidden air voids beneath the exposed concrete surface.
  - 3. Repair concrete defects and physical damage.
  - 4. Clean concrete surfaces of dust, mortar, formwork, fins, loose concrete particles, form release materials, oil, and grease.
  - 5. Fill voids to provide surface.
- E. Provide clean substrate visually free of calcium sulfate, loose, coarse, or fine aggregate, laitance, loose hydrated cement paste, and otherwise harmful substances.
  - 1. Confirm concrete surface minimum pH of 9.0 with surface pH testing.
  - 2. If after surface preparation the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
- F. Prepare concrete surface for coating in accordance with SSPC-SP 13.
  - 1. Provide ICRI 310.2 minimum No. 3 concrete surface profile (CSP) or as specified on Coating Detail Sheets.
  - 2. Evaluate profile of the prepared concrete using ICRI 310.2 surface profile replicas.
- G. Blast clean cementitious repair mortars or grouts to the same profile and degree of cleanliness requirements required for concrete substrates.
- H. Blast clean polymer-based surfacers or waterborne modified cementitious surfaces only if they have exceeded the CSM's recommended recoat time.
- I. Vacuum all concrete surfaces before coating application, leaving a dust free, sound concrete substrate.

1. Thoroughly clean concrete surfaces to be coated to remove loose dirt and spent abrasive.
  2. Remove debris produced by blast cleaning from the structures to be coated, and legally dispose of it off-site.
- J. Test moisture content of concrete to be coated:
1. Conduct ASTM D4263 plastic sheet test at least once for every 500 square feet of surface area to be coated.
    - a. Any moisture on plastic sheet after test period constitutes a non-acceptable test, and the concrete must be dried further.
  2. Conduct ASTM F1869 test at least once for every 1,000 square feet of concrete floor surface area to be coated.
  3. Conduct ASTM F2170 one relative humidity moisture test at least once for each 500 square feet of non-floor concrete surface area where the opposite side is exposed to soil or water.
    - a. Waterproof surfaces exposed to soil or water.
  4. Comply with specified minimum moisture content and CSM's written recommendations for moisture vapor transmission rates or relative humidity values.
- K. Masonry surfaces:
1. Cure for at least 28 days before coating.
  2. Prepare masonry surfaces to remove chalk, laitance, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
  3. Wash and scrub masonry surfaces with clear water. Do not use muriatic acid.
  4. Seal or fill masonry surfaces with a sealer or block filler compatible with the specified primer after cleaning.
  5. Confirm that masonry surfaces are dry before coating application.
    - a. If using pressure washing or low-pressure water blast cleaning for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or until the minimum ambient temperature is 70 degrees Fahrenheit before coating.

### **3.07 GENERAL PREPARATION REQUIREMENTS FOR METALLIC SURFACES**

- A. Remove rust, scale, and welding slag and spatter.
1. Remove and grind smooth all excessive weld material and weld spatter on metal surfaces before blast cleaning in accordance with NACE SP0178, Appendix C, Level C.
  2. Grind sharp edges on metal substrate to approximately 1/16-inch radius before abrasive blast cleaning.
- B. Prepare metallic surfaces in accordance with applicable portions of surface preparation specifications of the SSPC specified for each coating system.
1. Remove grease and oil in accordance with SSPC-SP 1.
  2. Use solvent as recommended by the CSM.
  3. Measure profile depth of the surface to be coated in accordance with Method C of ASTM D4417. Contractor shall select blast particle size and gradation to produce the specified surface profile.
  4. Constantly monitor and maintain ambient environmental conditions to ensure cleanliness and that no "rust back" occurs before coating material application.

- C. Prepare metallic surfaces by blast cleaning in accordance with SSPC-VIS 1 (ASTM D2200). Prepare abrasive blast representative areas for the Owner's representative to inspect on the first day of cleaning.
- D. Unless otherwise specified, the requirements for blast cleaning steel, ductile iron, and stainless steel substrates are as follows:
  - 1. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC-SP 10 unless blasting may damage adjacent surfaces, is prohibited, or is specified otherwise. Where abrasive blasting is not possible, clean surfaces to bare metal with power tools in accordance with SSPC-SP 11.
  - 2. Ferrous metal surfaces to be submerged: Abrasive blast in accordance with SSPC-SP 5, unless specified otherwise, to clean and provide roughened surface profile with a depth between 2 and 4 mils.
  - 3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products, or embedded abrasive from substrate before coating application.
  - 4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast clean surfaces again.
- E. Field preparation of shop-primed surfaces:
  - 1. Smooth welds and prominences with power tools before applying field-applied coatings.
  - 2. Clean and dry shop-primed ferrous metal surfaces and fabricated assemblies before applying field coats.
  - 3. Prepare shop epoxy primed surfaces with light abrasive blasting or abrading and then vacuum before applying finish coats.
    - a. Follow CSM instructions for surface preparation when the primer recoat limit has been exceeded.
  - 4. Non-immersion service: Clean in accordance with SSPC-SP 2 (Hand Tool Cleaning) or SSPC-SP 3 (Power Tool Cleaning) and uniformly roughen.
  - 5. Immersion, BSC, and SC service: Remove shop primer in accordance with SSPC-SP 5 (Near-White Blast Cleaning).
- F. Damaged shop primer or rust bleeding:
  - 1. Ferrous metals: Clean in accordance with SSPC-SP 1 (Solvent Cleaning) and spot blast in accordance with SSPC-SP 10 (Near-White Metal Blast Cleaning) to achieve a uniform surface profile between 2.0 and 2.5 mils before recoating.
  - 2. Reject galvanized steel with rust bleeding.
- G. Damaged coating: Repair by abrasive blast cleaning surfaces as specified for the coating system; feather to a smooth transition before touching up.

### **3.08 PREPARATION REQUIREMENTS BY SURFACE TYPE**

- A. Galvanized steel and non-ferrous metal surfaces:
  - 1. Degrease or solvent clean (SSPC-SP 1) to remove oily residue.
  - 2. Abrasive blast clean in accordance with SSPC-SP 16.
    - a. If abrasive blast cannot be performed, abrade in accordance with SSPC-SP 3 (Power Tool Cleaning).
  - 3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded, such as bolts, nuts, or preformed channels.

4. Test surface for contaminants using copper sulfate solution.
- B. Stainless-steel surfaces:
  1. Abrasive blast clean in accordance with SSPC-SP 16 to leave a clean, uniform appearance with surface profile between 1.5 and 2.5 mils.
- C. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.
- D. Sherardized, aluminum, copper, and bronze surfaces:
  1. Abrasive blast clean in accordance with SSPC-SP 16.
  2. Prepare in accordance with CSM's instructions.
- E. Cadmium-plated, zinc-plated, or sherardized fasteners:
  1. Abrasive blast in the same manner as uncoated metal when assembling equipment designated for abrasive blasting.
- F. PVC and FRP surfaces:
  1. Lightly sand surfaces to be coated.
    - a. Sand to remove gloss and establish uniform surface profile.
  2. Vacuum to remove loose dust, dirt, and other materials.
  3. Solvent clean with clean white rags and allow solvent to evaporate completely before applying coating materials.

### **3.09 APPLICATION REQUIREMENTS**

- A. Apply coatings in accordance with manufacturer's instructions.
- B. Empty aboveground piping to be coated of contents when applying coatings.
- C. Mechanical equipment shop primed by the manufacturer.
  1. Pumps and valves: Shop coat with manufacturer's highest quality coating system meeting the project specifications.
    - a. Contractor shall provide CTR shop coating reports.
  2. Non-immersed equipment: Touch up shop primer, and coat in the field with specified coating system after installation.
    - a. If project requires equipment removal and reinstallation, complete touch-up coating after final installation.
  3. Immersed equipment not shop coated: Remove shop primer before surface preparation and field apply coating.
- D. Verify surface preparation immediately before applying coating in accordance with SSPC SP COM and the SSPC visual standard for the specified surface preparation method.
- E. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.
- F. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.
- G. Do not apply coatings to a surface until it has been prepared as specified.



- H. Use equipment designed to apply materials specified.
  - 1. Use compressors with moisture traps and filters that remove water and oils from the air.
    - a. Perform a paper blotter test at the Engineer's request to verify air is sufficiently free of oil and moisture. Do not allow the amount of oil and moisture to exceed CSM-recommended amount.
  - 2. Equip spray equipment with properly sized mechanical agitators, pressure gauges, pressure regulators, and spray nozzles.
- I. Where 2 or more coats are required, tint prime coat intermediate coats as necessary to distinguish each coating and to help indicate coverage.
  - 1. Do not use color additives with chromium, lead or lead compounds that hydrogen sulfide, other corrosive gases, might destroy or alter. Apply the specified number of coats.
- J. Apply coating by brush, roller, trowel, or spray unless a specific application method is required by coating manufacturer's instructions or these Specifications.
  - 1. Apply primer or first coat by brush to power tool cleaned ferrous surfaces.
  - 2. Brush or spray-apply coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces.
  - 3. After prime coat dries, mark, repair, and retest pinholes and holidays before intermediate or top coats are applied.
- K. Spray application:
  - 1. With a brush, stripe coat edges, welds, corners, nuts, bolts, and difficult-to-reach areas, as necessary, before spray application to ensure specified coating thickness along edges.
  - 2. When using spray application, apply each coat to thickness no greater than recommended in coating manufacturer's instructions.
  - 3. Use airless spray method unless air spray method is required by CSM's instruction or these Specifications.
  - 4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.
- L. Lightly sand and thoroughly clean surfaces to receive high gloss finishes unless CSM instructs otherwise.
- M. Remove all dust on coatings between coats.
- N. Shop and field coats:
  - 1. Prime coat: Shop-apply or field-apply prime coats as specified. Use shop-applied primer compatible with the specified field coating system and apply at the minimum dry film thickness recommended by the finish coat CSM.
    - a. Provide data sheets identifying the shop primer to on-site coating application personnel.
    - b. Perform adhesion tests on the shop primer.
    - c. Remove and recoat damaged, deteriorated, and poorly applied shop coatings.
    - d. If shop primer coat meets this Section's requirements, spot prime exposed metal of shop-primed surfaces before spray applying primer over the entire surface.

2. Field coats: Apply field coats with 1 or more prime coats and finish coats to build up coating to dry film thickness specified for the coating system.
    - a. Do not apply finish coats until other work in the area is complete and previous coats are inspected.
  3. Adhesion confirmation: Perform adhesion tests after proper coating cure in accordance with ASTM D3359. Demonstrate that:
    - a. Prime coat adheres to the substrate.
    - b. Coatings adhere to the prime and intermediate coats.
      - 1) Coating 5 mils or more DFT: Achieve adhesion test result of 5A on immersed surfaces and 4A or better on other surfaces.
      - 2) Coating less than 5 mils DFT: Achieve adhesion test results of 5B on immersed surfaces and 4B or better on other surfaces.
- O. Brush, roll, trowel, or spray and back roll coats for concrete and masonry.
- P. Plural component coating application:
1. Premix contents of component drums if required by the CSM each day.
  2. Before starting application:
    - a. Verify gauges are working properly.
    - b. Complete ratio checks.
    - c. Sample the mix on plastic sheeting to ensure set time is appropriate and complete.
    - d. Label and retain all spray samples. Submit to Engineer when requested.
- Q. Drying and recoating:
1. Provide fans, heating devices, or other means to prevent condensate or dew on substrate surface or between coats and during curing after applying the last coat.
  2. Allow each coat to cure or dry thoroughly, in accordance with if required in CSM's printed instructions, before recoating.
  3. Use CSM's printed instructions and the requirements specified in this Section to determine minimum required drying time.
    - a. Do not allow excessive drying time or exposure, which may impair bond between coats.
    - b. Recoat all coatings within time limits recommended by CSM.
    - c. If time limits are exceeded, abrasive blast clean and de-gloss clean before applying another coat.
  4. If limitations on time between abrasive blasting and coating are not met before attaching components to surfaces that cannot be abrasive blasted, coat components before attachment.
  5. Ensure primer and intermediate coats of coating are unscarred and completely integral when applying each succeeding coat.
  6. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
  7. Leave no holidays. Repair all holidays in accordance with the requirements on pertinent Coating Detail Sheets or as recommended by the CSM.
  8. Sand and feather in to a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so repairs are invisible to the naked eye.

R. Workmanship:

1. Ensure that coated surfaces are free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce a smooth, even film of uniform thickness completely coating corners and crevices.
2. Coat surfaces without drops, overspray, dry spray, excessive runs, ridges, waves, holidays, laps, or brush marks.
3. Remove splatter and droppings after coating work is completed.
4. Evenly apply each coat of material and sharply cut to a line created with masking tape or other suitable materials.
5. Avoid over spraying or spattering paint on surfaces not to be coated. Protect glass, hardware, floors, roofs, vehicles, and other adjacent areas and installations by taping, drop cloths, or other suitable measures.
6. When coating complex steel shapes, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer before overall coating system application.
  - a. Brush apply stripe coat to ensure proper coverage.
  - b. Do not stripe coat with spray or roller.
7. Ensure that finish coat, including repairs, has a uniform color and gloss.

S. Coating properties, mixing, and thinning:

1. Thin prime coat and apply as recommended by the CSM. Thinned coating must comply with prevailing air pollution control regulations.
2. If maximum recoat time is exceeded, prepare surface with solvent washing, light abrasive blasting, or other procedures per CSM's instructions.
3. Allow adequate drying time between coats as instructed by the CSM, adjusted as necessary for the site conditions.
4. Ensure that coatings, when applied, provide a satisfactory film and a smooth even surface. Lightly sand glossy undercoats to provide a surface suitable for proper application and adhesion of subsequent coats. Thoroughly stir and strain coating materials during application and maintain uniform consistency.
5. Mix coatings with 2 or more components in accordance with CSM's instructions.
6. Where necessary to suit conditions of the surface, temperature, weather and method of application, thin the coating per CSM's recommendations.
  - a. Ensure that volatile organic content (VOC) of the thinned coating complies with prevailing air pollution control regulations.
  - b. Thin coatings to only what is necessary to obtain proper application characteristics.
  - c. Use a thinner recommended by the CSM.

T. Film thickness and continuity:

1. Apply coating to the specified thicknesses.
  - a. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.
2. Verify WFT of the coating system first coat and after applying each subsequent coat.
3. Do not allow the minimum thickness at any point to deviate more than 25 percent from the required average.
4. Do not allow the surface area covered per gallon of coating for various types of surfaces to exceed those recommended by the CSM.
  - a. Provide coating coverage worksheets listing the maximum and minimum coverage for each unit volume of coating for concrete surfaces.

5. Apply additional coats to achieve the specified dry film thickness if brush or roller application methods cannot achieve the specified film thicknesses per coat.
- U. Protecting coated surfaces:
1. Do not handle, work on, or otherwise disturb coated items until the coating is completely dry and hard.
  2. After installation, recoat shop-coated surfaces with specified coating system as necessary to match surrounding surfaces, and to coordinate with the specified color identification requirements.
- V. Special requirements:
1. Before erection, apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces inaccessible after assembly. Apply final coat after erection.
  2. Coat structural slip-critical connections and high strength bolts and nuts after erection.
  3. Areas damaged during erection:
    - a. Prepare surface for spot repairs as specified for the coating system.
    - b. Recoat with prime coat before applying subsequent coats.
    - c. Touch up surfaces after installation.
    - d. Clean and dry surfaces to be coated at time of application.
  4. Coat underside of equipment bases and supports not galvanized with at least 2 coats of primer specified before setting the equipment in place.
  5. Coat aluminum in contact with concrete.

### **3.10 APPLICATION REQUIREMENTS FOR CONCRETE COATING SYSTEMS**

- A. Apply filler/surfacer as recommended by CSM to fill bug holes and air voids in concrete or block texture in CMU, leaving a uniformly filled surface that does not produce blowholes or outgassing causing the coating system to pinhole.
1. Allow filler/surfacer to cure sufficiently before applying prime coat as required by the CSM. Use the CSM-recommended drying time between coats.
- B. Apply surfacer or filler and let dry before coating application.
1. Use the drying time between filler/surfacer and coating system specified by the CSM for the site conditions.
    - a. Let concrete substrate dry before applying filler/surfacer or coating system materials.
  2. If the maximum recoat time is exceeded, prepare surfaces by solvent washing, light abrasive blasting, and other procedures per CSM's instructions.
  3. Apply a complete parge coat of the specified filler/surfacer material over the entire substrate before applying the coating system.
    - a. Scrub filler/surfacer into the substrate to completely fill open air voids and bug holes.
    - b. Completely cover the substrate, unless otherwise specified, above such filled voids by 1/8 inch of thickness.
    - c. Provide relatively flat, uniformly even surface before coating application.
  4. Secondary containment: Place surfacer or filler 1/16 inch thick above concrete plane to create a monolithic surface free of pinholes.

- a. Floor surfaces: Broadcast with aggregate to create a non-slip surface texture.
  - b. Remove excess aggregates and apply base coat to encapsulate embedded non-slip aggregate.
- C. Concrete substrate temperatures:
  - 1. Apply filler/surfacers and the coating system when temperatures are falling, typically late afternoon or evening.
    - a. Do not coat concrete with rising concrete substrate surface temperatures or substrates in direct sunlight, to minimize outgassing from the substrate and formation of pinholes, and/or blistering.
  - 2. Should bubbles, pinholes, or other discontinuities form in the applied coating system material, they shall be repaired.
    - a. Should discontinuities develop in the filler/surfacer material or in the first coat of the coating material, repair them before the next coat.
    - b. When discontinuities occur, open the air void behind or beneath the discontinuities and completely fill with specified coating material. Then, abrade the coated area around the discontinuities repair reapply coating over that area.
- D. Perform application detail work in accordance with these Specifications, the CSM's current written recommendations, and drawings, whichever is stricter.
- E. Concrete coating systems application requirements:
  - 1. Concrete coating minimum dry film thickness excludes parge coat, block filler, and sealer.

### **3.11 COATING SYSTEM SCHEDULE**

- A. Appendix A specifies surfaces to be coated in the field with the coating systems required.

### **3.12 SURFACES NOT REQUIRING COATING**

- A. Stainless steel piping, valves, pipe supports, instrument sunshades.
- B. Sliding surfaces on expansion joints, motor and pump shafts, machined surfaces at bearings and seals, grease fittings, etc.
- C. Galvanized structural steel framing, galvanized roof decking, galvanized pipe supports.
- D. Copper and brass pipe, fittings, valves, etc.
- E. Bronze valves, bearings, bushings, and fasteners.
- F. Corrosion resistant special alloys: Inconel, Alloy 20, Hastelloy, etc.
- G. Exterior Concrete.
- H. Plastic surfaces except coat PVC, CPVC, and other plastic piping system exposed to sunlight.

- I. Buried Piping that is encased in concrete or cement mortar.

### **3.13 QUALITY CONTROL**

- A. Owner-provided inspection or inspection by others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Owner inspection is in addition to any inspection required of the Contractor.
- B. Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section. These inspections may include the following:
  - 1. Inspect materials upon receipt to ensure that the CSM supplied them.
  - 2. Verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
  - 3. Inspect and record findings for substrate cleanliness.
  - 4. Inspect and record pH of concrete and metal substrates.
  - 5. Inspect and record substrate profile (anchor pattern).
  - 6. Measure and record ambient air and substrate temperature.
  - 7. Measure and record relative humidity.
  - 8. Check for substrate moisture in concrete.
  - 9. Verify that mixing of coating system materials is in accordance with CSM's instructions.
  - 10. Inspect, confirm, and record that coating system materials' "pot life" is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
  - 11. Perform adhesion testing.
  - 12. Measure and record the coating system's thickness.
  - 13. Verify proper curing of the coating system in accordance with the CSM's instructions.
  - 14. Holiday or continuity testing in accordance with NACE SP0188 for coatings that will be immersed or exposed to aggressively corrosive conditions.
- C. Contractor shall perform holiday testing in accordance with NACE SP0188 to identify holidays or pinholes needing repair for coating over 100 percent of surfaces:
  - 1. Coated steel that will be immersed or exposed to aggressively corrosive conditions.
  - 2. Coated concrete.
  - 3. Perform holiday tests after proper application and coating system cure.

### **3.14 CORRECTIVE MEASURES**

- A. Repair pinholes or holidays identified by Holiday Testing as follows:
  - 1. Remove the coating system with a grinder or other suitable power tool.
  - 2. Remove coating system at all pinholes and holidays at least 2 inches diameter around the defect back to expose substrate.
  - 3. Concrete voids: chip back to expose entire cavity in all directions.
    - a. Completely fill void with approved filler/surfacer material using a putty knife or other suitable tool, and strike off. Cure per CSM's recommendations.

4. Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
5. Vacuum the prepared area to remove all dust, dirt, etc., leaving clean, sound surfaces.
6. Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
7. Apply the coating system with enough coats to achieve the specified finish coat thickness over the defect and coating removal area. Feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline.
8. Follow curing time between coats as specified by CSM for the site conditions. Solvent wash and abrasive blast per CSM's instructions, if the maximum recoat time is exceeded.
9. Apply coating at specified dry film thickness.

### **3.15 CLEANUP**

- A. Remove surplus materials, protective coverings, and accumulated rubbish after completing coating. Thoroughly clean surfaces and repair overspray or other coating-related damage.

### **3.16 FINAL INSPECTION**

- A. Conduct final inspection of coating system work to determine whether it meets specifications requirements.
- B. Conduct subsequent final inspection with Engineer to ensure work conforms to contract documents requirements.
- C. Mark any rework required.
  1. Re-clean and repair, as specified, at no additional cost to the Owner.

END OF SECTION





APPENDIX A  
Schedule of Surfaces to be Coated

- A. The following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Contact Engineer for clarification.

EPU-M-1	Metals, exterior, non-immersed	
EPX-M-2	Metals, interior, non-immersed	
EPX-M-5	Aluminum surfaces in contact with concrete or masonry. Locations where Alkali-resistant bitumastic is specified.	
SIL-M-1		0
SIL-M-2		0
EPX-C-2		0

Notes:

1: Non-immersed ferrous metal surfaces include:

- a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
- b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
- c. Motors and motor accessory equipment.
- d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
- e. Valve and gate operators and stands.
- f. Structural steel.
- g. Crane and hoist rails.
- h. Exterior of tanks and other containment vessels.
- i. Mechanical equipment supports, drive units, and accessories.
- j. Bare electrical equipment: boxes, exposed conduit, and accessories.
- k. Pumps not submerged.
- l. Other miscellaneous metals.

2: Immersed ferrous metal surfaces include:

- a. Interior surfaces of ferrous metal tanks.
- b. Field priming of ferrous metal surfaces with defective shop-prime coat; including non-submerged service.
- c. Bell rings, underside of manhole covers and frames.
- d. Sump pumps, including underside of base plates and submerged suction and discharge piping.
- e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
- f. Submerged pipe supports and hangers.
- g. Stem guides.
- h. Other submerged iron and steel metal unless specified otherwise.



Appendix B			
Coating Detail Sheet			
Coating System	EPU-M-1		
Coating Material	Two coats epoxy with polyurethane finish coat		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carbothane 134 VOC
International Paint	Devran 224V	Devran 224V	Devthane 379
PPG	Amercoat 385	Amercoat 385	Amercoat 450H
Sherwin Williams	Macropoxy 646	Macropoxy 646	Hi Solids Polyurethane
Tnemec	Series 66HS	Series 66HS	Series 1095
Service Condition	Interior or Exterior, subject to direct sunlight. Non-immersion.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP10, Near-White Blast Cleaning. Shop primed surfaces: SSPC-SP2, Hand Tool Cleaning or SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP10, Near White Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush Blast Cleaning. Test for surface contaminants.		
Surface profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	10 to 13 mils		
Primer	4 to 5 mils		
Intermediate Coat	4 to 5 mils		
Finish Coat	2 to 3 mils		
Application			
Special CTR Training	Not required.		

Appendix B			
Coating Detail Sheet			
Coating System	EPX-M-2		
Coating Material	Epoxy		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carboguard 890
International Paint	Bar-Rust 236	Bar-Rust 236	Bar-Rust 236
PPG	Amerlock 2/400 Series	Amerlock 2/400 Series	Amerlock 2/400 Series
Sherwin Williams	Tank Clad HS	Tank Clad HS	Tank Clad HS
Tnemec	Series 66HS	Series 66HS	Series 66HS
Service Condition	Immersed, non-immersed, moderately corrosive environment.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP5, White Metal Blast Cleaning. Shop primed surfaces: SSPC-SP7, Brush-Off Blast Cleaning. Damaged primer or rust: SSPC-SP5, White Metal Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface profile			
Ferrous Metal	2 to 4 mils		
Nonferrous Metal	1.0 to 1.5 mils		
Galvanized Metal	1.0 to 1.5 mils		
System Thickness (Dry Film)			
Total	12 to 16 mils		
Primer	4 to 6 mils		
Intermediate Coat	4 to 6 mils		
Finish Coat	4 to 6 mils		
Application			
Special CTR Training	Not required.		

Appendix B			
Coating Detail Sheet			
Coating System	EPX-M-5		
Coating Material	Epoxy mastic		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	CSM recommended	None applied	Carbomastic 15
International Paint	CSM recommended	Bar-Rust 231	Bar-Rust 231
PPG	CSM recommended	None applied	Amerlock 2 AL
Sherwin Williams	CSM recommended	None applied	Epoxy Mastic Aluminum II
Tnemec	CSM recommended	Series 135	Series 135
Service Condition	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP11, Power to Cleaning to Bare Metal. Shop primed surfaces: SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP11, Power to Cleaning to Bare Metal.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface profile			
Ferrous Metal	2.0 to 2.5 mils		
Nonferrous Metal	1.0 to 1.5 mils		
System Thickness (Dry Film)			
Total	15 to 19 mils		
Primer	2 to 4 mils		
Finish Coat	15 mils		
Application			
Special CTR Training	Not Required.		

Appendix B			
Coating Detail Sheet			
Coating System	SIL-M-1		
Coating Material	Proprierty primer with Silicone top coat		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
International Paint	Intertherm 50	None Applied	Intertherm 50
PPG	HiTemp 1027	None Applied	1000VS
Sherwin Williams	Heat Flex Hi-Temp 500	None Applied	Heat Flex Hi-Temp 500
Tnemec	Series 1552 Endura-heat, grey	None Applied	Series 1552 Endura-heat, grey
Service Condition	Temperature to 750 degrees F.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	SSPC-SP10, Near-White Metal Blast Cleaning.		
Surface profile			
Ferrous Metal	2.0 to 2.5 mils		
System Thickness (Dry Film)			
Total	6.5 to 8.0 mils		
Primer	5 to 6 mils		
Finish Coat	1.5 to 2.0 mils		
Application			
Special CTR Training	Not Required.		

Appendix B			
Coating Detail Sheet			
Coating System	SIL-M-2		
Coating Material	Proprierty primer with Silicone top coat		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
International Paint	Interbond 1202 UPC	None Applied	Interbond 1202 UPC
PPG	HiTemp 1027	None Applied	1000VS (black or aluminum)
Sherwin Williams	Heat Flex Hi-Temp 1200	None Applied	Heat Flex Hi-Temp 1000
Tnemec	Series 1528 Endura-heat DTM	None Applied	Series 1528 Endura-heat DTM
Service Condition	Temperature to 1200 degrees F.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	SSPC-SP10, Near-White Metal Blast Cleaning.		
Surface profile			
Ferrous Metal	2.0 to 2.5 mils		
System Thickness (Dry Film)			
Total	6.5 to 8.0 mils		
Primer	5 to 6 mils		
Finish Coat	1.5 to 2.0 mils		
Application			
Special CTR Training	Not Required.		

Appendix B			
Coating Detail Sheet			
Coating System	EPX-C-2		
Coating Material	Epoxy		
Substrate	Concrete or masonry		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carboguard 890
International Paint	Bar-Rust 236	Bar-Rust 236	Bar-Rust 236
PPG	Amerlock 2/400 Series	Amerlock 2/400 Series	Amerlock 2/400 Series
Sherwin Williams	Macropoxy 646	Macropoxy 646	Macropoxy 646
Tnemec	Series 66HS	Series 66HS	Series 66HS
Service Condition	Interior, Non-Immersion, Moderately Corrosive.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Concrete	Cure at least 28 days and dry to the CSM's recommended moisture content. Remove loose concrete and laitance from surfaces, and repair voids and cracks as specified in this Section.		
Existing Coated Concrete	Remove all existing coating to a sound substrate or intact, well-adhered coating. Abrade all surfaces to achieve required surface profile and vacuum to remove all loose dirt, paint chips, and dirt.		
Masonry	Cure at least 28 days and dry to CSM's recommended moisture content. Fill holes or other joint defects with mortar and repoint. Scrape or chip to remove loose or splattered mortar. Wash and scrub masonry surfaces with clear water to remove foreign and deleterious substances. Do not use muriatic acid. Fill surfaces with block filler compatible with the specified primer after cleaning.		
Surface profile			
Concrete	0.5 to 1.5 mils		
Existing Coated Concrete	0.5 to 1.5 mils		
Masonry	0.5 to 1.5 mils		
System Thickness (Dry Film)			
Total	10 mils, excluding block filler and sealer.		
Application			
General	Let sealer or filler dry at least 48 hours before primer application. Use CSM's recommended drying time between coats.		
Special CTR Training	Not Required.		



## SECTION 16050

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## **PART 1    GENERAL**

### **1.01    SUMMARY**

- A. Section includes:
  - 1. General requirements applicable to all Electrical Work.
  - 2. General requirements for electrical submittals.
- B. General:
  - 1. Interfaces to equipment, instruments, and other components:
    - a. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
    - b. Provide all material and labor needed to install the actual equipment furnished, and include all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the Work, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
      - 1) Make all changes necessary to meet the manufacturer's wiring requirements.
    - c. Submit all such changes and additions to the Engineer for acceptance as specified in Document 00700 - General Conditions.
    - d. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appear on the Drawings or in the Specifications from another discipline in the scope of Work:
      - 1) If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
  - 2. Loop drawings:
    - a. Provide all electrical information required in the preparation of loop drawings including, but not limited to:
      - 1) Conduit numbers and associated signal(s) contained within each conduit.
      - 2) Wire numbers.
      - 3) Equipment terminal numbers.
      - 4) Junction boxes and signal(s) contained within each junction box.
      - 5) Equipment power sources, and associated circuit numbers.
      - 6) As-built drawings detailing wiring.
  - 3. All electrical equipment and systems for the entire Project must comply with the requirements of the Electrical Specifications, whether referenced in the individual Equipment Specifications or not:
    - a. The requirements of the Electrical Specifications apply to all Electrical Work specified in other sections.
    - b. Inform all vendors supplying electrical equipment or systems of the requirements of the Electrical Specifications.
    - c. Owner is not responsible for any additional costs due to the failure of Contractor to notify all subcontractors and suppliers of the Electrical Specifications requirements.

- C. Contract Documents:
1. General:
    - a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
  2. Specifications:
    - a. The General and Supplementary Conditions of the Contract Documents govern the Work.
    - b. These requirements are in addition to all General Requirements.
  3. Contract Drawings:
    - a. The Electrical Drawings show desired locations, arrangements, and components of the Electrical Work in a diagrammatic manner.
    - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only; exercise professional judgment in executing the Work to ensure the best possible installation:
      - 1) The equipment locations and dimensions indicated on the Drawings are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
      - 2) The Contractor has the freedom to select any of the named manufacturers identified in the individual specification sections; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
    - c. Installation details:
      - 1) The Contract Drawings include typical installation details the Contractor is to use to complete the Electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
      - 2) Not all typical installation details are referenced within the Drawing set. Apply and use typical details where appropriate.
- D. Alternates/Alternatives:
1. Coordinate with Document 00700 - General Conditions for substitute item provisions.
- E. Changes and change orders:
1. As specified in Document 00700 - General Conditions.

## 1.02 REFERENCES

- A. Code compliance:
1. As specified in Section 01410 - Regulatory Requirements.
  2. The publications are referred to in the text by the basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of the bid governs.
  3. The standards listed are hereby incorporated into this Section.

- a. American National Standards Institute (ANSI).
- b. American Society of Civil Engineers (ASCE):
  - 1) ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- c. ASTM International (ASTM).
- d. Illuminating Engineering Society (IES).
- e. Institute of Electrical and Electronics Engineers (IEEE).
- f. Insulated Cable Engineers Association (ICEA).
- g. International Code Council (ICC):
  - 1) International Code Council Evaluation Service (ICC-ES).
    - a) AC 156 - Acceptance Criteria for Seismic Certification by Shake Table Testing of Non-Structural Components (ICC-ES AC 156).
- h. International Society of Automation (ISA).
- i. National Electrical Manufacturers Association (NEMA):
  - 1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
- j. National Fire Protection Association (NFPA):
  - 1) 70 - National Electrical Code (NEC).
- k. National Institute of Standards and Technology (NIST).
- l. Underwriters' Laboratories, Inc. (UL).

- B. Compliance with laws and regulations:
  - 1. As specified in Document 00700 - General Conditions.

### 1.03 DEFINITIONS

- A. General:
  - 1. Definitions of terms and other electrical and instrumentation considerations as set forth by:
    - a. IEEE.
    - b. NETA.
    - c. IES.
    - d. ISA.
    - e. NEC.
    - f. NEMA.
    - g. NFPA.
    - h. NIST.
- B. Specific definitions:
  - 1. FAT: Factory acceptance test.
  - 2. ICSC: Instrumentation and controls subcontractor.
  - 3. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
  - 4. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
  - 5. PCIS: Process control and instrumentation system.
  - 6. RS-232: RS-232 is also known as TIA-232 or EIA-232, is a standard for serial communication transmission of data. When compared to RS-485 it has lower transmission speed, short maximum cable length, large voltage swing, large standard connectors and no multipoint capability. USB has displaced RS-232 from most of its peripheral interface roles.
  - 7. RS-485: RS-485 is also known as TIA-485 or EIA-485, is a standard defining the electrical characteristics of drivers and receivers for use in serial

communications system. Electrical signaling is balanced, and multipoint systems are supported, can be used with data rates up to 10 Mbit/s or at lower speeds distances up to 1,000 m (4,000 ft).

8. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
9. Space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment, i.e., provide all standoffs, bus, and hardware, as part of the space.
10. Spare: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that physically contains a device with no load connections to be made.
11. USB: Universal Serial Bus is an industry standard that establishes specifications for cables, connectors, and protocols for connection, communication, and power supply interfacing between computer, peripherals, and other computers, it has largely replaced interfaces such as serial and parallel ports.
12. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
13. Unequipped space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.

#### 1.04 SYSTEM DESCRIPTION

A. General requirements:

1. The Work includes everything necessary for and incidental to executing and completing the Electrical Work indicated on the Drawings and specified in the Specifications and reasonably inferable there from:
2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of equipment furnished by others as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Provide all Electrical Work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the Work.
4. Coordinate all aspects of the Work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the electrical subcontractor, the other subcontractors or suppliers.
5. Demolition:
  - a. Where demolition is specified or indicated on the Drawings, disconnect all associated electrical equipment and render the equipment safe.
  - b. Remove and dispose of all conduit, wire, electrical equipment, controls, etc. associated with the items and/or areas to be demolished as indicated on the Drawings unless otherwise indicated.

- c. Salvage electrical equipment as specified in Section 01738 - Selective Alterations and Demolition.
- d. For each piece of equipment to be removed, remove all ancillary components (e.g. instruments, solenoid valves, disconnect switches, etc.).
- e. Conduit:
  - 1) Where conduit removal, other than associated with equipment to be removed, is indicated on the Drawings:
    - a) Remove exposed conduit to the point of encasement or burial.
    - b) Cut conduit flush and plug or cap encased or buried conduit.
  - 2) Where conduits are to remain in place and removal is not indicated on the Drawings:
    - a) Cap conduit open ends.
    - b) Re-label empty conduits as spare.
- f. Remove all wire back to the source for all conduits to be removed or abandoned in place.
- g. Provide new nameplates for modified electrical distribution equipment, motor control centers etc. to identify equipment and circuits that are no longer used as spares.
- h. Provide new typewritten schedules for all modified panelboards.
- 6. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
  - a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
  - b. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.
- 7. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the Electrical Work and installation:
  - a. As specified in the Contract Documents.
- 8. Defective work:
  - a. As specified in Document 00700 - General Conditions.
- B. Existing system:
  - 1. Disconnect transformer BB-TR-LP2 in Blower Building 3 to a new power feed from the Grit Removal Building.
  - 2. Demolish generator existing diesel generator EGU-3510 and Switchboard SG-EDA.
- C. New system:
  - 1. Install new the new diesel generator EGU-3510 and Switchboard SG-EDA.
- D. Operating facility:
  - 1. As specified in Section 01140 - Work Restrictions.
  - 2. The South Valley Water Reclamation Facility is an operating facility. Portions of this facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
    - a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction schedule to meet the

- requirements of the Owner. All changes in schedule and any needs to reschedule are included in the Work.
- b. As weather and water demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
  - c. Coordinate the construction and power renovation, bear all costs, so that all existing facilities can continue operation throughout construction.
3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
  4. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling that apply to the new installation apply equally to the existing installation which forms part of the modified system.

## **1.05 SUBMITTALS**

### **A. General:**

1. Furnish submittals as specified in Section 01330 - Submittal Procedures and this Section.
2. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
3. Furnish the submittals required by each section in the Electrical Specifications.
4. Adhere to the wiring numbering scheme specified in Section 16075 - Identification for Electrical Systems throughout the Project:
  - a. Uniquely number each wire.
  - b. Wire numbers must appear on all Equipment Drawings.
5. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.

### **B. Seismic requirements:**

1. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads based on the seismic design criteria in Section 01612 - Seismic Design Criteria.
2. For equipment installed in structures designated as seismic design category C, D, E or F, prepare and submit the following:
  - a. Statement of seismic qualification, and special seismic certification:
    - 1) "Statement of seismic qualification:" Provide manufacturer's statement that the equipment satisfies the seismic design requirements of the building code indicated in Section 01410 - Regulatory Requirements, including the requirements of ASCE 7, Chapter 13.
    - 2) "Special seismic certification:" Provide manufacturer's certification that the equipment, when subjected to shake table testing in accordance with ICC-ES AC 156, meets the "Post-Test Functional Compliance Verification" requirements of ICC-ES AC 156 for "Components with  $I_p = 1.5$ ." Compliance shall include both operability and containment of hazardous materials as appropriate to the unit being tested.
  - b. Substantiating test data: With seismic qualification and special seismic certification statements, submit results of testing in accordance with ICC-ES AC 156.



- c. Anchoring design calculations and details:
    - 1) Submit project-specific drawings and supporting calculations, prepared and sealed by a professional engineer licensed in the state where the Project is being constructed, and showing details for anchoring electrical equipment to its supports and for anchoring supports provided with the equipment to the structure. Prepare calculations in accordance with the requirements of Section 01612 - Seismic Design Criteria.
  - 3. Exemptions: A "statement of seismic qualification" and a "special seismic certification" are not required for the following equipment:
    - a. Temporary or moveable equipment.
    - b. Equipment anchored to the structure and having a total weight of 20 pounds or less.
    - c. Distribution equipment anchored to the structure and having a total unit weight of 3 pounds per linear foot, or less.
- C. Operation and maintenance manuals:
  - 1. As specified in Section 01782 - Operation and Maintenance Manuals.
  - 2. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.
- D. Record Documents:
  - 1. Furnish as specified in Section 01770 - Closeout Procedures.
- E. Test reports:
  - 1. As specified in Section 01330 - Submittal Procedures.
  - 2. Additional requirements for field acceptance test reports are specified in Sections 01756 - Commissioning and 16950 - Field Electrical Acceptance Tests.
- F. Calculations:
  - 1. Where required by specific Electrical Specifications:
    - a. Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

## **1.06 QUALITY ASSURANCE**

- A. General:
  - 1. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. General:
  - 1. As specified in Section 01600 - Product Requirements.

## **1.08 PROJECT OR SITE CONDITIONS**

- A. Site conditions:
  - 1. Provide an electrical, instrumentation and control system, including all equipment, raceways, and any other components required for a complete

installation that meets the environmental conditions for the Site as specified in the General Requirements and below.

2. Seismic load resistance:
  - a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads as specified in Section 01612 - Seismic Design Criteria.
3. Wind load resistance:
  - a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads as specified in Section 01614 - Wind Design Criteria.
4. Altitude, temperature and humidity:
  - a. As specified in Section 01610 - Project Design Criteria.
  - b. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
5. Site security:
  - a. Abide by all security and safety rules concerning the Work on the Site, as specified in the individual specification sections, and Section 01500 - Temporary Facilities and Controls.

**B. Enclosures:**

1. Provide enclosures for electrical, instrumentation and control equipment, regardless of supplier or subcontractor furnishing the equipment, that meet the requirements outlined in NEMA Standard 250 for the following types of enclosures:
  - a. NEMA Type 1: Intended for indoor use, primarily to provide a degree of protection from accidental contact with energized parts or equipment.
  - b. NEMA Type 12: Intended for indoor use, primarily to provide a degree of protection from dust, falling dirt and dripping non-corrosive liquids.

**C. Plant area electrical work requirements:**

1. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

<b>PLANT AREA</b>	<b>NEMA ENCLOSURE TYPE</b>	<b>EXPOSED CONDUIT TYPE</b>	<b>ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS</b>	<b>SUPPORT MATERIALS</b>
Generator Building	12,1	GRC	C	Galvanized Steel
Blower Building 3	12	GRC	C	Galvanized Steel

2. Modify exposed conduit runs as specified in Section 16130 - Conduits.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING**

### **A. General:**

1. As specified in Sections 01312 - Project Meetings and 01756 - Commissioning.
2. Testing requirements are specified in Section 01756 - Commissioning, 16950 - Field Electrical Acceptance Tests and other sections.
3. General scheduling requirements are specified in Section 01321 - Schedules and Reports.
4. Work restrictions and other scheduling requirements are specified in Section 01140 - Work Restrictions.
5. Commissioning requirements as specified in Section 01756 - Commissioning.

## **1.11 WARRANTY**

### **A. General:**

1. Warrant the Electrical Work as specified in Document 00700 - General Conditions:
  - a. Provide additional warranty as specified in the individual Electrical Specifications.

## **1.12 SYSTEM START-UP**

### **A. General:**

1. Replace or modify equipment, software, and materials that do not achieve design requirements after installation to attain compliance with the design requirements:
  - a. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE**

### **A. General:**

1. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
2. Furnish all spare parts as required by other sections of the Specifications.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

#### **A. General:**

1. Provide similar items of same manufacturer throughout the electrical and instrumentation portion of the Project.
2. Allowable manufacturers are specified in individual Electrical Specifications.

### **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS**

### **A. General:**

1. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.
2. Provide materials complying with the applicable industrial standard as specified in Document 00700 - General Conditions.

### **B. Stainless steel:**

1. Where stainless steel is indicated or used for any portion of the Electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
2. Provide exposed screws of the same alloys.
3. Provide finished material free of any burrs or sharp edges.
4. Use only stainless steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals.

## **2.04 MANUFACTURED UNITS (NOT USED)**

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES (NOT USED)**

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL**

### **A. General:**

1. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

#### **A. General:**

1. The electrical subcontractor is encouraged to visit the site to examine the premises completely before bidding.
2. It is the electrical subcontractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations.
3. Comply with pre-bid conference requirements as specified in Document 00100 - Instructions to Bidders.

4. Review the site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

### **3.02 PREPARATION (NOT USED)**

### **3.03 INSTALLATION**

- A. Equipment locations:
  1. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
  2. Verify all dimensions indicated on the Drawings:
    - a. Actual field conditions govern all final installed locations, distances, and levels.
  3. Review all Contract Documents and approved equipment shop drawings and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
  4. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
  5. Provide a complete electrical system:
    - a. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical system.
- B. Equipment installation:
  1. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. Cutting and patching:
  1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
    - a. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member such as drilling, cutting or piercing:
      - 1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made:
        - a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables, etc.
        - b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
    - b. Review the complete Drawing set to ensure that there are no conflicts or coordination problems before cutting, channeling, or core drilling any surface.
  2. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:
    - a. 3M: CP 25WB+: Caulk.
    - b. 3M: Fire Barrier: Putty.
  3. Use the installation details indicated on the Drawings as a guide for acceptable sealing methods.

- D. Conduits:
  - 1. Install all conduits and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
    - a. Install all conduits and equipment in accordance with working space requirements in accordance with the NEC.
      - 1) This includes any panel, disconnect switch or other equipment that can be energized while open exposing live parts regardless of whether it is likely to require examination or has serviceable parts.
    - b. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings.
      - 1) Adjust equipment locations as necessary to avoid any obstruction or interferences.
    - c. Where an obstruction interferes with equipment operation or safe access, relocate the equipment.
    - d. Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.
- E. Earthwork and concrete:
  - 1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the Electrical Work:
    - a. Requirements as specified in the Contract Documents.
- F. Terminations:
  - 1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.
- G. Miscellaneous installation requirements:
  - 1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer as specified in Document 00700 - General Conditions.
- H. Labeling:
  - 1. Provide all nameplates and labels as specified in Sections 16075 - Identification for Electrical Systems.
- I. Equipment tie-downs:
  - 1. Anchor all control panels, and equipment by methods that comply with seismic and wind bracing criteria, which apply to the Site.
    - a. All control panels must be permanently mounted and tied down to structures in accordance with the Project seismic criteria.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 COMMISSIONING**

- A. General:
  - 1. As specified in Section 01756 - Commissioning.

- B. Loop tests:
  - 1. Loop tests shall be conducted as specified in Section 01756 - Commissioning and Section 17950 - Commissioning for Instrumentation and Controls.
    - a. Electrical Contractor shall be on site and assist with troubleshooting and correcting issues found during loop testing.
- C. Owner training:
  - 1. As specified in Section 01756 - Commissioning and in this Section.
  - 2. Provide source testing and owner training on electrical equipment as defined in the table below:

Table1: Source Testing and Owner Training Requirements:

Section Number	Section Title	Source Testing (Witnessed or Non-witnessed)	Owner Training Requirements	
			Maintenance (hrs per session)	Operation (hrs per session)
16232	Single Diesel Fueled Engine Generator Above 200 KW	Non-Witnessed	6	4

### 3.08 FIELD QUALITY CONTROL

- A. Inspection:
  - 1. Allow for inspection of electrical system installation as specified in Section 01450 - Quality Control.
  - 2. Provide any assistance necessary to support inspection activities.
  - 3. Engineer inspections may include, but are not limited to, the following:
    - a. Inspect equipment and materials for physical damage.
    - b. Inspect installation for compliance with the Drawings and Specifications.
    - c. Inspect installation for obstructions and adequate clearances around equipment.
    - d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
    - e. Inspect equipment nameplate data to verify compliance with design requirements.
    - f. Inspect raceway installation for quality workmanship and adequate support.
    - g. Inspect cable terminations.
  - 4. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in Section 16950 - Field Electrical Acceptance Tests.
- B. Field acceptance testing (Functional Testing):
  - 1. Notify the Engineer when the Electrical Work is ready for field acceptance testing.
  - 2. Perform the field acceptance tests as specified in Section 16950 - Field Electrical Acceptance Tests.
  - 3. Record results of the required tests along with the date of test:
    - a. Use conduit identification numbers to indicate portion of circuit tested.

- C. Workmanship:
  - 1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
    - a. Neatly coil and label spare wiring lengths.
    - b. Shorten, re-terminate, and re-label excessive used as well as spare wire and cable lengths, as determined by the Engineer.

### **3.09 ADJUSTING (NOT USED)**

### **3.10 CLEANING**

- A. General:
  - 1. As specified in Section 01770 - Closeout Procedures.
  - 2. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
  - 3. Clean and vacuum all enclosures to remove all metal filings, surplus insulation and any visible dirt, dust or other matter before energization of the equipment or system start-up:
    - a. Use of compressors or air blowers for cleaning is not acceptable.
  - 4. As specified in other sections of the Contract Documents.

### **3.11 PROTECTION**

- A. General:
  - 1. Protect all Work from damage or degradation until Substantial Completion.
  - 2. Maintain all surfaces to be painted in a clean and smooth condition.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION



**SECTION 16070**  
**HANGERS AND SUPPORTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes:
  - 1. Mounting and supporting electrical equipment and components.

**1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. ASTM International (ASTM):
  - 1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 3. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

**1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**1.04 SYSTEM DESCRIPTION**

- A. Design requirements:
  - 1. Conform to the requirements of the Building Code as specified in Section 01410 - Regulatory Requirements.
  - 2. Demonstrate the following using generally accepted engineering methods:
    - a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
    - b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.
  - 3. Design loading and anchoring requirements:
    - a. As indicated in the Building Code unless otherwise specified.
    - b. Seismic loading requirements:
      - 1) Freestanding, suspended or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in Section 16050 - Common Work Results for Electrical.
    - c. Wind loading requirements:
      - 1) All exterior equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in Section 16050 - Common Work Results for Electrical.
    - d. Minimum safety factor against overturning: 1.5.

- e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.
- B. Performance requirements:
  - 1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.

## **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Supports:
    - a. Materials.
    - b. Geometry.
    - c. Manufacturer.
  - 2. Hardware:
    - a. Materials.
    - b. Manufacturer.
- C. Shop drawings:
  - 1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
  - 2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, and wall supports for all equipment:
    - a. For free standing supports and wall supports supporting equipment weight in excess of 200 pounds:
      - 1) Stamped by a professional engineer licensed in the state where the Project is being constructed.
    - b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.
  - 3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.
- D. Installation instructions:
  - 1. Furnish anchorage instructions and requirements based on the seismic and wind conditions of the Site:
    - a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

## **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM STARTUP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. One of the following or equal:
  - 1. Preformed channel:
    - a. Thomas & Betts.
    - b. Power-Strut.
    - c. Unistrut.
    - d. Cooper B-Line.
    - e. Robroy.
    - f. Tyco.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS**

- A. Use materials appropriate for the area as specified in Section 16050 - Common Work Results for Electrical.
- B. Preformed channel:
  - 1. Hot dip galvanized steel:
    - a. Supports:
      - 1) In accordance with ASTM A123 or A153.
      - 2) Minimum zinc coating thickness of 2.5 mils.
    - b. Hardware:
      - 1) Electro-galvanized.
      - 2) In accordance with ASTM A153.

## **2.04 MANUFACTURED UNITS (NOT USED)**

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES**

- A. Anchor bolts:
  - 1. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Preformed Channel:
  - 1. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
    - a. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.
  - 2. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
    - a. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.
  - 3. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
    - a. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
    - b. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
    - c. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.
  - 4. Corrosion protection:
    - a. Isolate dissimilar metals, except where required for electrical continuity.
      - 1) Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.
  - 5. Raceway:
    - a. Furnish all racks and trapeze structures needed to support the raceway from the structure.
      - 1) Group raceway and position on racks to minimize crossovers.

- 2) Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.
6. Anchoring methods:
  - a. Solid concrete: Anchor bolts, anchor rods or post-installed anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
  - b. Metal surfaces: Machine screws or bolts.
7. Recoat or seal all drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

**3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

**3.05 REPAIR/RESTORATION (NOT USED)**

**3.06 RE-INSTALLATION (NOT USED)**

**3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

**3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.09 ADJUSTING (NOT USED)**

**3.10 CLEANING (NOT USED)**

**3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.12 SCHEDULES (NOT USED)**

END OF SECTION



## **SECTION 16075**

### **IDENTIFICATION FOR ELECTRICAL SYSTEMS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Identification of electrical equipment, devices and components.
  - 2. Material, manufacturing and installation requirements for identification devices.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Occupational Safety and Health Administration (OSHA).

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

##### **1.04 SYSTEM DESCRIPTION**

- A. Nameplates:
  - 1. Provide a nameplate for each piece of electrical equipment and devices, control panel and control panel components.
  - 2. Provide all nameplates of identical style, color, and material throughout the facility.
  - 3. Device nameplates information:
    - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
- B. Wire numbers:
  - 1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
    - a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
    - b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
    - c. Internal panel wires on a common terminal shall have the same wire number.
    - d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
  - 2. Provide the following wiring numbering schemes throughout the project for field wires:

(ORIGIN LOC.)–(ORIGIN TERM.)/(DEST. LOC.)–(DEST. TERM.)

(ORIGIN LOC.)–(ORIGIN TERM.)  
(DEST. LOC.)–(DEST. TERM.)

OR

Where:

ORIGIN LOC. = Designation for originating panel or device

ORIGIN TERM. = Terminal designation at originating panel or device

DEST. LOC. = Designation for destination panel or device

DEST. TERM. = Terminal designation at destination panel or device or PLC

I/O address at destination panel:

- a. Identify equipment and field instruments as the origin.
- b. PCMs are always identified as the destination.
- c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
- d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
- e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
- f. Terminal designations at PCMs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen-Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project):
  - 1) Discrete Point: W:X:Y/Z.  
Analog Point: W:X:Y.Z.  
Where:  
W= I for input, O for output  
X= PLC number (1, 2, 3...)  
Y= Slot number (01, 02, 03...)  
Z= Terminal number (00, 01, 02...) for a discrete point or a word number for an analog point (1, 2, 3...)
- g. Terminal designations at PCMs where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with "A" (e.g. C0010A).



## **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Nameplates:
    - a. Color.
    - b. Size:
      - 1) Outside dimensions.
      - 2) Lettering.
    - c. Material.
    - d. Mounting means.
  - 2. Nameplate schedule:
    - a. Show exact wording for each nameplate.
    - b. Include nameplate and letter sizes.
  - 3. Wire numbers:
    - a. Manufacturer's catalog data for wire labels and label printer.
- C. Record documents:
  - 1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

## **1.06 QUALITY ASSURANCE (NOT USED)**

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 PROJECT SITE CONDITIONS (NOT USED)**

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Nameplates and signs:
  - 1. One of the following or equal:
    - a. Brady.
    - b. Seton.
- B. Conductor and cable markers:
  - 1. Heat-shrinkable tubing:
    - a. One of the following or equal:
      - 1) Raychem.
      - 2) Brady.
      - 3) Thomas & Betts.
      - 4) Kroy.
      - 5) Panduit.
- C. Conduit and raceway markers:
  - 1. Non-metallic, one of the following or equal:
    - a. Almetek: Mini Tags.
    - b. Lapp Group: Maxi System.

### **2.02 EXISTING PRODUCTS (NOT USED)**

### **2.03 MATERIALS**

- A. Nameplates:
  - 1. Colors:
    - a. Warning nameplates: White-center, red face.
    - b. Other nameplates: Black-center, white face.
  - 2. Laminated plastic engraving stock:
    - a. 3/32-inch-thick material.
    - b. 2-ply.
    - c. With chamfered edges.
  - 3. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
    - a. No characters smaller than 1/8-inch in height.
- B. Signs:
  - 1. Automatic equipment and high voltage signs:
    - a. Suitable for exterior use.
    - b. In accordance with OSHA regulations.
- C. Conductor and cable markers:
  - 1. Machine printed black characters on white tubing.
  - 2. 10-point type or larger.
- D. Conduit and raceway markers:
  - 1. Non-metallic:
    - a. UV resistant holder and letters.
    - b. Black letters on yellow background.
    - c. Minimum letter height: 1/4-inch - 1/2-inch.
    - d. Adhesive labels are not acceptable.

**2.04 MANUFACTURED UNITS (NOT USED)**

**2.05 EQUIPMENT (NOT USED)**

**2.06 COMPONENTS (NOT USED)**

**2.07 ACCESSORIES (NOT USED)**

**2.08 MIXES (NOT USED)**

**2.09 FABRICATION (NOT USED)**

**2.10 FINISHES (NOT USED)**

**2.11 SOURCE QUALITY CONTROL**

**A. Nameplates:**

1. Provide all nameplates for control panel operator devices (e.g. pushbuttons, selector switches, pilot lights, etc.):
  - a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

**PART 3 EXECUTION**

**3.01 EXAMINATION (NOT USED)**

**3.02 PREPARATION (NOT USED)**

**3.03 INSTALLATION**

**A. As specified in Section 16050 - Common Work Results for Electrical.**

**B. Nameplates:**

1. Attach nameplates to equipment with rivets, bolts or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
2. Nameplates shall be aligned and level or plumb to within 1/32 inch over the entire length:
  - a. Misaligned or crooked nameplates shall be remounted or provide new enclosures at the discretion of the Engineer.

**C. Conductor and cable markers:**

1. Apply all conductor and cable markers before termination.
2. Heat-shrinkable tubing:
  - a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.
  - b. Tubing shall be tight on the wire after it has been heated.
  - c. Characters shall face the open panel and shall read from left to right or top to bottom.
  - d. Marker shall start within 1/32 inch of the end of the stripped insulation.

- D. Conduit markers:
  - 1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
    - a. Conduit markings shall match the conduit schedule.
  - 2. Mark conduits at the following locations:
    - a. Each end of conduits that are greater than 10 feet in length.
    - b. The middle of conduits that are 10 feet or less in length.
    - c. Where the conduit penetrates a wall or structure.
    - d. Where the conduit emerges from the ground, slab, etc.
  - 3. Mark conduits after the conduits have been fully painted.
  - 4. Position conduit markers so that they are easily read from the floor.
  - 5. Attach non-metallic conduit markers with nylon cable ties:
    - a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
- E. Signs and labeling:
  - 1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
    - a. Fasten warning signs with round head stainless steel screws or bolts.
    - b. Locate and mount in a manner to be clearly legible to operations personnel.
  - 2. Furnish and install warning signs on equipment that has more than one source of power.
    - a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.

#### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

#### **3.05 REPAIR/RESTORATION (NOT USED)**

#### **3.06 RE-INSTALLATION (NOT USED)**

#### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

#### **3.08 FIELD QUALITY CONTROL**

- A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

#### **3.09 ADJUSTING (NOT USED)**

#### **3.10 CLEANING (NOT USED)**

#### **3.11 PROTECTION (NOT USED)**

#### **3.12 SCHEDULES (NOT USED)**

END OF SECTION

**SECTION 16123**  
**600-VOLT OR LESS WIRES AND CABLES**  
**TABLE OF CONTENTS**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Section includes:
  - 1. 600-volt class or less wire and cable.

**1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. ASTM International (ASTM):
  - 1. B3 - Standard Specification for Soft or Annealed Copper Wire.
  - 2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. CSA International (CSA).
- D. Insulated Cable Engineers Association (ICEA):
  - 1. NEMA WC 70/ICEA S-95-658-1999 - Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
  - 2. NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.
- E. National Fire Protection Association (NFPA):
  - 1. 72 - National Fire Alarm and Signaling Code.
  - 2. 101 - Life Safety Code.
- F. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
  - 1. 568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
  - 2. 569-B - Commercial Building Standards for Telecommunications Pathways and Spaces.
  - 3. 1005 - Industrial Cabling Standard.
- G. Underwriter's Laboratories Inc., (UL):
  - 1. 44 - Thermoset-Insulated Wires and Cables.

**1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Specific definitions and abbreviations:
  - 1. AWG: American wire gauge.
  - 2. BCCS: Bare copper-covered steel.

3. CPE: Chlorinated polyethylene.
  4. FEP: Fluorinated ethylene propylene.
  5. FHDPE: Foam high-density polyethylene.
  6. FPE: Foam polyethylene.
  7. OD: Outside diameter.
  8. PVC: Polyvinyl chloride.
  9. XHHW: Cross-linked high heat water resistant insulated wire.
- C. Definitions of terms and other electrical considerations as set forth in the:
1. ASTM.
  2. ICEA.

#### **1.04 SYSTEM DESCRIPTION**

- A. Furnish and install the complete wire and cable system.

#### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
1. Manufacturer of wire and cable.
  2. Insulation:
    - a. Type.
    - b. Voltage class.
  3. AWG size.
  4. Conductor material.
  5. Pulling compounds.
- C. Shop drawings:
1. Show splice locations.
    - a. For each proposed splice location provide written justification describing why the splice is necessary.
- D. Test reports:
1. Submit test reports for meg-ohm tests.
- E. Calculations:
1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
    - a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
    - b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

#### **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.

- B. All wires and cables shall be UL listed and labeled.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 PROJECT OR SITE CONDITIONS (NOT USED)**

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER`S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. One of the following or equal:
  - 1. 600-volt class wire and cable:
    - a. General Cable.
    - b. Okonite Co.
    - c. Southwire Co.
    - d. Service Wire.
  - 2. Instrumentation class wire and cable:
    - a. Alpha Wire Co.
    - b. Belden CDT.
    - c. General Cable.
    - d. Okonite Co.
    - e. Rockbestos Surprenant Cable Corp.
  - 3. Network cables:
    - a. General Cable.
    - b. Belden.
    - c. CommScope.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS**

- A. Conductors:
  - 1. Copper in accordance with ASTM B3.

## 2.04 MANUFACTURED UNITS

### A. General:

1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
2. Permanently mark each wire and cable with the following at 24-inch intervals:
  - a. AWG size.
  - b. Voltage rating.
  - c. Insulation type.
  - d. UL symbol.
  - e. Month and year of manufacture.
  - f. Manufacturer's name.
3. Identify and mark wire and cable as specified in Section 16075 - Identification for Electrical Systems:
  - a. Use integral color insulation for #2 AWG and smaller wire.
  - b. Wrap colored tape around cable larger than #2 AWG.

### B. 600-volt class wire and cable:

1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Conduit Schedules:
  - a. When not indicated on the Drawings, size wire as follows:
    - 1) In accordance with the NEC:
      - a) Use 75-degree Celsius ampacity ratings.
      - b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
    - 2) Provide #12 AWG minimum for power conductors.
    - 3) Provide #14 AWG minimum for control conductors.
2. Provide Class B stranding in accordance with ASTM B8:
  - a. Provide Class C stranding where extra flexibility is required.
3. Insulation:
  - a. XHHW-2.
  - b. 90-degree Celsius rating.

### C. Instrumentation class cable:

1. Type TC.
2. Suitable for use in wet locations.
3. Voltage rating: 600 volts.
4. Temperature rating:
  - a. 90-degree Celsius rating in dry locations.
  - b. 75-degree Celsius rating in wet locations.
5. Conductors:
  - a. Insulation:
    - 1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
  - b. #16 AWG stranded and tinned.
  - c. Color code: ICEA Method 1:
    - 1) Pair: Black and white.
    - 2) Triad: Black, white and red.
    - 3) Multiple pairs or triads:
      - a) Color-coded and numbered.
6. Drain wire:
  - a. #18 AWG.



- b. Stranded, tinned.
- 7. Jacket:
  - a. Flame retardant, moisture and sunlight resistant PVC.
  - b. Ripcord laid longitudinally under jacket to facilitate removal.
- 8. Shielding:
  - a. Individual pair/triad:
    - 1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
  - b. Multiple pair or triad shielding:
    - 1) Group shield: Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
    - 2) Completely isolate group shields from each other.
    - 3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
  - c. All shielding to be in contact with the drain wire.

D. Network cables:

- 1. Category 6:
  - a. General:
    - 1) Provide Cat 6 cables meeting the standards set by TIA/EIA-568-C.2 and verified by third-party testing laboratory.
  - b. Conductors:
    - 1) #23 AWG solid bare annealed copper.
    - 2) 4 Bonded pairs.
  - c. Drain wire:
    - 1) #24 AWG stranded (7/32) tinned copper.
  - d. Insulation:
    - 1) Non-Plenum: Polyolefin.
    - 2) Plenum: Fluoropolymer.
  - e. Shielding:
    - 1) None.
  - f. Color code:
    - 1) Pair 1: White/blue stripe and blue.
    - 2) Pair 2: White/orange stripe and orange.
    - 3) Pair 3: White/green stripe and green.
    - 4) Pair 4: White/brown stripe and brown.
  - g. Outer jacket:
    - 1) Non-Plenum: Flame-Retardant PVC.
    - 2) Plenum: Low-Smoke, Flame-Retardant PVC.
  - h. Electrical characteristics
    - 1) Voltage rating: 600VAC.

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES**

- A. Wire ties:
  - 1. One of the following or equal:
    - a. T&B, "Ty-Rap" cable ties.
    - b. Panduit, cable ties.

- B. Wire markers:
  - 1. As specified in Section 16075 - Identification for Electrical Systems.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL**

- A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.
- B. Test Type XHHW-2 in accordance with the requirements of UL 44.

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Color-coding:
  - 1. Color-coding shall be consistent throughout the facility.
  - 2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
    - d. Single phase system: Black for 1 hot leg, red for the other.
    - e. Neutral: White.
    - f. High phase or wild leg: Orange.
    - g. Equipment ground: Green.
  - 3. The following color code shall be followed for all 480/277 volt systems:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
    - d. Neutral: Gray.
    - e. Equipment ground: Green.
  - 4. The following color code shall be followed for all 120 VAC control wiring:
    - a. Power: Red.
    - b. Neutral: White.
  - 5. The following color code shall be followed for all general purpose DC control circuits:
    - a. Grounded conductors: White with blue stripe.
    - b. Ungrounded conductors: Blue.
  - 6. Switch legs shall be violet. 3-way switch runners shall be pink.

7. Wire colors shall be implemented in the following methods:
  - a. Wires manufactured of the desired color.
  - b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
    - 1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.
- C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
  1. Install wires only in approved raceways.
  2. Do not install wire:
    - a. In incomplete conduit runs.
    - b. Until after the concrete work and plastering is completed.
- D. Properly coat wires and cables with pulling compound before pulling into conduits:
  1. For all #4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
    - a. Ideal Products.
    - b. Polywater Products.
    - c. 3M Products.
    - d. Greenlee Products.
    - e. Or equal as recommended by cable manufacturer.
    - f. Do not use oil, grease, or similar substances.
- E. Cable pulling:
  1. Prevent mechanical damage to conductors during installation.
  2. For cables #1 AWG and smaller, install cables by hand.
  3. For cables larger than #1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
- F. Install and terminate all wire in accordance with manufacturer's recommendations.
- G. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
  1. Do not lace wires in gutter or panel channel.
  2. Install all wire ties with a flush cutting wire tie installation tool:
    - a. Use a tool with an adjustable tension setting.
  3. Do not leave sharp edges on wire ties.
- H. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
  1. Use ring type lugs if box lugs are not available on the equipment.
- I. Lighting circuits:
  1. Each circuit shall have a dedicated neutral.
- J. Splices:
  1. Provide continuous circuits from origin to termination whenever possible:
    - a. Obtain Engineer's approval prior to making any splices.
  2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
  3. Provide power conductors splices as indicated on the Drawings.

4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
  5. Clearly label equipment containing splices with the word "SPlice LOCATED WITHIN".
  6. Leave sufficient slack to make proper splices and connections. Do not pull splices into conduits.
  7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve.
- K. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.
- L. Instrumentation class cable:
1. Install instrumentation class cables in separate raceway systems from power cables:
    - a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
    - b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
  2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
- M. Copper Ethernet cables:
1. Comply with TIA/EIA-568-C.2.
  2. Pathways:
    - a. For initial installation, the maximum fill capacity for pathways (i.e. conduit, raceways, trays, baskets) is 40 percent. The maximum fill capacity of 60 percent is allowed to accommodate future additions after initial installation.
    - b. Conduit should be run in the most direct route possible with no more than two 90-degree bends between pull boxes and serve no more than 3 outlet boxes.
  3. Cable bend radius:
    - a. Proper cable bend radius control must be maintained throughout the pathways. The bend radius needs to be at a minimum 10 times the cable diameter.
  4. Cable pulling:
    - a. Provide cable pulling swivel system to prevent winding and tangling of rope and cables during pull.
    - b. The maximum pulling tension is not to exceed manufacturer recommendations. Cable installation should not in any way deform the cable jacket.
    - c. 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.
  5. Cable management:
    - a. Organize and manage cables for quick and easy moves, adds and changes.
  6. Testing:
    - a. All cables and termination hardware shall be 100 percent tested for defects in installation and to verify cabling system performance under

installed conditions according to the requirements of TIA/EIA-568-C.1 Section 11.

- 1) All pairs of each installed cable shall be verified prior to system acceptance.
  - 2) Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed.
  - b. All twisted-pair copper cable links shall be tested for compliance to the requirements in TIA/EIA/568-C.2 for the appropriate Category of cabling installed.
  - c. All cables shall be tested in accordance with the contract documents, TIA/EIA standards, and best industry practice.
  - d. The field test equipment shall meet the requirements of TIA/EIA-568-C. The appropriate level III tester shall be used to verify Category 6 cabling.
  - e. Visually inspect UTP 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/EIA-568-C.1.
  - f. Visually inspect cable placement, cable termination, grounding and bonding, equipment and labeling of all components.
  - g. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors.
    - 1) Test operation of shorting bars in connection blocks.
    - 2) Test cables after termination but not cross-connection.
      - a) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2.
        - (1) 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.
        - (2) Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
7. Separation from EMI sources:
  - a. Comply with TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
  - c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

- 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
  - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
  - e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
- N. Signal cable:
  - 1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.
- O. Wiring allowances:
  - 1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
  - 2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

#### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

#### **3.05 REPAIR/RESTORATION (NOT USED)**

#### **3.06 RE-INSTALLATION (NOT USED)**

#### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

#### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **3.09 ADJUSTING (NOT USED)**

#### **3.10 CLEANING (NOT USED)**

#### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **3.12 SCHEDULES (NOT USED)**

END OF SECTION

## SECTION 16125

### FIBER OPTIC CABLE AND APPURTENANCES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes:
  - 1. Fiber optic cable.
  - 2. Fiber splices and terminations.
  - 3. Accessories.
- B. Furnish a complete fiber optic network as indicated on the Drawings.

##### 1.02 REFERENCES

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Bellcore Standards:
  - 1. GR-409, "Generic Requirements for Indoor Fiber."
- C. Electronic Industry Association (EIA) 455B "Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components":
  - 1. FOTP-25 - Impact testing of Fiber Optic Cables and Cable Assemblies.
  - 2. FOTP-33 - Fiber Optic Cable Tensile Loading and Bending Test.
  - 3. FOTP-41 - Compressive Loading Resistance of Fiber Optic Cables.
  - 4. FOTP-81 - Compound Flow (Drip) Test for Filled Fiber Optic Cable.
  - 5. FOTP-104 - Fiber Optic Cable Cyclic Flexing Test.
  - 6. FOTP-181 - Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components.
- D. Insulated Cable Engineer's Association (ICEA):
  - 1. S-83-596, "Optic Fiber Premises Distribution Cables."
  - 2. S-87-640, "Optic Fiber Outside Plant Communications Cable."
  - 3. S-104-696, "Indoor-Outdoor Optic Fiber Cable."
- E. TIA/EIA Standards:
  - 1. 598 - "Optical Fiber Cable Color Coding."
  - 2. 11801 - Information technology - Generic cabling for customer premises.
- F. Underwriters Laboratories, Inc. (UL):
  - 1. 1666 - Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
  - 2. 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

### 1.03 DEFINITIONS

- A. As specified in Sections 16050 - Common Work Results for Electrical and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definition:
  - 1. N/Cm: Newtons per centimeter.
  - 2. OTLS: Optical Loss Test Set (Tier 1 test).
  - 3. OTDR: Optical Time Domain Reflectometer (Tier 2 test).

### 1.04 SYSTEM DESCRIPTION (NOT USED)

### 1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Complete manufacturer's brochures that identify materials and options.
  - 2. Completed data sheets, including catalog number and source for determining catalog number.
  - 3. Manufacturer's installation instructions.
  - 4. Include the following:
    - a. Manufacturer's data on testing equipment used on this project.
    - b. Manufacturer's specifications and data sheets for all fiber types.
    - c. Manufacturer's specifications and data sheets for all connectors, bulkheads, splicing kits, breakout devices, and appurtenances used in connecting and terminating the fiber spans.
  - 5. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the NIST.
  - 6. Manufacturer's test procedures and quality assurance procedures:
    - a. After review, the Engineer may require that additional tests be performed before installation.
- C. Shop drawings:
  - 1. Interconnection cabling diagrams for the complete system including every fiber in each cable.
  - 2. Drawings indicating the locations of all pull boxes including pull box identifiers and lengths.
  - 3. Submit optical power budget calculations for all fiber segments. Include the following:
    - a. Minimum transmit power of active devices.
    - b. Minimum receive sensitivity.
    - c. Available power, in dBm.
    - d. Loss for each segment in dBm, including cable attenuation and connector losses. Use manufacturer's data for cable attenuation, at the wavelength to be used. Assume 0.5 dB per connector.
    - e. Demonstrate that remaining power budget at each receiver is equal to or greater than 3.0 dBm.
- D. Installation instructions:
  - 1. Submit a cable pulling and splicing work plan a minimum of 45 days before the planned initiation of cable pulling. The cable pulling and splicing work plan



must be approved a minimum of 15 days before pulling cable. Include the following:

- a. Pull tension calculations.
- b. Detailed description of pull operation methods for all conduit runs.
- c. Tools and equipment to be used for cable installation and testing.
- d. Physical location of equipment setup and type.
- e. Exact locations of splice points.
- f. Safety and manual assist cable-pulling operations.
- g. Detailed schedule for pulling and testing cables.
- h. The name and qualifications of the supervisory personnel directly responsible for the installation of the conduit system.
- i. Sample fiber optic cable test sheets.
- j. All signed test sheet results.

E. Operation and maintenance manuals:

1. Compile completed test reports, instruction manuals, and manufacturer's information into the operating manuals and submitted in accordance with Section 01782 - Operation and Maintenance Manuals.

F. Test reports:

1. Submit the results of all specified tests to the Engineer.
2. Submit 3 copies of all test reports showing the results of all tests specified herein or in Section 16950 - Field Electrical Acceptance Tests:
  - a. Test forms shall include the following information at a minimum:
    - 1) Test type.
    - 2) Test location.
    - 3) Test date.
    - 4) Wavelength.
    - 5) Index of refraction.
    - 6) Cable identification.
    - 7) Fiber type.
    - 8) Fiber number.
    - 9) Fiber color.
    - 10) Result of the value of the tested parameter.
3. Furnish hard copy and electronic copy for all OTDR traces.
4. Submit certification that the fiber optic cable has passed each testing stage:
  - a. Submit separate documentation for each testing stage result.

G. Record documents:

1. Furnish updated electrical drawings, network diagrams, and fiber cable block diagrams at the end of construction and submit as Record Drawings.

H. Calculations:

1. Cable pulling calculations for all conduit runs:
  - a. Indicate on the submittal any additional pull boxes that are required, including pull box identifiers and a written description of the location.

## 1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Furnish all cable and appurtenances manufactured within 1 year of installation.

- C. Proof test all optical fibers by the fiber manufacturer at a minimum load of 50 kpsi.
- D. Provide 100 percent attenuation testing for all optical fibers:
  - 1. Include with each cable reel the attenuation of each fiber.
- E. Provide information on at least 5 successful fiber optic cable installations of comparable size and complexity in the past 3 years with name, address, and telephone number of facility owner, name of project with completion date, and type of conduit system and length of cable pulled.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Package the cable for shipment on wooden reels:
  - 1. Seal both ends of the cable to prevent the ingress of moisture.
  - 2. Place fiber cable assemblies on reels such that both cable ends are available for testing.
  - 3. Weatherproof cable reel markings shall include the following:
    - a. Manufacturer.
    - b. Date of manufacture.
    - c. Shipping date.
    - d. Cable identification.
    - e. Cable configuration/fiber count.
    - f. Cable length.
    - g. Gross weight.
    - h. Cable test date.
    - i. Handling instructions.
    - j. Direction to unreel.

#### **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.09 SEQUENCING**

- A. Testing:
  - 1. Perform testing of each fiber in each cable as follows:
    - a. At the factory before shipment.
    - b. At the project site upon delivery.
    - c. After installation, before breakout and terminations.
    - d. After installation is complete.
  - 2. Submit test reports following each set of tests as specified in this Section.
- B. Notify the Engineer and Owner a minimum of 15 days before post-installation testing.

#### **1.10 SCHEDULING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP (NOT USED)**

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. Acceptable manufacturers are indicated with each component type as listed in the remainder of this specification.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS (NOT USED)**

## **2.04 MANUFACTURED UNITS**

- A. General fiber cable requirements:
  - 1. Suitable for the installed environment.
  - 2. Color-coded fibers according to EIA/TIA-598.
  - 3. Color-coded buffer tubes according to EIA/TIA-598.
  - 4. Furnish buffer tubes of a single layer nylon construction or of a material with similar mechanical performance.
  - 5. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
  - 6. Apply binders with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes:
    - a. Provide binders that are:
      - 1) Non-hygroscopic.
      - 2) Non-wicking (or rendered so by the flooding compound).
      - 3) Dielectric with low shrinkage.
  - 7. Provide a minimum of 1 ripcord under the cable sheath.
  - 8. Provide the high tensile strength Aramid yarns, Kevlar, and/or fiberglass helically stranded evenly around the cable core:
    - a. No metallic elements whatsoever are allowed in non-armored cable.
  - 9. The jacket or sheath shall be free of holes, splits, and blisters.
  - 10. Mark the jacket or sheath with:
    - a. Manufacturer's name.
    - b. The words "Optical Cable".
    - c. Year of manufacture.
    - d. Sequential meter marks.
    - e. Repeat markings every 1-meter.
    - f. The actual length of the cable to be within 1 percent of the length marking.
    - g. The marking must be in a contrasting color to the cable jacket.
    - h. The height of the marking:
      - 1) Approximately 2.5 millimeters.

11. The shipping, storage, and operating temperature range of the cable shall be -40 degrees Celsius to +70 degrees Celsius.
12. General performance characteristics:
  - a. The rated tensile load of the cables:
    - 1) Indoor/outdoor:
      - a) Short term: 1,330 N.
      - b) Long term: 400 N.
  - b. Non-armored fiber optic cables: Compressive load withstand of 220 N/cm applied uniformly over the length of the cable.
  - c. Armored fiber optic cables: Compressive load withstand of 440 N/cm applied uniformly over the length of the cable.
  - d. The average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm for a cable subjected to this load:
    - 1) With no measurable increase in attenuation after load removal.
  - e. Test in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cable," except that the load must be applied at the rate of 3 millimeters to 20 millimeters per minute and maintained for 10 minutes.
  - f. Capable of withstanding 25 cycles of mechanical flexing at a rate of 30 within 1 cycles/minute.
  - g. The average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm at the completion of the test.
  - h. For armored cables, any visible cracks causing separation of the armor and propagating more than 5 millimeters constitutes failure.
  - i. Outer cable jacket cracking or splitting observed under 10X times magnification, constitutes failure.

B. Indoor/outdoor cable:

1. Cable construction:
  - a. General:
    - 1) Cable type: Indoor/Outdoor - Flame retardant, low smoke, zero halogen, UV resistant.
    - 2) Fiber count: 24 strand.
    - 3) Fiber type: Single mode.
    - 4) Buffer tube: Loose tube.
    - 5) Armoring: None.
    - 6) Waterproofing: Water blocking layer.
    - 7) Strength member:
      - a) Loose tube: Utilize a central, nonmetallic strength member with a coefficient of thermal expansion similar to the fibers as the central anti-buckling member.
    - 8) Approvals and listings: UL 1666 and UL 1685.
    - 9) Design and test criteria: In accordance with ICEA S-104-696.
  - b. Testing:
    - 1) All fibers in the cable:
      - a) Proof test of 100 kpsi.
      - b) Each optical fiber: Bellcore GR-409 strip force testing.
      - c) No gaps are allowed between the coating material and the buffer material visible under a 50-power microscope.
  - c. Outer jacket material:
    - 1) Linear low-density polyethylene.
    - 2) Meet all requirements of the NEC for use in all indoor/outdoor areas (excluding plenums) without being enclosed in conduit.

- 3) Flame retardant OFNR riser rated conforming to UL 1666.
- 4) Printed with all necessary UL marks and manufacturer identification.
- 5) Sequential printing of footage in 2-foot increments.
- 6) With a ripcord incorporated under the cable jacket.

C. Single mode fibers:

1. All fibers in the cable must be usable fibers and meet required specifications.
2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
3. Single mode fiber characteristics:
  - a. Category: OS2 compliant with ITU-G.657.A1.
  - b. Jacket color: Yellow

D. Indoor/outdoor:

1. Loose tube:
  - a. Corning Cable Systems, Freedm®.
  - b. CommScope, LazrSPEED/TerraSPEED.

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES**

A. Patch cords:

1. General:
  - a. Connector types to match supplied equipment and the patch panel terminations.
  - b. Maximum length of patch cords: 25 feet.
  - c. Provide 2 spare patch cords (or 1 duplex patch cord) of each type used at each PLC or network cabinet.
  - d. Factory assembled and optically tested.
2. Manufacturers: One of the following or equal:
  - a. CommScope.
  - b. Corning Cable Systems.

B. Fiber connectors:

1. As specified in Section 17733 - Control Systems: Network Materials and Equipment.

C. Fiber optic identification/warning tags:

1. Black letters on orange or yellow background.
2. UV resistant polyethylene or other suitable material.
  - a. Manufacturers: The following or equal.
    - 1) Almetek.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify the condition of the conduit system before installation of the fiber optic cable or inner duct.
- B. Pass a test mandrel through all fiber optic conduits prior to pulling fiber or installing inner duct.
  - 1. Run the mandrel in both directions.
- C. Examine all materials and equipment before installation and verify they are free from physical damage and defects.

#### **3.02 PREPARATION**

- A. Before fiber splicing terminating or testing activities, verify sufficient workspace is available to perform the activity without interferences from other trades.
- B. Pre-installation test:
  - 1. Conduct pre-installation tests on all fiber optic cable.
  - 2. Upon arrival at the site:
    - a. Inspect the cable and reel for damage.
    - b. Test all fibers with an optical time domain reflectometer (OTDR) for fiber integrity.
    - c. Verify that the fiber lengths are consistent with the cable manufacture.
    - d. Verify that all traces yield no point discontinuities.
  - 3. Complete test sequence and obtain approval from the Engineer of submitted test results before cable installation:
    - a. Replace any cable failing to meet the requirements of the required tests and test before installation.
  - 4. Submit copies of the test results to the Engineer within 5 days after the delivery to the site.

#### **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Install fiber optic patch cords in open network trays or in dedicated conduits no longer than 25 feet in length.
- C. Install all fiber optic system components in accordance with the recommendations of the manufacturer.
- D. Install fiber optic cable in continuous lengths without intermediate splices, except where approved by the Engineer.

E. Installation:

1. Utilize personnel certified by the manufacturer with specific knowledge of the cable manufacturer's recommended procedures:
  - a. Schedule Engineer, 5 days before installation, to witness all cable installations.
2. Properly attach the fiber optic cable's strength elements to a 600-pound breakaway swivel containing tension or shear pins using Kellums pulling grips that are a minimum of 18 inches long.
3. Certify that cable tensile limits do not exceed cable pull tension and bend limits using tension monitoring devices.
4. Leave an extra loop of fiber optic cable in each pull box.
5. Conform with the cable manufacturer's specifications, practices, and the following requirements:
  - a. When power equipment is used to install fiber optic cables, use low speeds and do not exceed a rate of 30 meters per minute.
  - b. Do not exceed the tensile and bending limitation for fiber optic cables under any circumstances.
  - c. Use large diameter wheels, pulling sheaves, and cable guides to maintain the specified bending radius.
  - d. Use commercial dynamometers or load cells to monitor pulling tension.
  - e. A nonfreezing type of swivel inserted between the pulling line and cable pulling grip to prevent twisting under strain.
  - f. All cable to be installed using a breakaway swivel.
6. Apply to all conduits a lubricant at each conduit ingress and egress location during the pull operation:
  - a. Pour or pump lubricant into the end of the conduit at the feed location at a nominal application rate of 3 gallons per 1,000 feet of cable.
  - b. If the conduit is open at intermediate locations, then apply the appropriate proportion of lubricant at each opening.
  - c. Continuously lubricate the cable as it is being pulled by pouring or pumping the lubricant into the conduit at the feed location and at each intermediate location.
  - d. Station workers at each intermediate location as required.
  - e. Remove all excess lubricant that has collected.
  - f. Remove and clean the surrounding area after cable installation.
7. Install using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions:
  - a. Use pulling equipment with "slip-load" capability to allow the winch to maintain a constant pulling force without taking up the winch line.
  - b. Use pulling equipment equipped with a hydraulic bypass set so that a maximum tension of 600 pounds is not exceeded.
  - c. Use only equipment designed to prevent a preset pulling tension from being exceeded.
  - d. Fiber optic cable manufacturer to provide the pulling tension setpoint.
  - e. If during the pulling operation excessive tension is detected, cease all operations and notify the Engineer.
8. Position the cable reel at the feed point in alignment with the raceway and in such a position that the cable can be passed from the top of the reel in a long, smooth bend into the raceway system:
  - a. The use of a cable feeder is required, unless the cable is hand-pulled.

9. Supply all bull wheels, blocks, split wheels, cable feeders, and necessary equipment required to provide a clean and safe operation:
    - a. The cable shall not be allowed to travel over any wheel or block that has a radius less than the minimum radius allowed by the cable manufacturer.
  10. Minimize the use of snatch blocks and rollers to guide the cable into the conduit at the feed point:
    - a. Slack feed by hand the cable into the feed point and raceway without the use of rollers.
  11. Tend the cable reel at all times and turn by hand to provide the required cable slack:
    - a. Under no circumstances shall the cable tension be allowed to turn the cable reel.
  12. Use a rim roller, with a wheel radius greater than the minimum cable bending radius placed at the manhole or vault opening to prevent the cable from dragging on the manhole rim or steps.
  13. Perform a continuous thorough visual inspection for flaws, breaks, and abrasions in the cable sheath as the cable leaves the reel, and maintain a slow pulling speed to permit this inspection.
  14. Damage to the sheath or finish of the cable is cause for rejecting the cable:
    - a. Replace any cable damaged in any way during installation.
  15. If the cable becomes damaged during installation, stop operations and notify the Engineer immediately:
    - a. Engineer to determine whether to replace the entire reel of cable or to install a termination panel to eliminate the damaged section.
  16. Document all pulls by a graph which is annotated with the following information:
    - a. Reel number.
    - b. Pull point ID.
    - c. Date and time.
    - d. Explanations for abnormalities in readings or interruptions.
    - e. Sign-off by Contractor and Engineer.
  17. Under no conditions shall the fiber optic cable be left exposed or unattended.
- F. After the cables are installed and spliced:
1. Rack the cables.
    - a. Loosely secure in racked position with wire ties.
    - b. Attach imprinted plastic coated cloth identification/warning tags to each cable in at least 2 locations in each handhole/manhole.
- G. Splices:
1. Submit all splice locations to the Engineer for approval before installation of the fiber cables.
  2. Provide field splices in a splice tray located in a waterproof splice enclosure:
    - a. Manufacturers: The following or equal:
      - 1) Tyco/Raychem, FOSC style splice enclosure.
  3. Loop the individual fibers a minimum of 1 full turn within the splice tray to avoid macro/micro bending.
  4. After completion of cable terminations, neatly dress all cables.
  5. Protect all splices with a thermal shrink sleeve.
  6. Provide fusion type fiber optic cable splicing meeting the following requirements:
    - a. Joins multimode or single mode fibers.



- b. Establishes a permanent fusion splice.
  - c. Waterproof.
  - d. Re-enterable, rearrangable, and reusable.
  - e. Splice loss less than 0.10 dB.
  - f. Protected by a splice enclosure.
- 7. Requirement for outdoor fiber splice enclosures:
  - a. Seal.
  - b. Bond.
  - c. Anchor.
  - d. Protect fiber optic cable splices.
  - e. Stand-alone unit that does not require an outer enclosure.
  - f. Provide for a maximum of 6 cable entries in a butt-end configuration.
  - g. Used in aerial, underground, and direct buried applications.
- 8. Requirement for indoor fiber splice enclosures:
  - a. Anchor.
  - b. Protect fiber optic cable splices.
  - c. Stand-alone unit that does not require an outer enclosure.
  - d. Suitable for the minimum number of splices at that location plus additional capacity for reconfigurations.
- 9. Re-splice any splice that has a loss greater than 0.10 dB.
- 10. Leave a minimum of 20 feet of fiber optic cable at each end of splice.

H. Terminations:

- 1. Terminate all fiber inside a patch panel.
  - a. Direct landing to a switch, router hub, or PLC will not be allowed.
- 2. Terminate outdoor cables using a breakout kit that seals the cable and provides physical protection for the fiber strands.
- 3. Terminate indoor cables using breakout kits with field installed terminators.
- 4. Labeling:
  - a. Permanently label all cable terminations. Use labels produced by a wire printer using pressure sensitive polyester labels. Label patch panels as specified in Section 16075 - Identification for Electrical Systems.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.
- B. Factory test:
  - 1. Before shipment and while on the shipping reel, test 100 percent of all fibers for attenuation:
    - a. Copies of the results shall be:
      - 1) Maintained on file.
      - 2) Attached to the cable reel in a waterproof pouch.
      - 3) Submitted before the delivery of the cable to the job site to Engineer for approval.
  - 2. Conduct the flex test in accordance with FOTP-104 test condition I and III with a maximum sheave diameter of 20 times the cable OD.

3. Verify that the cable withstands 25 impact cycles with:
  - a. The average increase in attenuation for the fibers less than 0.20 dB at 1,550 nm.
  - b. No evidence of cracking or splitting.
  - c. Conduct the test in accordance with FOTP-25.
4. Certify that the cable withstands a tensile load of 2,700 N (600 pounds):
  - a. Without exhibiting an average increase in attenuation of greater than 0.10 dB.
  - b. Test in accordance with FOTP-33 using a maximum mandrel and sheave diameter of 560 millimeters.
  - c. Apply the load for 1 hour in Test Condition II.
5. Certify that the cable withstands a simulated lightning strike:
  - a. Peak value of the current pulse greater than 105kA.
  - b. Use a test current with a damped oscillatory maximum time-to-peak value of 15  $\mu$ s (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz.
  - c. The time to half-value of the waveform envelope 40 to 70  $\mu$ s.
  - d. Conduct the test in accordance with the FOTP-181.
  - e. In addition to the analysis criterion set forth in FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e. core tube) and strength members must be intact after removal of the cable specimens from the test box.

### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. General:
  1. All test results shall meet or exceed manufacturer specifications:
    - a. Test each fiber of each cable for breaks, abnormalities, and overall attenuation characteristics.
    - b. Replace any fiber that does not meet or exceed manufacturer specifications.
  2. Conduct post-installation tests of the fiber optic system in accordance with Section 16950 - Field Electrical Acceptance Tests.
  3. Pre-installation tests and post-installation tests to be witnessed and signed off by Engineer and Owner.
  4. Perform OLTS test with equipment capable and calibrated to show anomalies of 0.1 dB as a minimum:
    - a. Test multimode fibers at 850 nm and 1,300 nm.
    - b. Test single mode fibers at 1,310 and 1,550 nm.
  5. Perform OTDR tests on fiber cables less than 100 meters with the aid of a launch cable:
    - a. Adjust OTDR pulse width settings to a maximum setting of 1/1000th of the cable length or 10 nanoseconds.

### **3.09 ADJUSTING (NOT USED)**

### **3.10 CLEANING**

- A. Clean all fiber optic connectors after termination and before testing. After cleaning, cover all un-terminated connectors with a protective boot.

- B. At the completion of construction, touch up the finish on all fiber patch panels and enclosures.

### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Protect the fiber system from physical damage and the encroachment of dust, before, during, and after installation.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION



## SECTION 16130

### CONDUITS

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## **PART 1 GENERAL**

### **1.01 SUMMARY**

- A. Section includes:
  - 1. Metallic conduits.
  - 2. Nonmetallic conduits.
  - 3. Conduit bodies.
  - 4. Conduit fittings and accessories.
  - 5. Conduit installation.

### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. American National Standards Institute (ANSI):
  - 1. C80.1 - Electrical Rigid Steel Conduit.
  - 2. C80.3 - Steel Electrical Metallic Tubing.
  - 3. C80.5 - Electrical Rigid Aluminum Conduit.
  - 4. C80.6 - Electrical Intermediate Metal Conduit.
- C. National Electrical Manufacturer's Association (NEMA):
  - 1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
  - 2. TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
  - 3. TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
  - 4. TC7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
  - 5. TC13 - Electrical Nonmetallic Tubing.
  - 6. TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
- D. Underwriters Laboratories (UL):
  - 1. 1 - Standard for Flexible Metal Conduit.
  - 2. 6 - Standard for Electrical Rigid Metal Conduit - Steel.
  - 3. 6A - Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel.
  - 4. 360 - Standard for Liquidtight Flexible Steel Conduit.
  - 5. 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
  - 6. 651B - Standard for Continuous Length HDPE Conduit.
  - 7. 797 - Standard for Electrical Metallic Tubing - Steel.
  - 8. 1203 - Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.
  - 9. 1242 - Standard for Electrical Intermediate Metal Conduit - Steel.
  - 10. 1653 - Standard for Electrical Nonmetallic Tubing.
  - 11. 1660 - Standard for Liquidtight Flexible Nonmetallic Conduit.
  - 12. 1684 - Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

- B. Specific definitions and abbreviations:
  - 1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, Shapes C, E, LB, T, X, etc.
  - 2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.
  - 3. GRC: Galvanized rigid steel conduit.
  - 4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
  - 5. HDPE: High-density polyethylene conduit.
  - 6. SLT: Sealtight-liquidtight flexible conduit.
  - 7. FRD: Fiberglass-reinforced duct.
  - 8. NPT: National pipe thread.

#### **1.04 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Furnish complete manufacturer's catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
  - 2. Furnish complete manufacturer's recommended special tools to be used for installation if required.
  - 3. Certified test results for PVC-coated metallic conduit showing the adhesive bond is stronger than the tensile strength of the PVC.
- C. Certifications:
  - 1. Furnish PVC-coated conduit manufacturer's valid, unexpired certification for each installer.

#### **1.05 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. All conduits, conduit bodies, and fittings shall be UL listed and labeled.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Do not expose non-metallic conduit to direct sunlight.
- C. Do not store conduit in direct contact with the ground.

#### **1.07 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.08 SEQUENCING**

- A. Before installing any conduit or locating any device box:
  - 1. Examine the complete set of Drawings and Specifications, and all applicable shop drawings.

2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

## **1.09 SCHEDULING (NOT USED)**

## **1.10 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.11 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.13 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. Galvanized rigid steel conduit:
  1. One of the following or equal:
    - a. Western Tube and Conduit.
    - b. Allied Tube and Conduit.
    - c. Wheatland Tube Co.
- B. PVC-coated rigid steel conduit:
  1. One of the following or equal:
    - a. Robroy Ind.
    - b. Ocal, Inc.
    - c. Calbond.
    - d. Allied.
    - e. NEC, Inc. BlackGuard.
- C. Sealtight-liquidtight flexible conduit:
  1. One of the following or equal:
    - a. Southwire.
    - b. AFC Cable Systems.
    - c. Electri-Flex Co.
    - d. Anaconda.
- D. Conduit bodies:
  1. One of the following or equal:
    - a. Crouse-Hinds.
    - b. Appleton.
    - c. O-Z/Gedney.
    - d. Ocal, Inc.
    - e. Robroy Ind.
    - f. Calbond.
    - g. Carlon.



- E. Joint compound:
  - 1. The following or equal:
    - a. Thomas and Betts.
- F. Galvanized rigid steel conduit expansion fittings:
  - 1. One of the following or equal:
    - a. Crouse-Hinds.
    - b. Appleton.
    - c. O-Z/Gedney.
- G. Conduit hangers and supports:
  - 1. As specified in Section 16070 - Hangers and Supports.

## **2.02 SYSTEM DESCRIPTION**

- A. Provide conduits, conduit bodies, fittings, junction boxes, and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

## **2.03 EXISTING PRODUCTS (NOT USED)**

## **2.04 MATERIALS (NOT USED)**

## **2.05 MANUFACTURED UNITS (NOT USED)**

## **2.06 EQUIPMENT (NOT USED)**

## **2.07 COMPONENTS**

- A. GRC:
  - 1. All threads: NPT standard conduit threads with a 3/4-inch taper per foot:
    - a. Running conduit threads are not acceptable.
  - 2. Hot-dip galvanized inside and out:
    - a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
    - b. Electro-galvanizing is not acceptable.
  - 3. Manufactured in accordance with:
    - a. UL-6.
    - b. ANSI C80.1.
- B. PCS:
  - 1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, conforming to the requirements for Type GRC.
  - 2. Coated conduit NEMA Standard RN-1:
    - a. The galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
  - 3. Factory-bonded PVC jacket:
    - a. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
    - b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.

- c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
  - d. The PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
    - 1) Confirm bond with certified test results.
- 4. A urethane coating shall be uniformly and consistently applied to the interior of all conduits and fittings:
  - a. Nominal thickness of 0.002 inch.
  - b. Conduits having areas with thin or no coating are not acceptable.
  - c. All threads shall be coated with urethane.
- 5. The PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
- 6. PCS conduit bodies and fittings:
  - a. Malleable iron.
  - b. The conduit body, before PVC coating, shall be new, unused material and shall conform to appropriate UL standards.
  - c. The PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of ribs to protect the coating from tool damage during installation.
  - d. 0.002-inch interior urethane coating.
  - e. Utilize the PVC coating as an integral part of the gasket design.
  - f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
  - g. A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
    - 1) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
    - 2) The sleeve shall provide a vapor- and moisture resistant seal at every connection.
    - 3) Fittings shall be Form 8 and supplied with plastic encapsulated stainless steel cover screws. Fittings shall be UL Type 4X. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty.

C. SLT:

- 1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
  - a. General purpose:
    - 1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
  - b. Oil-resistant:
    - 1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
- 2. Sunlight-resistant, weatherproof, and watertight.
- 3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
- 4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
- 5. Overall PVC jacket.
- 6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.

- D. Conduit bodies:
  - 1. Material consistent with conduit type:
    - a. Malleable iron bodies and covers when used with Type GRC.
    - b. PVC-coated malleable iron bodies and covers when used with Type PCS.
    - c. Malleable iron or aluminum bodies with pressed steel or aluminum covers when used with Type EMT.
  - 2. Conduit bodies to conform to Form 8, Mark 9, or Mogul design:
    - a. Mogul design conforming to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
  - 3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

## **2.08 ACCESSORIES**

- A. Connectors and fittings:
  - 1. Manufactured with compatible materials to the corresponding conduit.
- B. Insulated throat metallic bushings:
  - 1. Construction:
    - a. Malleable iron or zinc-plated steel when used with steel conduit.
    - b. Positive metallic conduit end stop.
    - c. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
    - d. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.
- C. Insulated grounding bushings:
  - 1. Construction:
    - a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
    - b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
    - c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.
- D. Electrical unions (Erickson Couplings):
  - 1. Construction:
    - a. Malleable iron for use with steel conduit.
    - b. Concrete tight, 3-piece construction.
    - c. Rated for Class I Division 1 Group D in hazardous areas.
- E. SLT fittings:
  - 1. Construction:
    - a. Malleable iron.
    - b. Furnished with locknut and sealing ring.
    - c. Liquidtight, raintight, oiltight.
    - d. Insulated throat.
    - e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
    - f. Designed to prevent sleeving:
      - 1) Verify complete bonding of the raceway jacket to the plastic gasket seal.

- g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
    - h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.
  - 2. Corrosion-resistant and outdoor SLT fittings:
    - a. Construction:
      - 1) PVC-coated liquidtight fittings with a bonded 0.040-inch-thick PVC coating on the metal connector to form a seal around the SLT conduit.
      - 2) Insulated throat and an integral sealing ring.
- F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
- 1. Construction:
    - a. Insulated throat.
    - b. PVC-coated when used in corrosive areas.
    - c. Bonding locknut.
    - d. Recessed neoprene o-ring to ensure watertight and dusttight connector.
    - e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
    - f. 1-1/2-inch through 6-inch malleable iron zinc plated.
  - 2. Usage:
    - a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.
- G. Expansion/deflection couplings:
- 1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
  - 2. Shall allow movement of 3/4 inch from the normal in all directions.
  - 3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
  - 4. Constructed to maintain electrical continuity of the conduit system.
  - 5. Materials:
    - a. End couplings: Bronze or galvanized ductile iron.
    - a. Sleeve: Neoprene.
    - b. Bands: Stainless steel.
    - c. Bonding jumper: Tinned copper braid.
- H. Expansion couplings:
- 1. Shall allow for expansion and contraction of conduit:
    - a. Permitting 8-inch movement, 4 inches in either direction.
  - 2. Constructed to maintain electrical continuity of the conduit system.
  - 3. Materials:
    - a. Head: Malleable or ductile iron.
    - a. Sleeve: Steel.
    - b. Insulating bushing: Phenolic.
    - c. Finish: Hot-dip galvanized.
    - d. PVC-coated steel when used with Type PCS.

- I. Conduit markers:
  - 1. As specified in Section 16075 - Identification for Electrical Systems.

## **2.09 MIXES (NOT USED)**

## **2.10 FABRICATION (NOT USED)**

## **2.11 FINISHES (NOT USED)**

## **2.12 SOURCE QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. General:
  - 1. Conduit routing:
    - a. The electrical drawings are diagrammatic in nature:
      - 1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
      - 2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
        - a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
        - b) Make changes in conduit routing due to the relocation of equipment.
      - 3) The electrical drawings do not indicate all required junction boxes and pull boxes:
        - a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
          - (1) To meet cable manufacturer's pulling tension requirements.
          - (2) To limit total conduit bends between pull locations.
        - b) Install junction boxes and pull boxes at locations acceptable to the Engineer.
    - b. The Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:
      - 1) The Engineer is the sole source in determining whether the change is constituted as a deviation:
      - 2) Perform any changes resulting in additional conduits, or extra work from such deviations.
      - 3) Incorporate any deviations on the Record Documents.

2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.
3. Provide adequate clearances from high-temperature surfaces for all conduit runs. Provide minimum clearances as follows:
  - a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
  - b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.
  - c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
  - d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.
4. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.
5. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
  - a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
  - b. Make changes in direction with long radius bends or with conduit bodies.
6. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.
7. Route all exposed conduits to preserve headroom, access space and workspace, and to prevent tripping hazards and clearance problems:
  - a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
  - b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.
8. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
9. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
10. For existing and new 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
  - a. Remove and replace conduits through which mandrel will not pass.
11. Provide all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
12. Install complete conduit systems before conductors are installed.
13. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.

- C. Equipment grounding conductors:
1. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
    - a. Provide a separate equipment grounding conductor in each individual raceway for parallel feeders.
  2. Conductors shall be the same type and insulation as the circuit conductors:
    - a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
  3. Minimum size in accordance with the NEC or as indicated on the Drawings, whichever is larger.
- D. Lighting and receptacle conduits:
1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings:
  2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
  3. Minimum conduit size:
    - a. 3/4-inch for exposed conduits.
    - b. 1-inch for underground or in-slab conduits.
  4. Provide conduit materials for the installed location as specified in Section 16050 - Common Work Results for Electrical.
- E. Conduit usage:
1. Exposed conduits:
    - a. Rigid conduit:
      - 1) Install the rigid conduit type for each location as specified in Section 16050 - Common Work Results for Electrical.
      - 2) Minimum size: 3/4-inch.
    - b. Flexible conduit:
      - 1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
        - a) Use Type SLT with rigid metallic conduit.
      - 2) Minimum size: 3/4-inch:
        - a) 1/2 when required for connection to instruments.
      - 3) Maximum length:
        - a) Fixed equipment:

Conduit Trade Size	Flexible Conduit Length (inch)
3/4	18
1	18
1-1/4	18
1-1/2	18
2	36
2-1/2	36
3	36
3-1/2	38

Conduit Trade Size	Flexible Conduit Length (inch)
4	40

- b) Removable instruments or hinged equipment:
      - (1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.
  - 2. Concrete-encased and embedded conduits:
    - a. Straight runs and bends less than 45 degrees:
      - 1) Type PVC Schedule 40.
    - b. Bends with total deflection greater than 45 degrees:
      - 1) PCS.
  - 3. Direct-buried and sand-bedded duct bank conduits:
    - a. Type PCS.
    - b. Minimum size: 1-inch.
  - 4. PVC-coated rigid metallic conduit:
    - a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
    - b. Repair damage to PVC coatings with manufacturer supplied touchup compound or PVC Coating Repair Kit for PVC Coated Raceway Systems.
  - 5. GRC:
    - a. Conduit shall be cut square and reamed before threading.
- F. Conduit joints and bends:
  - 1. General:
    - a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
    - b. Keep bends and offsets in conduit runs to an absolute minimum.
    - c. All bends shall be symmetrical.
    - d. The following conduit systems shall use large-radius sweep elbows:
      - 1) Underground conduits.
      - 2) Conduits containing fiber optic cables.
    - e. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.
    - f. Make field bends with a radius of not less than the requirements found in the NEC:
      - 1) The minimum bending radius of the cable must be less than the radius of the conduit bend.
      - 2) Make all field bends with power bending equipment or manual benders specifically intended for the purpose:
        - a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
        - b) For the serving utilities, make bends to meet their requirements.
    - g. Replace all deformed, flattened, or kinked conduit.
  - 2. Threaded conduit:
    - a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that all bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints become secure and wrench-tight just preceding the point



where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.

- b. Thoroughly ream conduit after threads have been cut to remove burrs.
- c. Use bushings or conduit fittings at conduit terminations.
- d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar™," or CRC "Zinc It."
- e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
  - 1) Apply to the male threads and tighten joints securely.
  - 2) Clean excess sealant from exposed threads after assembly.
- f. Securely tighten all threaded connections.
- g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating.

G. Conduit supports:

1. General:

- a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
  - 1) As specified in Section 16070 - Hangers and Supports.
  - 2) Provide support materials consistent with the type of conduit being installed as specified in Section 16050 - Common Work Results for Electrical.
- b. Support conduit at the intervals required by the NEC.
- c. Perforated strap and plumbers' tape are not acceptable for conduit supports.

2. Conduit on concrete or masonry:

- a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
- b. Use preset inserts in concrete when possible.
- c. Use pipe spacers (clamp backs) in wet locations.

3. Suspended conduit:

- a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
- b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2 feet long, provide rigid sway bracing.

4. Supports at structural steel members:

- a. Use beam clamps.
- b. Drilling or welding may be used only as specified or with approval of the Engineer.

H. Expansion or expansion/deflection fittings:

1. General:

- a. Align expansion coupling with the conduit run to prevent binding.
- b. Follow manufacturer's instructions to set the piston opening.
- c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
- d. Furnish fittings of the same material as the conduit system.

2. For metallic conduit, provide expansion or expansion/deflection couplings, as appropriate, where:
  - a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.
- I. Empty conduits:
  1. Seal ends of all conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
    - a. Keep ends sealed until immediately before pulling conductors.
- J. Miscellaneous:
  1. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
    - a. Running threads and threadless couplings are not allowed.
  2. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.

**3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)**

**3.05 REPAIR/RESTORATION (NOT USED)**

**3.06 RE-INSTALLATION (NOT USED)**

**3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

**3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.09 ADJUSTING (NOT USED)**

**3.10 CLEANING (NOT USED)**

**3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.12 SCHEDULES (NOT USED)**

END OF SECTION

## **SECTION 16134**

### **BOXES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Device boxes.
  - 2. Raceway system boxes.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. American Association of State Highway and Transportation Officials (AASHTO):
  - 1. Standard Specifications for Highway Bridges.
- C. ASTM International (ASTM):
  - 1. A47 - Standard Specification for Ferritic Malleable Iron Castings.
  - 2. D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
  - 3. D495 - Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
  - 4. D570 - Standard Test Method for Water Absorption of Plastics.
  - 5. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
  - 6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
  - 7. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- D. Joint Industry Conference (JIC).
- E. Underwriters Laboratories, Inc. (UL):
  - 1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Specific definitions:
  - 1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
  - 2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

#### **1.04 SYSTEM DESCRIPTION**

- A. Provide boxes as indicated on the Drawings or as needed to complete the raceway installation.

#### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Manufacturer.
  - 2. Materials.
  - 3. Dimensions:
    - a. Height.
    - b. Width.
    - c. Depth.
    - d. Weight.
    - e. NEMA rating.
  - 4. Conduit entry locations.
  - 5. Catalog cutsheets.
  - 6. Installation instructions.
- C. Shop drawings:
  - 1. Include identification and sizes of pullboxes.

#### **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Regulatory requirements:
  - 1. Outlet boxes shall comply with all applicable standards of:
    - a. JIC.
    - b. NEC.
    - c. NEMA.
    - d. UL.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.09 SEQUENCING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. One of the following or equal:
  - 1. Cast device boxes:
    - a. Appleton.
    - b. Crouse - Hinds.
    - c. OZ/Gedney.
  - 2. Formed steel enclosures:
    - a. Hoffman.
    - b. Thomas and Betts.
    - c. Stahlin.
    - d. Rittal.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS (NOT USED)**

## **2.04 MANUFACTURED UNITS**

- A. Cast device boxes:
  - 1. Construction:
    - a. With internal green ground screw.
    - b. Furnished with a suitable gasketed cover.
    - c. With integral cast mounting lugs when surface mounted.
    - d. Conduit sizes range from 3/4 inch to 1 inch.
    - e. Tapered threaded hubs with integral bushing.
  - 2. Malleable iron boxes:
    - a. Conforming to ASTM A47 Grade 32510.
- B. Formed steel enclosures:
  - 1. Steel:
    - a. NEMA Type 12.
    - b. Fabricated from 14-gauge steel, minimum.
    - c. All seams continuously welded ground smooth.
  - d. Door:
    - 1) Rolled lip around 3 sides.

- 2) Attached to enclosure by means of a continuous stainless-steel hinge and pin.
- e. Neoprene door gasket to provide a watertight, dusttight, oiltight seal:
  - 1) Attached with an adhesive.
  - 2) Retained by a retaining strip.
- f. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
  - 1) With a hasp and staple for padlocking.
- g. Provide large enclosures with door and body stiffeners for extra rigidity.
- h. No holes or knockouts.
- i. Finish:
  - 1) ANSI-61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
  - 2) White electrostatically applied polyester powder mounting plate.
- j. Heavy gauge steel external mounting brackets when surface mounted.

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES**

- A. Fasteners:
  - 1. Electroplated or stainless steel in boxes with wiring devices.
  - 2. Screws, nuts, bolts, and other threaded fasteners:
    - a. Stainless steel.
- B. Provide breather and drain fittings where appropriate.
- C. Internal panels:
  - 1. Provide internal panels where required for mounting of terminal strips or other equipment.
  - 2. With plated steel shoulder studs.
  - 3. Steel with white polyester powder finish.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

- B. General:
  - 1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 16050 - Common Work Results for Electrical.
  - 2. Provide outlet box materials to match the conduit system:
    - a. GRC - Cast ferrous boxes.
  - 3. Use cast malleable iron boxes when box must support other devices.
  - 4. Boxes serving luminaires or wiring devices:
    - a. Use as pullboxes wherever possible.
  - 5. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.
  - 6. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.
- C. Pullboxes and junction boxes:
  - 1. Size pullboxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
  - 2. Install pullboxes such that access to them is not restricted.
- D. For boxes not indicated:
  - 1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 16050 - Common Work Results for Electrical.

#### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

#### **3.05 REPAIR/RESTORATION (NOT USED)**

#### **3.06 REINSTALLATION (NOT USED)**

#### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

#### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **3.09 ADJUSTING (NOT USED)**

#### **3.10 CLEANING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **3.12 SCHEDULES (NOT USED)**

END OF SECTION





## **SECTION 16150**

### **LOW VOLTAGE WIRE CONNECTIONS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Wire connecting devices.
  - 2. Terminations.
  - 3. Splices.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. ASTM International (ASTM):
  - 1. D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- C. CSA International (CSA):
  - 1. C22.2 - No.197-M1983 (R2208) - PVC Insulating Tape.
- D. Underwriters Laboratories, Inc. (UL):
  - 1. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

##### **1.04 SYSTEM DESCRIPTION**

- A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

##### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Catalog cutsheets.
  - 2. Installation instructions.

##### **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. All materials shall be UL listed.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 PROJECT OR SITE CONDITIONS**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

A. Manufacturers for each type of technology are specified with the equipment in this Section.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS (NOT USED)**

## **2.04 MANUFACTURED UNITS (NOT USED)**

## **2.05 EQUIPMENT**

A. Control connections:

1. Use insulated ring type wire terminators for connections to all screw terminals:
  - a. With chamfered/funneled terminal barrel entry.
  - b. Deep internal serrations.
  - c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
  - d. Electroplated-tin copper conductor.
  - e. Manufacturers: The following or equal:
    - 1) Thomas and Betts, Stakon.
2. For process equipment connections work from manufacturer's drawings.

B. Joints, splices, taps, and connections:

1. 600-volt conductors:
  - a. Use solderless connectors.
  - b. Use only plated copper alloy connectors or lugs:
    - 1) Aluminum connectors or lugs are not acceptable for copper conductors.
  - c. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
  - d. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps:
    - 1) Manufacturers: The following or equal:
      - a) Buchanan, 2006S or 2011S, with 2007 or 2014 insulating caps.
  - e. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
    - 1) Manufacturers: One of the following or equal:
      - a) Burndy.
      - b) Thomas and Betts.
  - f. Heat shrink tubing:
    - 1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
    - 2) Minimum shrink ratio: 4 to 1.
    - 3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
    - 4) Internally applied adhesive sealant.
    - 5) Cross-linked polyolefin:
      - a) Manufacturers: One of the following or equal:
        - (1) 3M, ITCSN.
        - (2) Thomas & Betts, Shrink-Kon.
2. Instrumentation class cable splices:
  - a. Suitable for indoor, outdoors, weather exposed, direct buried, or submersed applications.
  - b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
  - c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
  - d. Two-part mold body with tongue and groove seams and built-in spacer webbing.
  - e. Manufacturers: The following or equal:
    - 1) 3M, Scotchcast 72-N.

C. Insulating tape:

1. General purpose insulating tape:
  - a. Minimum 7 mil vinyl tape.
  - b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
  - c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
  - d. Flame retardant, hot- and cold- weather resistant, UV resistant.
  - e. For use as a primary insulation for wire cable splices up to 600 VAC.
  - f. Meeting and complying with:
    - 1) ASTM D3005 Type I.
    - 2) UL 510.
    - 3) CSA C22.2.

- g. Manufacturers: The following or equal:
    - 1) 3M, Scotch Number Super 33+.
- 2. General-purpose color-coding tape:
  - a. Minimum 7 mil vinyl tape.
  - b. Suitable for application on PVC and polyethylene jacketed cables.
  - c. For use indoors and outdoors in weather protected enclosures.
  - d. Available with the following colors:
    - 1) Red.
    - 2) Yellow.
    - 3) Blue.
    - 4) Brown.
    - 5) Gray.
    - 6) White.
    - 7) Green.
    - 8) Orange.
    - 9) Violet.
  - e. For use as phase identification, marking, insulating, and harnessing.
  - f. Meeting and complying with:
    - 1) UL 510.
    - 2) CSA C22.2.
  - g. Manufacturers: The following or equal:
    - 1) 3M, Scotch Number 35.

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES (NOT USED)**

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Load connections:
  - 1. Connect loads to the circuits as indicated. Color-code all branch circuits as specified in Section 16123 - 600-Volt or Less Wires and Cables.
- C. Zero to 600-volt systems:
  - 1. Make all connections with the proper tool and die as specified by the device manufacturer.

2. Use only tooling and dies manufactured by the device manufacturer.
3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
4. Number all power and control wires before termination.

**3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

**3.05 REPAIR/RESTORATION (NOT USED)**

**3.06 RE-INSTALLATION (NOT USED)**

**3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

**3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.09 ADJUSTING (NOT USED)**

**3.10 CLEANING (NOT USED)**

**3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.12 SCHEDULES (NOT USED)**

END OF SECTION



## SECTION 16232

### SINGLE DIESEL FUELED ENGINE GENERATOR ABOVE 200 KW

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## **PART 1 GENERAL**

### **1.01 SUMMARY**

- A. Section includes:
  - 1. Packaged automatic "standby" diesel engine generator systems.

### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. ASTM International (ASTM):
  - 1. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- C. National Electrical Manufacturers Association (NEMA):
  - 1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
  - 2. MG-1 - Motor and Generators.
- D. National Fire Protection Association (NFPA):
  - 1. 30 - Flammable and Combustible Liquids Code.
  - 2. 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
  - 3. 110 - Standard for Emergency and Standby Power Systems.
  - 4. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
- E. Underwriters Laboratories (UL):
  - 1. 142 - Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
  - 2. 2200 - Standard for Stationary Engine Generator Assemblies.

### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Specific definitions:
  - 1. Standby rated duty: Continuous operation for the duration of any power outage of a utility power source.

### **1.04 SYSTEM DESCRIPTION**

- A. Provide a complete automatic diesel engine driven generator system, with all necessary components and accessories to make a complete and operating standby power supply.
  - 1. Coordinate the generator control system with the transfer equipment specified in the Electrical Specifications and as indicated on the Drawings.
- B. Provide such minor details of electrical, plumbing, or mechanical work not specified or indicated on the Drawings, which are necessary for the successful operation of the diesel engine-driven generator required by these Specifications.
- C. Participate in Programming and Data Exchange Coordination Meeting.



1. Coordinate with the Owner.
2. System networking and communication approach and data exchange include any specific requirements relating to Gateway supply and configuration as applicable.
3. Provide communication mapping details and instructions.
4. Field services, support and testing procedures and expectations.

## **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  1. General:
    - a. Manufacturer of:
      - 1) Engine.
      - 2) Generator.
      - 3) Governor.
      - 4) Voltage regulator.
      - 5) Generator control panel.
      - 6) Radiator.
      - 7) Battery charger.
      - 8) Batteries.
      - 9) Silencer.
      - 10) Load bank.
    - b. Wet weight of engine generator system:
      - 1) List weight of fuel separately.
    - c. Dimensions of engine generator system:
      - 1) Length.
      - 2) Width.
      - 3) Height.
    - d. Type and grade of fuel recommended.
    - e. Fuel oil consumption at:
      - 1) 50 percent load.
      - 2) 75 percent load.
      - 3) 100 percent load.
    - f. Type and grade lubricating oil recommended.
    - g. Amount of lubricating oil required per oil change.
    - h. Normal lubricating oil consumption.
    - i. Recommended lubricating oil change periods:
      - 1) By hours run.
      - 2) By time.
    - j. Heat rejection by engine generator to the room area.
    - k. Time interval from start-up contact closure until full load capabilities are available.
  2. Engine:
    - a. Number of cylinders, bore, stroke, and piston speed.
    - b. Displacement in cubic inches.
    - c. Compression ratio.
    - d. Engine RPM at 60 hertz.
    - e. Combustion air required.
    - f. Cooling air required.

- g. Size of exhaust outlet.
- h. Gauges.
- i. Jacket water heater:
  - 1) Rating.
  - 2) Voltage and phase requirements.
- 3. Emissions:
  - a. Certification of EPA compliance.
  - b. Other exhaust emissions as required by the local air quality management district issuing the permit for the engine generator system.
  - c. Reported at rated speed and load as measured by SAE J177 and J215 or ISO 8178 recommended practices.
- 4. Generator (alternator):
  - a. Rated output:
    - 1) kW standby.
    - 2) Power factor.
    - 3) Voltage.
    - 4) Current.
  - b. Number of poles.
  - c. Number of leads and wires per lead.
  - d. Pitch.
  - e. Stator and field ratings including temperature rise at full and overload conditions.
  - f. Insulation system:
    - 1) Insulation class.
    - 2) Stator rise.
    - 3) Rotor rise.
    - 4) Heat dissipated (kW).
    - 5) Air flow (m<sup>3</sup>/min).
  - g. Impedances (per unit and ohms):
    - 1) Synchronous reactance: Direct axis ( $X_d$ ).
    - 2) Synchronous reactance: Quadrature axis ( $X_q$ ).
    - 3) Transient reactance: Saturated ( $X'_d$ ).
    - 4) Subtransient reactance: Direct axis ( $X''_d$ ).
    - 5) Subtransient reactance: Quadrature axis ( $X''_q$ ).
    - 6) Negative sequence reactance ( $X_2$ ).
    - 7) Zero sequence reactance ( $X_0$ ).
  - h. Time constants:
    - 1) Open circuit transient: Direct axis.
    - 2) Short circuit transient: Direct axis.
    - 3) Open circuit subtransient: Direct axis.
    - 4) Short circuit subtransient: Direct axis.
    - 5) Open circuit subtransient: Quadrature axis.
    - 6) Short circuit subtransient: Quadrature axis.
    - 7) Exciter time constant.
    - 8) Armature short circuit.
  - i. Short circuit ratio.
  - j. Stator resistance.
  - k. Field resistance.
  - l.  $I^2t$  or K (heating time constant).
  - m. Voltage and frequency variation and duration with the step application and removal of 25 percent, 50 percent, 75 percent, and 100 percent of resistive load maximum.

- n. Generator efficiency at:
  - 1) 25 percent load.
  - 2) 50 percent load.
  - 3) 75 percent load.
  - 4) 100 percent load.
- o. Generator output characteristic curves:
  - 1) Open circuit.
  - 2) Short circuit.
  - 3) Zero power factor.
  - 4) Air gap.
- p. Reactive capability curve.
- q. Certified published engine horsepower curves showing manufacturer's engine rating for generator set standby and prime power application.
- r. Decrement curve.
- s. Thermal damage curve.
- 5. Governor.
- 6. Voltage regulator.
- 7. Generator control panel:
  - a. Dimensions:
    - 1) Length.
    - 2) Width.
    - 3) Height.
    - 4) Weight.
  - b. Power requirements.
  - c. Controls.
  - d. NEMA enclosure rating.
- 8. Space and ambient temperature requirements.
- 9. Battery system:
  - a. Battery charger:
    - 1) Dimensions:
      - a) Length.
      - b) Width.
      - c) Height.
      - d) Weight.
    - 2) Input power requirements.
  - b. Batteries:
    - 1) Number.
    - 2) Dimensions:
      - a) Length.
      - b) Width.
      - c) Height.
      - d) Weight.
    - 3) Amount of electrolyte.
    - 4) Enclosure or rack.
- 10. Silencer:
  - a. Grade.
  - b. Dimensions:
    - 1) Length.
    - 2) Width.
    - 3) Height.
    - 4) Weight.

11. Free field mechanical noise level at 23 feet. Provide overall decibels (dBA) rating referenced at 20  $\mu$ Pa.
  12. Exhaust sound level in dBA at 5 feet from discharge end of silencer.
  13. Recommended spare parts and special tools lists, specifying quantity of each item.
  14. Load bank:
    - a. Dimensions:
      - 1) Length.
      - 2) Width.
      - 3) Height.
      - 4) Weight.
    - b. Ratings:
      - 1) Overall kW rating.
      - 2) Number of steps.
    - c. Enclosure.
    - d. Control panel.
    - e. Electrical connections.
- C. Shop drawings:
1. Provide detailed dimensional and to-scale layout drawings including:
    - a. A single drawing incorporating all equipment furnished:
      - 1) Submittals that consist solely of individual drawings for each component and require that these sheets be compiled by the Engineer, in order to view the entire piece of equipment, are not acceptable.
    - b. Conduit stub-out locations.
  2. Detailed electrical wiring diagrams of the engine and generator including:
    - a. Engine interconnection terminal box.
    - b. Generator interconnection terminal box.
    - c. Fuel system.
    - d. All interfaces between the engine driven generator skid and the transfer equipment.
    - e. All wire numbers and terminal block identifications:
      - 1) Wire numbers are to correspond to the wire number on the equipment.
      - 2) All wires are to be numbered.
    - f. Complete interior and exterior control panel layout:
      - 1) Scaled.
      - 2) With device descriptions.
      - 3) With nameplates.
  3. Piping connection and instrumentation diagrams.
  4. Mounting and installation drawings:
    - a. Detailing mounting requirements for the Project Site seismic requirements as specified in Section 16050 - Common Work Results for Electrical.
    - b. Prepared and sealed by a registered structural professional engineer in the state where the Project is being constructed.
- D. Operation and maintenance manuals:
1. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this Section.

2. Operating manual:
  - a. The manual must detail the operational functions of all normally used controls that have been placed on the front of the control equipment.
  - b. Standard operational manuals normally furnished by the manufacturer.
3. Maintenance manual:
  - a. Printed and bound instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.
  - b. These manuals must include but are not limited to the following:
    - 1) Electrical controls:
      - a) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
      - b) Detailed control instructions, which outline the purpose and operation of every control device used in normal operation.
      - c) Description of the sequence of operation that outlines the steps the controls follow during normal power failure and normal power return conditions.
      - d) All schematic, wiring, and external diagrams. Also, internal device wiring and schematic diagrams for all sub-assemblies used in the equipment:
        - (1) Drawing to be furnished in a reduced 11-inch by 17-inch format and shall be fully legible at that drawing size.
    - 2) Engine and generator:
      - a) Repair parts manuals normally furnished by the manufacturer.
        - (1) Detailing all parts and sub-assemblies, which are available as repair parts.
    - 3) Shop maintenance manuals:
      - a) Provide 1 shop manual on-site that is equivalent to the manual used by factory-authorized shop repair personnel.
      - b) Manuals for the following equipment:
        - (1) Engine.
        - (2) Radiator.
        - (3) Generator.
        - (4) Engine generator control panel.
    - c. Material safety data sheets:
      - 1) Complete MSDS forms for all substances.
      - 2) Located in O&M manual.
      - 3) Include separate manual labeled MSDS with additional copies of all MSDS forms.
  4. Warranty Data.
  5. Maintenance Contract information (if applicable).

E. Test reports:

1. Furnish complete test reports as specified in this Section.

F. Certificates:

1. Certification of the emissions performance of the generator set engine by the engine manufacturer.
2. Certification that a torsional analysis between the engine and generator has been completed.
3. Seismic certification, as required.

4. Certification letter from the Generator manufacturer that the generator(s) has been inspected and installed in accordance with the manufacturer's requirements.
  5. Upon completion of installation, manufacturer must issue a certification of compliance with the Contract Documents.
- G. Calculations:
1. Supply documentation identifying the maximum static pressure acceptable for the radiator fan. It is the manufacturer's responsibility to then provide calculations as part of the layout drawings, to ensure that the load bank and transition ductwork at the discharge of the radiator does not exceed the maximum static pressure acceptable for the radiator fan.
  2. Submit exhaust system silencer noise attenuation curves.
  3. Structural support system, mounting, and seismic calculations to be signed and stamped by a licensed structural professional engineer, registered in the state where the Project is located:
    - a. Vibration isolator selection calculations.
    - b. Vibration isolator anchoring calculations.
    - c. Exhaust silencer structural support calculations on indoor applications.
  4. Submit factory certification of the radiator ambient capability.
  5. Submit exhaust system pressure loss calculations:
    - a. Include piping, fittings, silencer, and rain cap in loss calculations on indoor applications.

## 1.06 QUALITY ASSURANCE

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Manufacturer qualifications:
1. The manufacturer of the engine, generator, and all major items of auxiliary equipment must be in current production of such equipment.
  2. A factory authorized parts and service facility located within 100 miles of the Project Site.
  3. Manufacturer is responsible for furnishing, testing, installation supervising, testing, and guaranteeing the system.
- C. Regulatory requirements:
1. In accordance with NFPA-110 Type 10 (ten second) transfer requirements.
  2. Fuel tanks:
    - a. UL listed.
    - b. Primary and secondary tanks shall be tested under pressure per the manufacturer's recommendation to check for leaks.
    - c. Comply with the following, if applicable:
      - 1) NFPA 30 - Flammable and Combustible Liquids.
      - 2) NFPA 37 - Standard for Installation and Use of Stationary Combustible and Gas Turbines.
      - 3) NFPA 110 - Standard for Emergency and Standby Power Systems.
  3. Regulations of the Fire Prevention Bureau of the fire department having jurisdiction.
  4. Fire Code as specified in Section 01410 - Regulatory Requirements.
  5. Other applicable state and local codes.
  6. EPA approved.

7. Requirements of local Air Quality Management District or Air Pollution Control District.
  8. Comply with the Specifications that may be in excess of, and not contrary to, the regulations.
- D. The generator set(s) shall be manufactured to the applicable specifications on file with UL and labeled with the UL 2200 mark.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Furnish the generator skid with removable lifting and jacking angles, eye bolts, etc., attached to the structural base to facilitate unloading and move-in operations.
- C. Provisions on skid for the use of "Multiton" type rollers for moving the generator skid into position and then removal of the "Multiton" rollers and then for setting the engine generator skid in place.
- D. Provide the services of a manufacturer's authorized representative to:
  1. Be present at the jobsite when the engine-driven generator arrives:
    - a. Act as an advisor in assisting the Contractor regarding the unloading and move-in operations.
  2. Coordinate the delivery of the shipment with the Contractor.

#### **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.09 SEQUENCING**

- A. Complete factory prototype and factory production tests in accordance with NFPA 110 before equipment is shipped.

#### **1.10 SCHEDULING (NOT USED)**

#### **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.12 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

#### **1.14 MAINTENANCE**

- A. Furnish the following spare parts:
  1. 3 sets of lube oil filters, fuel filters, and gaskets.
  2. 2 sets of air filters.
  3. 2 spare lamps of each different lamp type.
  4. 2 fuses (for each control circuit).

5. 1 set of crankcase breather filters, when used.
- B. Special tools: Furnish a set of specialty tools necessary for routine maintenance of the equipment.
  1. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The following list of manufacturers is a general guideline and makes no statement as to the capability of the manufacturer to meet the Specification requirements. The burden of proof of conformance with these Specifications lies with the Contractor and manufacturer. Contractor must make special written application to use other than these named manufacturers.
- B. The design drawings are based on the first named manufacturer. The Contractor shall make all necessary electrical, mechanical, structural and controls modifications to accommodate equipment from another manufacturer at no additional cost to the Owner.
  1. Engine generators:
    - a. One of the following or equal:
      - 1) Caterpillar.
      - 2) Cummins Power Generation.
      - 3) MTU Onsite Energy.
  2. Governor:
    - a. One of the following or equal:
      - 1) Woodward.
      - 2) Isochronous electronic by engine manufacturer.
  3. Load banks:
    - a. One of the following or equal:
      - 1) Avtron.
      - 2) LoadTec.
      - 3) Simplex.
- C. Exhaust system:
  1. One of the following or equal:
    - a. Silencer:
      - 1) GTE Ind.
      - 2) Harco Manufacturing.
      - 3) Silex Innovations.
    - b. Corrugated, flexible engine connector:
      - 1) DME.
      - 2) GTE Ind.
      - 3) Engine-generator manufacturer's equivalent.
    - c. Expansion joint:
      - 1) DME, Inc.
      - 2) GTE Ind.
    - d. Exhaust pipe insulation:
      - 1) As specified in Section 15082- Piping Insulation.



- e. Expansion joint insulation:
  - 1) Pittsburgh-Corning/JPS Composite Materials Corp., Temp-Mat.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS (NOT USED)**

## **2.04 MANUFACTURED UNITS (NOT USED)**

## **2.05 EQUIPMENT**

### **A. Characteristics of assembled unit:**

1. The engine-driven generator consists of a diesel engine directly coupled to an electric generator providing electric power.
2. The engine shall start, attain full speed, voltage, and assume full load within a maximum of 10 seconds, with jacket water at 85 degrees Fahrenheit.
3. Furnish the engine-driven generator on a steel sub-base to support engine, generator, and accessories as a unit:
  - a. Base: Welded construction.
  - b. Engine direct connected through a flexible coupling to a single bearing generator.
  - c. System free of injurious torsional and bending vibrations within a speed range from 10 percent below to 10 percent above synchronous speed.
  - d. Engine-driven generator balanced such that the peak-to-peak amplitude of vibration velocity in any direction does not exceed the engine or generator manufacturer's published limits.
  - e. If shims are required under the feet of the generator for alignment purposes, use 1-piece laminated shim stock that covers at least 90 percent of the foot.
  - f. Provide a complete assembled engine-driven generator skid requiring only field electrical and mechanical connections.
4. Connections to engine-driven generator skid:
  - a. Flexible connections are required on all connections to the engine generator.
  - b. These connections include but are not limited to:
    - 1) Exhaust.
    - 2) Fuel lines.
    - 3) Radiator discharge air ductwork.
  - c. The length of all flexible connections to exceed the flexible connector manufacturer's minimum length recommendations for the diameter used and for the misalignment as measured after installation.

### **B. Generator system performance requirements:**

1. Power output rating:
  - a. Kilowatts and voltage as indicated on the Drawings.
  - b. 0.8 power factor.
  - c. 3-phase, 4-wire, 60 hertz.
  - d. In accordance with NEMA MG-1 temperature rise limits.

2. Regulatory requirements:
  - a. Specifically designed to meet the discharge of gaseous pollutants to the atmosphere as required by the EPA statute and local agency issuing the permit for the engine generator system.

## 2.06 COMPONENTS

- A. Engine generator base:
  1. Support system:
    - a. Bolt the engine-driven generator to steel pads that are an integral part of structural support base.
    - b. Vibration isolators shall be provided with the engine-driven generator and be installed between the engine generator and structural support base or between the base and the floor:
      - 1) As recommended by the isolator manufacturer.
      - 2) Located for equal load distribution and deflection per isolator.
      - 3) Designed for the load and seismic conditions as identified for the site.
- B. Engine:
  1. Full compression ignition, 4-cycle, turbocharged, and aftercooled meeting the required emissions rating.
  2. The rated net horsepower of the engine with all accessories, including radiator fan, must not be less than that required to produce the minimum specified generator capacity at site altitude and maximum ambient temperature.
  3. Equipped and designed as follows:
    - a. Spin-on type replaceable lube oil filters.
    - b. Spin-on type replaceable fuel filters.
    - c. Heat treated forged steel crankshaft:
      - 1) Dynamically balanced.
    - d. Forged steel connecting rods.
    - e. Crankshaft driven gear type lubricating pump.
    - f. Electric fuel shut-off valve.
    - g. Engine air cleaner: Dry type replaceable filter.
    - h. 12- or 24-VDC positive engagement solenoid shift-starting motor:
      - 1) The starting equipment must include the necessary devices to prevent an overcrank and lockout if the starter pinion fails to engage the flywheel ring gear on the initial crank attempt.
      - 2) This starter disconnect shall electronically sense the speed of the flywheel and when the flywheel setpoint speed has been reached, the electronic control signals the starter disconnect to disengage.
    - i. Oil level dip stick and oil drainpipe with valve and pipe plug:
      - 1) Oil drainpipe and valve are to extend 3 inches beyond edge of engine base.
    - j. Engines requiring glow plugs are not acceptable.
    - k. Crankcase breather filter for engines not equipped with EPA Tier certified engine's crankcase emissions control equipment:
      - 1) Provide crankcase ventilation system with coalescing filter/trap for blowby:
        - a) Coalescing filter to be replaceable.

- 2) If engine manufacturer recommends an open crankcase breather system, route outlet of breather filter to outside at 3 inches above grade and away from engine components:
  - a) Provide on breather outlet Nelson "EcoVent" or equal, sized to match engine breather flow.
- 3) If engine manufacturer recommends a closed crankcase breather system, provide integral crankcase pressure regulator with an automatic internal filter bypass and bypass indicator:
  - a) Racor Model CCV 4500 or equal.

C. Governor:

1. Isochronous type to maintain engine speed:
  - a. Within 0.5 percent for steady state conditions.
  - b. Within 5 percent for a no load to full load step with recovery to within 10 seconds of step load application.
  - c. Suitable for use on diesel engines.
  - d. Electronic governor control of fuel.
  - e. Suitable for automatic, unattended starts.
  - f. Speed sensing failure circuit to signal actuator to close if speed pick-up signal is lost.
  - g. With speed pick-up sensor.
  - h. With capabilities of local speed settings.
  - i. Adjustable acceleration rate control from 0 to 8 seconds.
  - j. Personnel guards over all exposed moving parts.
  - k. Equipped with a continuous duty shutdown system for normal remote stopping.

D. Engine jacket water heater:

1. Provide an in-line thermostat that disconnects power when coolant temperature exceeds the manufacturer's suggested setpoint.
2. Contacts from an oil pressure switch or control panel contacts disconnect the heater power when the engine is running.
3. Provided with shutoff valves and unions to allow heater replacement without draining the cooling system.
4. Make all water heater connections with high temperature silicon type hoses and constant torque hose clamps.
5. Size heater such that the engine block temperature is maintained at 85 degrees Fahrenheit at the specified minimum ambient temperature.
6. Connect water heater and thermostat to the engine to minimize heated water circulation through the radiator circuit.
7. Power supply:
  - a. 460 volts, 3-phase.

E. Alternator (generator):

1. Brushless synchronous alternator.
2. Re-connectable 12 lead if available.
3. Self-ventilated.
4. Full amortisseur windings.
5. 2/3 pitch windings, skewed for smooth voltage waveform.
6. With permanent magnet generator pilot exciter.
7. Drip-proof enclosure.
8. Protected against corrosion.

9. Single bearing design.
    - a. Alternators over 2,000 kW may be 2 bearing design.
  10. Insulation:
    - a. Insulated for continuous operation at 40 degrees Celsius ambient temperature.
    - b. Class F (105 degrees Celsius rise by resistance) for medium voltage or Class H (125 degrees Celsius rise by resistance) for low voltage generators.
    - c. Vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092.
    - d. Multiple dipped and baked with a non-hygroscopic varnish with a final dip of epoxy.
  11. Terminate alternator power leads using compression lugs on an insulator and bus bar system within the alternator junction box:
    - a. Provide space on the insulator system to terminate the cables that extend to the load bank.
    - b. These terminations must not require any taping to complete the connection.
    - c. Utilize copper flexible, fine stranded type cables to connect from the alternator to the load bank:
      - 1) Sized for 125 percent of the alternator full load current.
      - 2) Neutral conductors shall be sized at 100 percent of the alternator full load rating.
    - d. Provide a ground terminal inside the junction box to terminate the ground cables between the alternator to the automatic transfer equipment ground bus:
      - 1) Minimum size of the equipment-grounding conductor: 12-1/2 percent of the size of the phase conductors.
  12. Maximum balanced telephone interference factor not to exceed 50.
  13. Designed to supply power to the non-linear loads as specified and as indicated on the Drawings.
- F. Alternator digital voltage regulator:
1. Located in the engine control panel.
  2. Performance requirements:
    - a. Maintain the steady state voltage within 1 percent:
      - 1) From 40 degrees Fahrenheit to 120 degrees Fahrenheit.
      - 2) From no load to full load conditions.
  3. Constant volts per hertz characteristics with under frequency roll-off for better transient response.
  4. Static type.
  5. Sized to match the power requirements of the exciter circuit and power from the permanent magnet generator pilot exciter.
  6. Include manual control to adjust voltage drop, voltage level, and voltage gain.
  7. With 3-phase sensing.
  8. Sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.
  9. Include loss of sensing shutdown to protect the generator against uncontrolled voltage output when the sensing circuit to the regulator is opened.
  10. Shut down regulator when the sensing circuit to the regulator does not have continuity.

11. Include over-excitation shutdown to protect the generator against thermal damage caused by prolonged field forcing.

G. Exhaust system:

1. General:

- a. Provide a complete exhaust system following as indicated on the Drawings and as specified.
- b. Back pressure:
  - 1) Provide components such that the maximum backpressure in the exhaust system including piping and silencer is less than the maximum allowable backpressure published by the engine manufacturer, measured at the exhaust manifold header:
    - a) Reduce backpressure when recommended by the engine manufacturer.
- c. Provide each exhaust manifold header with a plugged, tapped connection for the attachment of a test manometer.

2. Exhaust silencer:

- a. Heavy-duty industrial type fabricated of welded steel with ported tubes and snubbing chambers, and a rating meeting the specified sound attenuation.
- b. Mounting: As indicated on the Drawings.
- c. End connections: Steel flanges with Class 150-pound drilling pattern.
- d. Shell:
  - 1) Sufficiently heavy and reinforced to eliminate excessive vibration, stress, or deflection and to support all operating loads with the silencer at elevated temperatures and insulated as specified.
  - 2) Loads include insulation weight and connecting piping.
- e. Drain: Provide threaded, plugged condensate drain.
- f. Sound attenuation: Attain the following minimum sound attenuation at the listed octave band center frequencies with the engine at full load:

Frequency (Hz)	63	125	250	500	1,000	2,000	4,000	8,000
Attenuation (dB)	39	42	42	40	38	38	38	38

- g. Supports: Provide shell lug supports suitable for supporting and mounting the silencer as indicated on the Drawings; support design to account for elevated temperatures under insulated shell.
  - h. Insulate as specified for engine exhaust piping in Section 15082- Piping Insulation.
  - i. Pressure drop not to exceed manufacturer's recommendation at maximum engine rating.
3. Exhaust piping:
- a. Schedule 40 high temperature black steel pipe conforming to ASTM A106.
  - b. Slope piping to a drain point and provide drain plug.
  - c. Finish:
    - 1) Sand blast and coat outside of exhaust piping with not less than 6 mils of inorganic zinc primer:
    - 2) Finish coat in the field as specified in Section 09960 - High-Performance Coatings.
  - d. Insulation: As specified in Section 15082- Piping Insulation for engine exhaust piping.

4. Exhaust expansion joints:
  - a. Type:
    - 1) Metal with convoluted portion of 0.038-inch-thick Type 321 stainless steel.
    - 2) Non-convoluted portions of expansion joint to be Type 304 stainless steel, Schedule 10S pipe.
    - 3) Provide flanged ends with ASME B16.5, Class 150 bolt hole drilling.
  - b. Length: Minimum of 18 inches in length.
  - c. Movement:
    - 1) Rated for a minimum of 1-inch lateral movement, and 1/2-inch axial movement.
    - 2) Rated movement defined as plus or minus travel from neutral or free position.
  - d. Infinite cycle life with 1,200 degrees Fahrenheit exhaust, no insulation over the expansion joint, and continuous duty service.
  - e. Insulation:
    - 1) Insulate expansion joints with custom fitted, removable with reusable fastening system, ceramic fiber insulation blankets enclosed between inner and outer high temperature fabric cover rated for 1,200 degrees Fahrenheit continuous duty.
    - 2) Do not insulate expansion joints directly connected to turbocharger outlet.
- H. Radiator and cooling system:
  1. Unit mounted:
    - a. Furnish a skid mounted closed type radiator system for the engine driven generator:
    - b. Sized and selected by engine manufacturer to cool the engine and turbo charge aftercooler under ambient conditions.
    - c. Provide all necessary coolant specifically suitable for the location and conditions of service throughout the year:
    - d. Ship both the engine and the radiator with the coolant installed.
- I. Generator control panel:
  1. Microprocessor-based control system that is designed to provide automatic starting, monitoring, protection and control functions for the generator set.
  2. Mounted on the generator set:
    - a. Provide vibration isolation:
      - 1) Prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
  3. Control system features and functions:
    - a. Control switches:
      - 1) Mode selector switch:
        - a) Provide a rotary switch or control panel keypads with status indicators.
        - b) The mode select switch initiates the following control modes:
          - (1) RUN or Manual position:
            - (a) Generator set starts, and accelerates to rated speed and voltage.
          - (2) OFF or STOP position:
            - (a) Generator set immediately stops, bypassing all time delays.

- (3) AUTO position:
      - (a) Generator set accepts a signal from a remote device to start and accelerate to rated speed and voltage.
  - 2) EMERGENCY STOP switch:
    - a) Red “mushroom-head” pushbutton.
    - b) Activating the emergency stop switch causes the engine to immediately stop and be locked out from automatic restarting.
  - 3) RESET switch:
    - a) Clears all faults and allow restarting the engine generator after it has shut down for any fault condition.
  - 4) PANEL LAMP switch or automatic display panel illumination.
- b. AC output metering: Provide the control system with metering including the following features and functions:
  - 1) Provide digital metering:
    - a) 1.0 percent accuracy.
  - 2) Voltmeter:
    - a) RMS voltage.
    - b) Line-to-line.
    - c) Line-to-neutral.
  - 3) Ammeter:
    - a) RMS current.
  - 4) Frequency.
  - 5) Power Factor.
  - 6) Kilowatts (kW):
    - a) kW-hours.
    - b) Output kW.
  - 7) Kilovars (kVars):
    - a) kVar-hours.
    - b) Output kVar.
- c. Generator alarm and status display:
  - 1) Provide high-intensity LED alarm and status indication lamps. Functions indicated include:
    - a) Red alarm-indicating lamps.
    - b) Red common shutdown lamp.
    - c) Green lamp to indicate the engine generator is running at rated frequency and voltage based on actual sensed voltage and frequency on the output terminals of the generator set.
    - d) Flashing red lamp to indicate that the control is not in automatic state.
    - e) Amber common warning indication lamp.
  - 2) Display the following alarm and shutdown conditions on an alphanumeric digital display panel:
    - a) Low oil pressure (alarm).
    - b) Low oil pressure (shutdown).
    - c) Oil pressure sender failure (alarm or indication).
    - d) Low coolant temperature (alarm).
    - e) High coolant temperature (alarm).
    - f) High coolant temperature (shutdown).
    - g) High oil temperature (warning).
    - h) Engine temperature sender failure (alarm or indication).
    - i) Low coolant level (alarm or shutdown - selectable).
    - j) Fail to crank (shutdown).

- k) Fail to start/overcrank (shutdown).
  - l) Overspeed (shutdown).
  - m) Low DC battery voltage (alarm).
  - n) High DC battery voltage (alarm).
  - o) Low fuel-day tank (alarm).
  - p) High AC voltage (shutdown).
  - q) Low AC voltage (shutdown).
  - r) Under frequency (programmable for alarm or shutdown).
  - s) Overcurrent (programmed for warning or shutdown).
  - t) Short circuit - circuit breaker function (trip).
  - u) Emergency stop (shutdown).
- d. Engine status monitoring:
  - 1) Display the following status conditions on an alphanumeric digital display panel:
    - a) Engine oil pressure (pounds per square inch or kilopascal).
    - b) Engine coolant temperature (degrees Fahrenheit or Celsius).
    - c) Engine oil temperature (degrees Fahrenheit or Celsius).
    - d) Engine speed (revolutions per minute).
    - e) Number of start attempts.
    - f) Battery voltage (DC volts).
- e. Data logging and display provision:
  - 1) Log the last 10 warning or shutdown indications on the engine generator.
  - 2) Monitor the total load on the generator:
    - a) Maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments.
    - b) Display total hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.
  - 3) The control system to log:
    - a) Total number of operating hours.
    - b) Total kW hours.
    - c) Total control operational hours.
- f. Engine control functions:
  - 1) Provide a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles:
    - a) Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
  - 2) Provide an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification, including adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
  - 3) Provide time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.
- g. Battery monitoring system:
  - 1) Initiate alarms when the DC control and starting voltage is outside the manufacturer's tolerances.
  - 2) Disable the low voltage limit during engine cranking (starter engaged).
  - 3) Monitor DC voltage as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.



- h. Remote control interface:
  - 1) Provide a minimum of 4 programmable output relays:
    - a) Configurable for any alarm, shutdown, or status condition.
  - 2) Provide a minimum of 4 programmable inputs:
    - a) Label as indicated on the Drawings.
    - b) Labels shall match other control labels.
- 4. Communications:
  - a. MODBUS TCP.

J. Battery system:

- 1. Installed on the engine-driven generator skid.
- 2. Provide extra flexible minimum 4/0 welding cable to make the connection between the battery and the engine:
  - a. Proper compression lugs and tooling must be used to terminate these cables.
- 3. Provide a 12- or 24-volt lead acid recombination no maintenance engine start battery system:
  - a. The battery shall have sufficient capacity, at the minimum and maximum temperature specified, to provide the specified cranking periods.
  - b. Provide battery capacity in order to supply power to the following:
- 4. Charger:
  - a. Sized to provide sufficient power to both fully charge a drained battery.
  - b. Location: Wall mounted as indicated on the Drawings.
  - c. DC ammeter and DC voltmeter.
  - d. On-Off switch.
  - e. Solid-state device with adjustable float voltage control.
  - f. Constant voltage design with current limit.
  - g. With an equalize switch which will allow the battery to be overcharged for maintenance purposes or an automatic charging cycle that has an equalize period.
  - h. Designed to meet the charge, float, and equalize requirement of the battery furnished.
  - i. Overload and short circuit protection.

## 2.07 ACCESSORIES

A. Fuel system:

- 1. Engine fuel pump:
  - a. Positive displacement pump.
  - b. Capable of 5-foot lift minimum.

B. Wiring:

- 1. All external wiring connections to and from the engine and alternator shall be made via 2 engine mounted junction boxes:
  - a. One box shall be used for all control and DC power connections.
  - b. The other box shall be used for the alternator output connections:
    - 1) The alternator output breaker may be used for these connections.
- 2. Enclose wiring in an NEC approved and recognized conduit system selected and sized by the engine generator manufacturer:
  - a. Suitable for the temperatures, vibrations, and conditions on the engine-driven generator skid.

3. Control wiring shall terminate on terminal blocks in the control junction box:
    - a. All connections shall be made to terminal blocks:
      - 1) 600 volt rated.
      - 2) Wires terminated on box with compression type ring type lugs, installed with proper tooling.
      - 3) Terminal blocks shall be numbered.
      - 4) All wiring in terminal box both internal and field connections shall be routed in plastic wire duct.
  4. Terminate alternator output connection wires using solderless compression type lugs when connecting to bus bar:
    - a. Lug manufacturer's termination methods and tools must be used.
  5. Splices are not allowed:
    - a. All connections are to be made at the terminal blocks in the control junction boxes.
- C. Miscellaneous engine generator skid items:
1. Provide the following items:
    - a. Sectionalized drip pans.
    - b. Wall sleeves.
    - c. Rain shields for exhaust lines.
    - d. Roof jacks.
- D. Generator output circuit breaker and load bank circuit breaker:
1. Engine generator skid mounted and line side connected to alternator.
  2. Manually resettable.
  3. Line current sensing.
  4. Inverse time versus current response.
  5. Sized and coordinated to protect the generator from damage from overload and/or short circuit:
    - a. Coordinated with downstream devices:
  6. Breakers shall be as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers:
    - a. Provide solid-state trip units.
  7. Provide breakers with proper number of lugs to match cables as indicated on the Drawings.
- E. Manual load bank and manual transfer breakers:
1. Furnish load bank integrally mounted on the engine-generator skid and fully connected:
    - a. Engine radiator airflow cooled, resistive load bank.
    - b. Load bank designed for local and manual control.
    - c. Install the load bank as follows:
      - 1) Bolted attachment to radiator with duct and flex coupling to air outlet in wall.
    - d. Electrical connection:
      - 1) Power source to load bank connection is 3-phase, 3-wire plus ground from engine-generator.
      - 2) 60 hertz.
    - e. Rating:
      - 1) Capacity minimum of 50 percent horsepower rating in kW of engine or as recommended by the manufacturer.
      - 2) 50 kW load step resolution.

- 3) Air intake temperature coordinated with the maximum discharge temperature of the radiator.
  - 4) Duty cycle: Continuous.
  - 5) Air temperature rise 100 degrees Fahrenheit nominal.
  - 6) Air back-pressure to be coordinated with the engine and radiator requirements.
- f. Design:
- 1) Completely self-contained unit that includes:
    - a) Resistive load elements.
    - b) Load control devices.
    - c) Load element branch circuit fuse protection.
    - d) Main load bus and terminals.
    - e) Control terminals.
    - f) System protection devices.
    - g) Enclosure.
  - 2) Enclosure:
    - a) NEMA Type 12 galvanized steel, unit construction.
    - b) Consisting of:
      - (1) Power section, for installation and wiring of the load elements.
      - (2) Control section for installation and wiring of control components. Physically and thermally isolated from both the hot load elements and the heated airflow.
    - c) Screen the exhaust of the load bank.
  - 3) Load elements:
    - a) UL listed, labeled, or recognized.
    - b) Totally enclosed, sealed, and weatherproofed.
    - c) Electrically grounded outer sheath such that the element cannot be electrically short circuited by external foreign objects, and personnel are protected against accidental electrical shock.
    - d) Replaceable individual elements.
    - e) Open wire type elements in which the electrically live conductors are exposed and which can be short circuited to each other or to ground by foreign objects or by the breakage of an element or an element support shall not be permitted.
    - f) Load element short circuit protection: branch circuit fuses, per each load step branch circuit:
      - (1) Fuses: 200,000 A.I.C. current limiting type.
  - 4) Load control: 1 magnetic contactor per each fused branch circuit.
  - 5) Load bank power wiring: 150 degrees Celsius insulated.
  - 6) Main terminals:
    - a) Barrier type power terminal block with compression type terminal to accept stranded building wire.
    - b) Provide chassis ground stud with compression type terminal.
  - 7) Control wiring: 105 degrees Celsius insulated.
  - 8) Control power: Derived internally from the main load bus, control and protective circuits operating at 120 VAC via control power transformer.
  - 9) System protection:
    - a) Protect against overheating.

- b) Disconnect the load elements from the power source and activate an alarm upon sensing a loss of cooling airflow, or an exhaust air temperature greater than 300 degrees Fahrenheit.
- g. Local control panel:
  - 1) Provide a NEMA Type 12 control panel for manual operation that includes:
    - a) Control power On-Off pushbuttons.
    - b) Normal operation indicator lamp.
    - c) Master load control switch.
    - d) Load step control switches.
    - e) Cooling failure alarm indicator lamp.
    - f) Load dump circuit. Connected to engine/generator control panel to de-energize the load bank in the event of the generator receiving a start command from the automatic transfer switch.
- 2. Transfer switch:
  - a. Integrally mounted on the engine-generator skid.
  - b. Connects the generator manually to either the load bank or to the automatic transfer equipment.
  - c. Engine breaker and the load bank breaker form the manual transfer system for the load bank:
    - 1) Mechanically (key) interlocked so that only one breaker may be closed at any one time.
  - d. UL listed and labeled.
  - e. Fully load break rated.
  - f. Manually operated with the door to the transfer switch closed.
  - g. Furnish load bank circuit breaker in accordance with Section 16412 - Low Voltage Molded Case Circuit Breakers.
  - h. Provide generator breaker and load bank breaker with equipment protective ground fault trip units.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. General:
  - 1. Install the equipment as indicated on the Drawings.
  - 2. Perform all Work in accordance with manufacturer's instructions and shop drawings.

3. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with the Drawings and Specifications.
- C. Installation shall be by personnel experienced and regularly engaged in field installation of power generation systems:
  1. Make all field mechanical and electrical connections.

#### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

#### **3.05 REPAIR/RESTORATION (NOT USED)**

#### **3.06 RE-INSTALLATION (NOT USED)**

#### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.
- B. Design prototype tests as follows:
  1. Use design prototypes similar to the equipment specified in this Section for testing, and not the actual equipment for the Project.
  2. Minimum testing requirements:
    - a. In accordance with NFPA.
    - b. Maximum power in kW.
    - c. Maximum starting kilovolt-ampere at 35 percent instantaneous voltage dip.
    - d. Alternator temperature rise:
      - 1) By embedded thermocouple.
      - 2) By resistance method.
      - 3) In accordance with NEMA MG1-22.40 and 16.40.
    - e. Governor speed regulation under steady state and transient conditions.
    - f. Fuel consumption at 25 percent, 50 percent, 75 percent, and 100 percent load.
    - g. Harmonic analysis, voltage wave form deviation, and telephone influence factor.
    - h. Cooling airflow.
    - i. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
    - j. Endurance testing.
    - k. A certified copy of the test results will be furnished to the Owner.
- C. Test each engine generator under varying loads with all machine safety guards and exhaust system in place.
- D. Test the complete engine generator system at full load and rated power factor with a reactive load bank in the manufacturer's factory:
  1. Tests shall include:
    - a. Radiator.
    - b. Engine control panel.
    - c. Load bank.
    - d. Single-step load pickup.
    - e. Transient and steady-state governing.
    - f. Safety shutdown device testing.

- g. Rated power.
    - h. Maximum power.
  - 2. During the tests, re-circulate the radiator cooling air through the radiator as necessary to test the system under the maximum ambient conditions specified in this Section.
  - 3. Run the unit for 2 hours with the following recordings made hourly:
    - a. Frequency.
    - b. Voltage.
    - c. Amperage.
    - d. Kilowatts.
    - e. Room temperature measured at the generator end of the unit.
    - f. Radiator air inlet temperature.
    - g. Coolant temperature.
    - h. Oil pressure.
  - 4. Record the following items:
    - a. Time required for the engine/generator to start and reach rated voltage and frequency in seconds.
    - b. Maximum block load capabilities of the unit.
    - c. Point at which overtemperature shutdown occurs.
    - d. Point at which overspeed shutdown occurs.
    - e. Point at which low oil pressure shutdown occurs.
    - f. Point at which overcrank shutdown occurs.
    - g. Low water temperature alarm.
    - h. Low fuel level alarm.
    - i. Fuel leak alarm.
    - j. Overvoltage alarm and shutdown.
    - k. Undervoltage alarm and shutdown.
    - l. Under frequency alarm and shutdown.
    - m. Low battery voltage alarm.
  - 5. Furnish a certified copy of the test results to the Owner:
    - a. Record any minor adjustments made during the test.
    - b. If major changes, as determined by the Engineer, are made, the 2-hour test must be repeated.
- E. Owner training:
- 1. As specified in Sections 01756 - Commissioning and 16050 - Common Work Results for Electrical.

### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Test actual backpressure during acceptance testing of the system.
- C. Provide the services of a manufacturer's representative for the following:
  - 1. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with all Drawings and Specifications.

2. Furnish the services of factory-certified technicians during the start-up and adjustment period to make sure all items furnished are in proper operating condition:
  - a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
  - b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
  - c. These technicians to instruct the Owner's personnel regarding the operation and maintenance of all items supplied:
    - 1) Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.
  - d. Furnish a written report after the start-up:
    - 1) Report must state that the installation is complete and satisfactory.
    - 2) List the items requiring additional attention.
- D. Manufacturer to perform installation check, start-up, and load test.
- E. Certify that fuel, lubricating oil, and antifreeze conform to the manufacturer's recommendations under the environmental conditions present.
- F. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine:
  1. These accessories include but are not limited to:
    - a. Jacket water heaters.
    - b. Fuel heaters, when used.
    - c. Battery charger.
    - d. Generator strip heaters, when used.
- G. Start-up under manual mode:
  1. Check for the following items:
    - a. Exhaust leaks.
    - b. External path for exhaust gases.
    - c. Cooling airflow.
    - d. Movement during starting and stopping.
    - e. Vibration during running.
    - f. Normal and emergency line-to-line voltage and phase rotation.
- H. Perform functional testing of load bank:
  1. Verify all load bank steps operate properly.
  2. Verify load dump circuitry is active.
- I. Perform field acceptance tests as specified in Section 16950 - Field Electrical Acceptance Tests.

### **3.09 ADJUSTING**

- A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

**3.10 CLEANING (NOT USED)**

**3.11 PROTECTION**

A. As specified in Section 16050 - Common Work Results for Electrical.

**3.12 SCHEDULES (NOT USED)**

END OF SECTION



## **SECTION 16412**

### **LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Low voltage molded case circuit breakers.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. National Electrical Manufacturers Association (NEMA):
  - 1. AB 3. - Molded Case Circuit Breakers and Their Application.
- C. Underwriter's Laboratories (UL):
  - 1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  - 2. 943 - Ground Fault Circuit Interrupters.

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. In accordance with UL 489.

##### **1.04 SYSTEM DESCRIPTION**

- A. Molded case thermal magnetic, or solid-state as indicated on the Drawings and connected to form a completed system.

##### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Catalog cutsheets.
  - 2. Manufacturer's time-current curves for all molded case circuit breakers furnished.

##### **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Low voltage molded case circuit breakers shall be UL listed and labeled.

## **1.07 DELIVERY, STORAGE AND HANDLING**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 PROJECT OR SITE CONDITIONS**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP**

A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

A. One of the following or equal:

1. Eaton.
2. Schneider Electric.
3. ABB.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS (NOT USED)**

## **2.04 MANUFACTURED UNITS**

A. General:

1. Conforming to UL 489.
2. Operating mechanism:
  - a. Quick-make, quick-break, non-welding silver alloy contacts.
  - b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
  - c. Mechanically trip free from the handle.
  - d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
  - e. Lockable in the "OFF" position.
3. Arc extinction:
  - a. In arc chutes.

4. Voltage and current ratings:
  - a. Minimum ratings as indicated on the Drawings.
  - b. Minimum frame size 100A.
5. Interrupting ratings:
  - a. Minimum ratings as indicated on the Drawings.
  - b. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.).

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS**

- A. Terminals:
  1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.
- B. Case:
  1. Molded polyester glass reinforced.
  2. Ratings clearly marked.
- C. Trip units:
  1. Provide solid-state trip units as indicated on the Drawings.
  2. Solid state:
    - a. With the following settings as indicated on the Drawings.
      - 1) Adjustable long time current setting.
      - 2) Adjustable long time delay.
      - 3) Adjustable short time pickup.
      - 4) Adjustable short time delay.
      - 5) Adjustable instantaneous pickup.
      - 6) Adjustable ground fault pickup as indicated on the Drawings.
      - 7) Adjustable ground fault delay as indicated on the Drawings.
      - 8) Energy reducing maintenance switch on breakers 1200 amps and above and on additional breakers as indicated in the Drawings.
        - a) Indication on the breaker.

## **2.07 ACCESSORIES (NOT USED)**

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL**

- A. Test breakers in accordance with:
  1. UL 489.
  2. Manufacturer's standard testing procedures.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION (NOT USED)**

### **3.02 PREPARATION (NOT USED)**

### **3.03 INSTALLATION**

- A. Install breakers to correspond to the accepted shop drawings.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.09 ADJUSTING**

- A. Adjust trip settings in accordance with Protective Device Coordination Study as provided by the Engineer and in accordance with manufacturer's recommendations.

### **3.10 CLEANING (NOT USED)**

### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION

## **SECTION 16413**

### **LOW VOLTAGE INSULATED CASE CIRCUIT BREAKERS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Low voltage insulated case circuit breakers.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. American National Standards Institute (ANSI):
  - 1. C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
  - 2. C37.16 - Low Voltage Power Circuit Breakers and AC Power Circuit Breakers - Preferred Ratings, Related Requirements, and Application Recommendations.
  - 3. C37.17 - Standard for Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
  - 4. C37.50 - Low Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures.
- C. National Electrical Manufacturers Association (NEMA):
  - 1. Standard No. AB 1. - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures. (Adopted as UL 489).
- D. Underwriter's Laboratories (UL):
  - 1. UL 1066 - Standard for Safety for Low Voltage AC and DC Power Circuit Breakers Used in Enclosures.

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

##### **1.04 SYSTEM DESCRIPTION**

- A. Insulated case circuit breakers as indicated on the Drawings and connect to form a completed system:
  - 1. Used to open and close a circuit, and to open a circuit automatically on a predetermined overload or overcurrent, without damage to itself when properly applied within its ratings.

##### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

- B. Product data:
  - 1. Catalog cutsheets.
  - 2. Manufacturer's time-current curves for all trip devices furnished.

## **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Insulated case circuit breakers shall be UL listed and labeled.

## **1.07 DELIVERY, STORAGE AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. One of the following or equal:
  - 1. Eaton.
  - 2. GE by ABB.
  - 3. Schneider Electric.
  - 4. ABB.

## **2.02 EXISTING PRODUCTS (NOT USED)**

## **2.03 MATERIALS (NOT USED)**

## 2.04 MANUFACTURED UNITS

- A. Operating mechanism:
  - 1. Manual or electric as indicated on the Drawings:
    - a. Manual operation:
      - 1) The circuit breaker closing spring is energized by no more than 6 operations of the constant force charging handle.
      - 2) Pushing the "CLOSE (ON)" button will close the breaker's contacts and pushing the "OPEN (OFF)" button will open the breaker's contacts.
      - 3) The opening springs are automatically charged when the breaker is closed.
    - b. Quick-make, quick-break, non-welding silver alloy contacts.
    - c. Common trip, open and close for multi-pole breakers such that all poles open and close simultaneously.
    - d. Mechanically trip free from the handle.
    - e. Trip indicating handles - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
    - f. Lockable in the "OFF" position.
- B. Arc extinction:
  - 1. In arc chutes.
- C. Voltage and current ratings:
  - 1. Minimum ratings as indicated on the Drawings.
- D. Interrupting ratings:
  - 1. Minimum ratings as indicated on the Drawings.
  - 2. Matching the rating of the assembly.
- E. Circuit breaker mounting shall be as indicated on the Drawings and consist of one of the following configurations:
  - 1. Draw out type capable of being racked to the disconnect position with the door closed:
    - a. Interlocks shall be provided to prevent connecting or disconnecting the circuit breaker unless the breaker is in the open position.
    - b. The breaker shall be prevented from being closed during any racking operation.
    - c. A test position shall be provided to permit operating the breaker while it is disconnected from the power circuit.
    - d. Equipped with interlocks to discharge stored energy spring before the circuit breaker is withdrawn from the cell.
  - 2. Plug-in (stationary) type capable of being removed with the main bus power off.
  - 3. Individually mounted in a separate enclosure.

## 2.05 EQUIPMENT (NOT USED)

## 2.06 COMPONENTS

- A. Terminals:
  - 1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.
- B. Case:
  - 1. Molded polyester glass reinforced.
  - 2. Double level of insulation between primary current-carrying parts and operating personnel.
  - 3. Ratings clearly marked.
  - 4. Open contact indication.
  - 5. Closed contact indication.
  - 6. Charging spring charged indication.
  - 7. Charging spring discharged indication.
  - 8. Open pushbutton.
  - 9. Close pushbutton.
  - 10. Retractable charging handle.
- C. Trip units:
  - 1. Microprocessor based with positive action flux-shifting trip device and a solid-state type with the following functions:
    - a. Adjustable ampere setting:
      - 1) To determine the value of current that the breaker will carry indefinitely.
    - b. Adjustable long time delay:
      - 1) Varies the time it will take the breakers to trip under sustained overload.
    - c. Adjustable short time pickup:
      - 1) Controls the level of high current the breaker will carry for short periods.
    - d. Adjustable short time delay:
      - 1) Controls the length of time the breaker will carry a high current without tripping.
    - e. Adjustable instantaneous pickup:
      - 1) Controls level at which immediate tripping of breaker occurs.
    - f. Adjustable ground fault pickup:
      - 1) Controls the level at which the breaker will trip under a ground fault condition.
    - g. Adjustable ground fault delay:
      - 1) Controls the time that a ground fault can exist without tripping the breaker.
    - h. Long time pickup indicator:
      - 1) Provides a visual indication that the breaker is experiencing an overload condition.
    - i. Energy reducing maintenance switch.
      - 1) Allows for input of alternative trip settings for arc flash hazard reduction during maintenance procedures.
      - 2) Enabled by the following:
        - a) Hardwired input.
        - b) Trip unit controls.
        - c) Trip unit network.



- 3) Status:
  - a) Contact for remote indication.
  - b) Indication on trip unit.
  - c) Status communicated over trip unit network.

- D. Fault indicators:
  - 1. Powered from a lithium battery.
  - 2. LED indicators for:
    - a. Overcurrent fault trip on long-time feature.
    - b. Overcurrent fault trip on short-time feature.
    - c. Short circuit fault trip on the instantaneous feature.
    - d. Ground fault trip.

## **2.07 ACCESSORIES**

- A. Provide circuit breakers with the following accessories as indicated on the Drawings.
  - 1. Operations counter.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL**

- A. Test breakers in accordance with:
  - 1. UL 489.
  - 2. Manufacturer's standard testing procedures.

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. Install breakers to correspond to the accepted shop drawings.

## **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

## **3.05 REPAIR/RESTORATION (NOT USED)**

## **3.06 RE-INSTALLATION (NOT USED)**

## **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.09 ADJUSTING**

- A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with the manufacturer's recommendations.

### **3.10 CLEANING (NOT USED)**

### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION

## **SECTION 16441**

### **GROUP-MOUNTED CIRCUIT BREAKER SWITCHBOARDS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Free standing, dead-front type metal-enclosed distribution, low voltage switchboards, utilizing group mounted circuit protective devices.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. National Electrical Manufacturers' Association (NEMA):
  - 1. PB-2 - Dead-front Distribution Switchboards.
- C. Underwriters' Laboratories, Inc. (UL):
  - 1. 50 - Standard for Enclosures for Electrical Equipment.
  - 2. 891 - Switchboards.

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

##### **1.04 SYSTEM DESCRIPTION**

- A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including but not limited to, circuit breakers, bus and enclosure with accessories and features specified in this Section and indicated on the Drawings.
- B. Description of sections:

##### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  - 1. Manufacturer of switchboard.
  - 2. Manufacturer of all component parts of switchboard.
  - 3. Weight of switchboard.
  - 4. Dimensions:
    - a. Height.
    - b. Length.
    - c. Width.
  - 5. Nameplate schedule.
  - 6. Bill of material.

7. Ratings:
    - a. Voltage.
    - b. Phase.
    - c. Current.
    - d. Interrupting rating (circuit breakers and fuses).
    - e. Momentary current rating.
  8. List of recommended spare parts.
  9. Name and telephone number of manufacturer's authorized parts and repair provider.
  10. Furnish circuit breaker submittals as specified in:
    - a. Section 16412 - Low Voltage Molded Case Circuit Breakers.
    - b. Section 16413 - Low Voltage Insulated Case Circuit Breakers.
  11. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050 - Common Work Results for Electrical:
    - a. Manufacturer's statement of seismic qualification with substantiating test data.
    - b. Manufacturer's special seismic certification with substantiating test data.
- C. Shop drawings:
1. Layout drawings:
    - a. Complete, detailed, and scaled switchboard layout:
      - 1) Front panel.
      - 2) Sub-panels.
      - 3) Interior panels.
      - 4) Top and bottom conduit windows.
- D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
  2. For equipment installed in structures designated as seismic design category A or B:
    - a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
  3. For equipment installed in structures designated as seismic design category C, D, E, or F:
    - a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050 - Common Work Results for Electrical.
    - b. Submit anchoring drawings with supporting calculations.
    - c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.
- E. Operating and maintenance manuals:
1. Submit operating instructions and a maintenance manual for the switchboard(s) furnished and/or installed under this Contract.
  2. Maintenance manual:
    - a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.

- F. Test forms and reports:
  - 1. Submit complete factory acceptance test procedures and all forms used during the test.
  - 2. Manufacturer to furnish a certified report after the factory tests.
- G. Certification letters:
  - 1. Provide a letter from the switchboard manufacturer that lists every paragraph, subparagraph etc. of this Section and states compliance or non-compliance with said paragraph. If non-compliance is indicated, provide an explanation for the deviation and alternative method to address the non-compliance.
- H. Calculations:
  - 1. Detailed calculations or details of the actual physical testing performed on the switchboard to prove the switchboard is suitable for the seismic requirements at the Project Site.

## **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Sections and devices shall be UL listed and labeled.

## **1.07 DELIVERY STORAGE AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Ship the switchboard to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment:
  - 1. Energize space heaters in NEMA 3R switchboards.
- C. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

## **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.09 SEQUENCING**

- A. Submit the complete equipment submittal.
- B. Conduct factory acceptance test and submit certified test results for Engineer's review.
- C. Ship equipment to Project Site after successful completion of factory acceptance test.
- D. Assemble equipment in the field.
- E. Conduct field acceptance test and submit results for Engineer's review.
- F. Submit manufacturer's certification that equipment has been properly installed and is fully functional for Engineer's review.

- G. Conduct Owner's training sessions.
- H. Commissioning as specified in Section 01756 - Commissioning.

#### **1.10 SCHEDULING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.12 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

#### **1.14 MAINTENANCE (NOT USED)**

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. One of the following or equal:
  - 1. Eaton, "Pow-R-Line C."
  - 2. GE by ABB, "Spectra Series."
  - 3. Schneider Electric, "Power-Style QED."
- B. Circuit breakers: Same manufacturer as the switchboard.

#### **2.02 EXISTING PRODUCTS (NOT USED)**

#### **2.03 MATERIALS (NOT USED)**

#### **2.04 MANUFACTURED UNITS (NOT USED)**

#### **2.05 EQUIPMENT**

- A. Switchboard:
  - 1. Furnish low voltage Class 2 switchboards as specified and indicated on the Drawings.
  - 2. Provide complete and functional switchboards with required controls.
  - 3. Furnish and install devices or accessories not described in this Section but necessary for the proper installation and operation of the equipment.
- B. Voltage ratings:
  - 1. Voltage level and configuration: As indicated on the Drawings.
  - 2. Frequency: 60 hertz.

- C. Bus:
  - 1. General:
    - a. Tin-plated copper.
    - b. Bus cross-section in accordance with UL heat rise requirements.
    - c. Current density of 1,000 amperes per square inch.
    - d. Mounted on supports of high-impact, non-tracking insulators.
    - e. Phase A-B-C bus arrangement:
      - 1) Top-to-bottom, left-to-right, front-to-back throughout the switchboard.
    - f. Symmetrical short circuit current bracing of as indicated on the Drawings.
    - g. Continuous current rating as indicated on the Drawings.
  - 2. Horizontal bus:
    - a. Provisions for future connections to additional switchboard sections.
  - 3. Ground bus:
    - a. Sized per UL 891.
- D. Enclosure:
  - 1. General:
    - a. Self-supporting structures bolted together to form the required line-up.
    - b. All sections rear aligned.
    - c. Dead-front.
    - d. Conduit entry:
      - 1) Open-bottom.
      - 2) Removable top cover.
  - 2. Frame:
    - a. Die-formed 12-gauge steel.
  - 3. Covers:
    - a. Bolt-on.
    - b. Code gauge steel.
    - c. Removable front covers.
      - 1) Held in place by captive screws.
  - 4. Rating:
    - a. NEMA Type 12.

## 2.06 COMPONENTS

- A. Circuit breakers:
  - 1. General:
    - a. Molded case circuit breakers as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
    - b. Insulated case circuit breakers as specified in Section 16413 - Low Voltage Insulated Case Circuit Breakers.
  - 2. Main circuit breaker:
    - a. Frame, trip and short circuit ratings as indicated on the Drawings.
    - b. Fixed mounted insulated case.
  - 3. Feeder breakers:
    - a. Frame, trip and short circuit ratings as indicated on the Drawings.
- B. Wiring:
  - 1. Provide all necessary internal wiring, fuse blocks, and terminal blocks as required.
  - 2. Number all wires at each end and indicate wire numbers on shop drawings.
  - 3. Type SIS switchboard wire with at least 26 strands.

4. Minimum wire size:
  - a. No. 14 for control circuits.
  - b. No. 12 for potential and current transformer circuits.
5. Numbered and labeled in accordance with Section 16075 - Identification for Electrical Systems.

## **2.07 ACCESSORIES**

- A. Nameplates:
  1. Provide engraved plastic nameplates to identify:
    - a. Switchboard units.
    - b. Door mounted components.
    - c. Interior mounted devices.
  2. As specified in Section 16075 - Identification for Electrical Systems.
  3. Engraved with the circuit number and circuit name as indicated on the Drawings.
  4. Manufacturers labels:
    - a. Each vertical section shall have a label identifying:
      - 1) Serial number.
      - 2) Shop order number.
      - 3) Bus rating.
      - 4) Vertical section reference number.
      - 5) Date of manufacture.
- B. Warning signs:
  1. Voltage:
    - a. Provide a minimum of 2 warning signs on the front of the switchboard lineup and 2 on the back.
    - b. Red laminated plastic engraved with white letters approximately 1/2 inch high.
    - c. Signs shall read:
      - 1) "WARNING-HIGH VOLTAGE-KEEP OUT".
  2. Arc flash:
    - a. Provide one warning sign for each switchboard compartment.
    - b. Signs shall have read a minimum of:
      - 1) "DANGER ELECTRIC ARC FLASH HAZARD."
      - 2) Signs shall meet the requirements of NFPA 70E and NEC Article 110.16.
- C. Lugs:
  1. For all external connections of No. 6 AWG or larger.
  2. UL listed for copper or aluminum conductors.
  3. Rated for 75-degree Celsius conductors.
  4. Lugs shall be of the compression type in design requiring a hydraulic press and die for installation.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES**

- A. Chemically clean all steel surfaces before painting.



- B. Exterior color manufacturer's standard gray over phosphate-type rust inhibitor.

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

## **PART 3 EXECUTION**

### **3.01 EXAMINATION (NOT USED)**

### **3.02 PREPARATION (NOT USED)**

### **3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. General:
  - 1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete the installation of the switchboard.
  - 2. Assemble and install the switchboard in the location and layout indicated on the Drawings.
  - 3. Perform work in accordance with manufacturer's instructions and shop drawings.
  - 4. Furnish components and equipment as required to complete the installation.
  - 5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
  - 6. Install the switchboard on a raised concrete housekeeping pad:
    - a. Weld and/or bolt the switchboard frame to be to the leveling channels.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 REINSTALLATION (NOT USED)**

### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.
- B. Factory tests:
  - 1. Owner and Engineer will witness the factory acceptance test as specified in Section 16050 - Common Work Results for Electrical.
  - 2. Completely assemble, wire and test the switchboard:
    - a. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.

### **3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.09 ADJUSTING**

- A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

### **3.10 CLEANING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION

## **SECTION 16510**

### **LIGHTING: LED LUMINAIRES**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes: LED luminaires, drivers, and accessories.

##### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Illuminating Engineering Society (IES):
  - 1. LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
  - 2. LM-80 - Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
  - 3. TM-21 - Projecting Long Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources.
  - 4. RP-7 - Recommended Practice for Lighting Industrial Facilities.
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- D. National Electrical Manufacturers Association (NEMA):
  - 1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- E. Underwriters Laboratories (UL):
  - 1. 1598 - Luminaires.
  - 2. 8750 - Light Emitting Diode (LED) Equipment for Use In Lighting Products.

##### **1.03 DEFINITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Specific definitions and abbreviations:
  - 1. CCT: Correlated color temperature - Scientific scale to describe how "warm" or how "cool" the light source is, measured in Kelvin. The lower the Kelvin temperature, the warmer the light feels, or appears.
  - 2. CRI: Color Rendering Index - A quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.
  - 3. Driver - Device that manages power and controls the current flow from AC to DC for an LED lighting product.
  - 4. Efficacy - Lumen output of a light source per unit of power supplied to that source (lumens per watt).

5. EMI: Electromagnetic Interference - Electrical interference (noise) generated by electrical and electronic devices.
6. FC: Foot Candles - Measure of light level on a surface being illuminated.
7. L70 - The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
8. LED: Light emitting diode - A solid-state semiconductor device that produces light when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - The international (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by one candle power when all parts of the surface are exactly one foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
14. Luminaire - Lighting unit.
15. THD: Total harmonic distortion - The combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

#### 1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. Product data:
  1. LED Luminaires:
    - a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule in the Drawings.
    - b. Provide for each luminaire type:
      - 1) Materials.
      - 2) Type of diffuser.
      - 3) Hardware.
      - 4) Gasketing.
      - 5) Reflector.
      - 6) Chassis.
      - 7) Finish and color.
      - 8) Driver type and protection.
      - 9) LED luminaire:
        - a) Initial lumen output at 40 degrees Celsius ambient.
        - b) Correlated color temperature.
        - c) Lumen maintenance factors.
        - d) Lumen ambient temperature multipliers.
        - e) Drive current.
        - f) Efficacy.
      - 10) Picture of luminaire.
      - 11) IES optical distributions.
      - 12) Dimensioned drawings:
        - a) Effective projected area rating for pole mounted luminaires.

- 13) Weight.
- 14) Photometric data:
  - a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
  - b) Luminaire dirt depreciation factor.
  - c) Candlepower distribution curves.
  - d) Average luminaire brightness.
  - e) Lumen output charts.
- 15) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
  - a) Support methods shall be based on seismic requirements at the project site as specified in Section 16050 - Common Work Results for Electrical.
- c. Luminaire substitutions:
  - 1) Provide complete literature for each luminaire substitution:
  - 2) Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
    - a) Photometric data:
      - (1) IES file in standard IES format.
      - (2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
      - (3) Candlepower distribution curves.
      - (4) Average luminaire brightness.
      - (5) Lumen output charts.
      - (6) Power requirements in watts and volt-amperes.
    - b) Calculations:
      - (1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
        - (a) Use surface reflectance values in accordance with IES RP-7.
        - (b) Use manufacturer Projected Lumen Maintenance factor for minimum of 60,000 hours to perform all calculations.
    - c) Specification sheets:
      - (1) If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications necessary to meet the requirements of the contract documents.
  - 3) Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
  - 4) Substitutions shall comply with all applicable building and energy codes.
2. Driver: Provide for each driver type:
  - a. Catalog number.

- b. Type of driver.
- c. Output wattage.
- d. Input voltage.
- e. Operating voltage range.
- f. Maximum input power.
- g. Efficiency.
- h. Operating line current.
- i. Power factor.
- j. Operating temperature range.
- k. Current output range in ambient temperatures of 30 to 55 degrees Celsius.
- l. Surge suppression data.

C. Record documents:

- 1. Update the the Drawings to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

## **1.05 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.07 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.08 SEQUENCING (NOT USED)**

## **1.09 SCHEDULING**

- A. Lighting demonstration shall occur within 2 weeks before substantial completion.

## **1.10 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. LED luminaire:
  - 1. 5-year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

## **1.11 SYSTEM START-UP**

- A. As specified in Section 16050 - Common Work Results for Electrical.

## **1.12 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.13 MAINTENANCE**

- A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Luminaires:
  - 1. The following or equal:
    - a. As noted on the Drawings.
- B. Drivers:
  - 1. One of the following or equal:
    - a. Philips Advance.
    - b. Thomas Research.
    - c. eldoLED.
- C. Substitutions:
  - 1. The lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor's responsibility to ensure and prove to the Engineer at time of submittal the substitutions meet the quality and photometric requirements of the original design.

### **2.02 SYSTEM DESCRIPTION**

- A. Provide luminaires, and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.
- B. Individual luminaire types are indicated on the Drawings.

### **2.03 EXISTING PRODUCTS (NOT USED)**

### **2.04 MATERIALS (NOT USED)**

### **2.05 MANUFACTURED UNITS (NOT USED)**

### **2.06 EQUIPMENT**

- A. LED Luminaires:
  - 1. General:
    - a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
    - b. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
  - 2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
  - 3. Minimum rated life:
    - a. Process Areas: 100,000 hours when operated at 40 degrees Celsius.
  - 4. Minimum efficacy of 70 lumens/watt.
  - 5. Minimum Color Rendering Index of 70.
  - 6. Tested according to IES LM-79 and LM-80.
  - 7. Lumen maintenance projection in accordance with IES TM-21.
  - 8. RoHS compliant.
  - 9. Integral driver.
  - 10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule.

- a. Wet or damp locations: UL 1598 listed.
- 11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.

**B. Drivers:**

- 1. Input power source:
  - a. As indicated on the Drawings.
- 2. Drive current:
  - a. As indicated in the Luminaire Schedule.
- 3. Power factor: greater than 0.90.
- 4. Efficiency: greater than 80 percent.
- 5. Total harmonic distortion (THD) of the input current less than 20 percent.
- 6. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
- 7. Minimum operating temperature of 0 degrees Celsius.
- 8. Sound rating: Class A+ or quieter.
- 9. In accordance with IEEE C62.41 Category A for transient protection.
- 10. Driver must limit inrush current:
  - a. Meet or exceed NEMA 410 driver inrush standard:
    - 1) 230 Amps per 10 Amp load with a maximum of 106 Amps squared-seconds at 120V.
    - 2) 430 Amps per 10 Amp load with a maximum of 370 Amps squared-seconds at 277V.

**2.07 COMPONENTS (NOT USED)**

**2.08 ACCESSORIES (NOT USED)**

**2.09 MIXES (NOT USED)**

**2.10 FABRICATION (NOT USED)**

**2.11 FINISHES (NOT USED)**

**2.12 SOURCE QUALITY CONTROL (NOT USED)**

**PART 3 EXECUTION**

**3.01 EXAMINATION (NOT USED)**

**3.02 PREPARATION (NOT USED)**

**3.03 INSTALLATION**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Install luminaires per the manufacturer's guidelines and submitted installation calculations to meet seismic and wind requirements at the project site.
- C. Special techniques:
  - 1. Support luminaires from structural elements capable of carrying the total weight.



2. Install luminaires plumb and square with building and wall intersections.
3. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
4. Provide ceiling or pendent mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.

**3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

**3.05 REPAIR/RESTORATION (NOT USED)**

**3.06 RE-INSTALLATION (NOT USED)**

**3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.

**3.08 FIELD QUALITY CONTROL**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.09 ADJUSTING (NOT USED)**

**3.10 CLEANING**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Clean all lenses, diffusers, and reflectors.

**3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

**3.12 SCHEDULES**

- A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION



## SECTION 16950

### FIELD ELECTRICAL ACCEPTANCE TESTS

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## **PART 1 GENERAL**

### **1.01 SUMMARY**

- A. Section includes:
  - 1. Responsibilities for testing the electrical installation.
  - 2. Adjusting and calibration.
  - 3. Acceptance tests.
- B. Copyright information:
  - 1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc. (NETA). See NETA publication ATS for details.

### **1.02 REFERENCES**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. American National Standards Institute (ANSI).
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
  - 2. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
  - 3. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) With High Direct Voltage.
  - 4. 421.3 - IEEE Standard for High-Potential Test Requirement for Excitation Systems for Synchronous Machines.
- D. Insulated Cable Engineer's Association (ICEA).
- E. InterNational Electrical Testing Association (NETA).
  - 1. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- F. International Electrotechnical Commission (IEC).
- G. Manufacturer's testing recommendations and instruction manuals.
- H. National Fire Protection Association (NFPA):
  - 1. 70 - National Electrical Code (NEC).
  - 2. 110 - Standard for Emergency and Standby Power Systems.
- I. National Institute of Standards and Technology (NIST).
- J. Specification sections for the electrical equipment being tested.
- K. Shop drawings.

### **1.03 DEFINITIONS**

- A. As specified in Sections 01756 - Commissioning and 16050 - Common Work Results for Electrical.

- B. Specific definitions:
  - 1. Testing laboratory: The organization performing acceptance tests.

#### **1.04 SYSTEM DESCRIPTION**

- A. Testing of all electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section.
- B. Conduct all tests in the presence of the Engineer or the Engineer's representative:
  - 1. Engineer will witness all visual, mechanical, and electrical tests, and inspections.
- C. The testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.
- D. Responsibilities:
  - 1. Contractor responsibilities:
    - a. Ensure that all resources are made available for testing, and that all testing requirements are met.
  - 2. Electrical subcontractor responsibilities:
    - a. Perform routine tests during installation.
    - b. Demonstrate operation of electrical equipment.
    - c. Commission the electrical installation.
    - d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including but not limited to:
      - 1) Providing electrical power as required.
      - 2) Operating of electrical equipment in conjunction with testing of other equipment.
      - 3) Activating and shutting down electrical circuits.
      - 4) Making and recording electrical measurements.
      - 5) Replacing blown fuses.
      - 6) Installing temporary jumpers.
  - 3. Testing laboratory responsibilities:
    - a. Perform all acceptance tests specified in this Section.
    - b. Provide all required equipment, materials, labor, and technical support during acceptance tests.

#### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.
- B. LAN cable test form:
  - 1. LAN cable test reports:
    - a. Submit 3 copies of test reports showing the results of all tests specified in this Section:
      - 1) Test type.
      - 2) Test location.
      - 3) Test date.
      - 4) Cable number.
      - 5) Cable length.
      - 6) Certification that the cable meets or exceeds the specified standard.

- b. Furnish hard copy and electronic copy for all traces.
- C. Manufacturers' testing procedures:
  - 1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.
- D. Test report:
  - 1. Include the following:
    - a. Summary of Project.
    - b. Description of equipment tested.
    - c. Description of tests performed.
    - d. Test results.
    - e. Conclusions and recommendations.
    - f. Completed test forms.
    - g. List of test equipment used and calibration dates.
    - h. LAN cable test reports.
- E. Test data records:
  - 1. Include the following:
    - a. Identification of the testing organization.
    - b. Equipment identification.
    - c. Nameplate data.
    - d. Humidity, temperature and or other conditions that may affect the results of the tests and or calibrations.
    - e. Dates of inspections, tests, maintenance and or calibrations.
    - f. Indication of the inspections, tests, maintenance, and or calibrations to be performed and recorded.
    - g. Expected results when calibrations are to be performed.
    - h. Indication of as-found and as-left results as applicable.
    - i. Indication of all test results outside specified tolerances.
- F. Testing laboratory qualifications:
  - 1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
    - a. This statement will be used to determine whether the laboratory is acceptable, and shall include:
      - 1) Corporate history and references.
      - 2) Resume of individual performing test.
      - 3) Equipment list and test calibration data.
- G. Division of responsibilities:
  - 1. Submit a list identifying who is responsible for performing each portion of the testing.

## **1.06 QUALITY ASSURANCE**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. Testing laboratory qualifications:
  - 1. The testing laboratory may be qualified testing personnel from the electrical subcontractor's staff or an independent testing company.
  - 2. NETA certification required.

3. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

#### **1.07 DELIVERY, STORAGE, AND PROTECTION (NOT USED)**

#### **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.09 SEQUENCING**

- A. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for all equipment to be tested.
- B. Perform testing in the following sequence:
  1. Perform routine tests as the equipment is installed including:
    - a. Insulation-resistance tests.
    - b. Continuity tests.
    - c. Rotational tests.
  2. Adjusting and preliminary calibration.
  3. Acceptance tests.
  4. Demonstration.
  5. Commissioning and plant start-up.

#### **1.10 SCHEDULING (NOT USED)**

#### **1.11 WARRANTY**

- A. As specified in Section 16050 - Common Work Results for Electrical.

#### **1.12 SYSTEM START-UP (NOT USED)**

#### **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

#### **1.14 MAINTENANCE (NOT USED)**

### **PART 2 PRODUCTS**

Not Used.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION (NOT USED)**

#### **3.02 PREPARATION**

- A. Test instrument calibration:

1. Utilize a testing laboratory with a calibration program which maintains all applicable test instrumentation within rated accuracy.
    - a. The calibrating standard shall be of better accuracy than that of the equipment tested.
  2. The accuracy shall be traceable to the NIST in an unbroken chain.
  3. Calibrate instruments in accordance with the following frequency schedule:
    - a. Field instruments: 6 months maximum.
    - b. Laboratory instruments: 12 months maximum.
    - c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
  4. Dated calibration labels shall be visible on all test equipment.
  5. Maintain an up-to-date instrument calibration record for each test instrument:
    - a. The records shall show the date and results of each calibration or test.
  6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.
- B. Do not begin testing until the following conditions have been met:
1. All instruments required are available and in proper operating condition.
  2. All required dispensable materials such as solvents, rags, and brushes are available.
  3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment are available or scheduled.
  4. All instruction books, calibration curves, or other printed material to cover the electrical devices are available.
  5. Data sheets to record all test results are available.
- C. Engine generator tests:
1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
    - a. Manufacturer's field engineer for the voltage regulator.
    - b. Manufacturer's field engineer for the governor and governor controller.
    - c. Electrical contractor.

### **3.03 INSTALLATION**

- A. Test decal:
1. The testing laboratory shall affix a test decal on the exterior of equipment or equipment enclosure of protective devices after performing electrical tests.
  2. The test decal shall be color coded to communicate the condition of maintenance of the protective. The color scheme for condition of maintenance of overcurrent protective devices shall be:
    - a. White: electrically and mechanically acceptable.
    - b. Yellow; minor deficiency not affecting fault detection and operation, but minor electrical or mechanical condition exists.
  3. The decal shall include the following information at a minimum:
    - a. Testing organization.
    - b. Project identifier.
    - c. Test date.
    - d. Technician identifier.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**



### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 COMMISSIONING**

- A. As specified in Section 01756 - Commissioning.
- B. Testing and Training Phase: Installation Testing:
  - 1. Also called "Field Acceptance Testing".
  - 2. Switchgear and switchboard:
    - a. Visual and mechanical inspection:
      - 1) Compare equipment nameplate data with the Contract Documents.
      - 2) Inspect physical and mechanical condition.
      - 3) Inspect anchorage, alignment, grounding and required area clearances.
      - 4) Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
      - 5) Verify that circuit breaker sizes and types correspond to the approved submittals.
      - 6) Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
      - 7) Inspect bolted electrical connections for high resistance using one of the following methods:
        - a) Use of low-resistance ohmmeter.
        - b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
          - (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      - 8) Verify operation and sequencing of interlocking systems:
        - a) Attempt closure on locked-open devices.
        - b) Attempt to open locked-closed devices.
        - c) Make/attempt key-exchanges in all positions.
      - 9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      - 10) Inspect insulators for evidence of physical damage or contaminated surfaces.
      - 11) Verify correct barrier and shutter installation and operation.
      - 12) Exercise all active components.
      - 13) Inspect mechanical indicating devices for correct operation.
      - 14) Verify that filters are in place and/or vents are clear.
    - b. Electrical tests:
      - 1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      - 2) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute.
        - a) Perform test in accordance with NETA ATS tables.
      - 3) Perform electrical tests on instrument transformers as specified in this Section.

- 4) Perform ground-resistance tests:
  - a) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
- c. Test values:
  - 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Bolt-torque levels shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
  - 3) Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
    - b) Investigate insulation values less than the allowable minimum.
    - c) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
  - 4) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
  - 5) Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
  - 6) Phasing checks shall prove the switchgear or switchboard phasing is correct and in accordance with the system design.
3. Low voltage cables, 600 volt maximum:
  - a. Visual and mechanical inspection:
    - 1) Compare cable data with the Drawings and Specifications.
    - 2) Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
    - 3) Inspect bolted electrical connections for high resistance by one of the following methods:
      - a) Use of low-resistance ohmmeter.
      - b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        - (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    - 4) Inspect compression applied connectors for correct cable match and indentation.
    - 5) Inspect for correct identification and arrangement.
    - 6) Inspect cable jacket insulation and condition.
  - b. Electrical tests:
    - 1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    - 2) Perform insulation resistance test on each conductor sized #8 AWG or larger with respect to ground and adjacent conductors:
      - a) Applied potential shall be 500 volts dc for 300 volt rated cable and 1,000 volts dc for 600 volt rated cable.
      - b) Test duration shall be 1 minute.

- 3) Perform continuity tests on all power and control conductors to insure correct cable connection.
- 4) Verify uniform resistance of parallel conductors.
- c. Test values:
  - 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Insulation-resistance values shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
    - b) Investigate values of insulation-resistance less than the allowable minimum.
  - 3) Cable shall exhibit continuity.
  - 4) Deviations in resistance between parallel conductors shall be investigated.
4. Low voltage molded case and insulated case circuit breakers:
  - a. Visual and mechanical inspection:
    - 1) Compare equipment nameplate data with the Contract Documents.
    - 2) Inspect physical and mechanical condition.
    - 3) Inspect anchorage and alignment.
    - 4) Verify the unit is clean.
    - 5) Operate the circuit breaker to ensure smooth operation.
    - 6) Inspect bolted electrical connections for high resistance by one of the following methods:
      - a) Use of low-resistance ohmmeter.
      - b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        - (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    - 7) Perform adjustments for final protective device settings in accordance with the coordination study.
  - b. Electrical tests:
    - 1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    - 2) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
      - a) Apply voltage in accordance with manufacturer's published data.
      - b) Refer to NETA ATS tables in the absence of manufacturer's published data.
    - 3) Perform a contact/pole-resistance test.
    - 4) Determine long-time pickup and delay by primary current injection.
    - 5) Determine short-time pickup and delay by primary current injection.
    - 6) Determine ground-fault pickup and delay by primary current injection.
    - 7) Determine instantaneous pickup value by primary current injection.
    - 8) Verify operation of charging mechanism.

- c. Test values:
  - 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Bolt-torque levels shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
  - 3) Insulation-resistance values shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
    - b) Investigate values of insulation-resistance less than the allowable minimum.
  - 4) Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
    - a) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
  - 5) Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors:
    - a) If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
  - 6) Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
  - 7) Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
  - 8) Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
  - 9) Pickup values and trip characteristics shall be within manufacturer's published tolerances.
  - 10) Determine energy reducing maintenance switch pickup value by primary current injection.
  - 11) Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
  - 12) The charging mechanism shall operate in accordance with manufacturer's published data.
- 5. Single Engine generator:
  - a. Visual and mechanical inspection:
    - 1) Compare equipment nameplate data with the Contract Documents.
    - 2) Inspect physical and mechanical condition.
    - 3) Inspect anchorage, alignment, and grounding.
    - 4) Verify the unit is clean.

- b. Electrical and mechanical tests:
- 1) Perform insulation-resistance tests in accordance with IEEE 43:
    - a) Machines larger than 150 kilowatts: Test duration shall be 10 minutes. Calculate polarization index.
    - b) Machines 150 kilowatts and less: Test duration shall be 1 minute. Calculate the dielectric-absorption rate.
  - 2) Test protective relay devices as specified in this Section.
  - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
  - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
  - 5) Conduct performance test in accordance with NFPA 110.
  - 6) Verify correct functioning of governor and regulator.
  - 7) Load bank testing:
    - a) Provide a resistive load bank to test the operation of the engine generator.
    - b) Load bank shall be capable of loading the engine generator to its full nameplate kilowatt rating at unity power factor.
    - c) Load steps shall simulate the plant load steps used in sizing the engine generator.
    - d) Test run at full nameplate kilowatt rating for a minimum of 4 hours:
      - (1) Record at 10-minute intervals:
        - (a) Voltage.
        - (b) Frequency.
        - (c) Current.
        - (d) Power factor.
        - (e) Engine oil pressure.
        - (f) Engine oil temperature.
        - (g) Air inlet temperature.
        - (h) Radiator discharge temperature.
        - (i) Engine coolant temperature.
        - (j) Vibration levels at each main bearing cap.
- c. Test values:
- 1) Anchorage, alignment, and grounding should be in accordance with manufacturer's published data and system design.
  - 2) The dielectric absorption ratio or polarization index shall be compared to previously obtained results and should not be less than 1.0. The recommended minimum insulation ( $IR_{1 \min}$ ) test results in megohms shall be corrected to 40 degrees Celsius and read as follows:
    - a)  $IR_{1 \min}$  equals kilovolt + 1 for most windings made before 1970, all field windings, and others not described below.
      - (1) Kilovolt is the rated machine terminal-to-terminal voltage in rms kilovolt.
    - b)  $IR_{1 \min}$  equals 100 megohms for most dc armature and ac windings built after 1970 (form-wound coils).
    - c)  $IR_{1 \min}$  equals 5 megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kilovolt.

- (1) Dielectric withstand voltage and surge comparison tests shall not be performed on machines having lower values than those indicated above.
  - 3) The polarization index value shall not be less than 2.0.
  - 4) The dielectric absorption ratio shall be greater than 1.0.
  - 5) Protective relay device test results shall be as specified in this Section.
  - 6) Phase rotation, phasing, and synchronizing shall be in accordance with system design requirements.
  - 7) Low oil pressure, over temperature, over speed, and other protection features shall operate in accordance with manufacturer's published data and system design requirements.
  - 8) Vibration levels shall be in accordance with manufacturer's published data and shall be compared to baseline data.
  - 9) Performance tests shall conform to manufacturer's published data and NFPA 110.
  - 10) Governor and voltage regulator shall operate in accordance with manufacturer's published data and system design requirements:
    - a) Steady state voltage regulation shall be within 0.5 percent of set point.
    - b) The output voltage of the generator shall not fall below 10 percent of the power system nominal rating for more than 5 seconds.
    - c) The output voltage of the generators shall not exceed the power system nominal rating at any time.
    - d) Steady state frequency regulation shall be within 59.5 hertz to 60.5 hertz.
    - e) Frequency variations shall not exceed 2 hertz from 60 hertz for more than 2 seconds.
6. Fiber-optic cables:
- a. Visual and mechanical inspection:
    - 1) Compare cable, connector, and splice data with the Contract Documents.
    - 2) Inspect cable and connections for physical and mechanical damage.
    - 3) Verify that all connectors and splices are correctly installed.
  - b. Optical tests:
    - 1) Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):
      - a) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.
      - b) Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.
    - 2) Perform connector and splice integrity test using an optical time domain reflectometer.
    - 3) Perform cable attenuation loss measurement with an optical power loss test set:
      - a) Perform attenuation tests with an Optical Loss Test Set capable and calibrated to show anomalies of 0.1 dB as a minimum.
      - b) Test multimode fibers at 850 nanometer and 1,300 nanometer.
      - c) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.

- 4) Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:
  - a) At the conclusion of all outdoor splices at 1 location, and before they are enclosed and sealed, all splices shall be tested with OTDR at the optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. The splices shall be tested for integrity as well as attenuation.
- 5) Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an Optical Loss Test Set:
  - a) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer, and 1,300 nanometer for multimode fibers.
  - b) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.
- c. Test values:
  - 1) Cable and connections shall not have been subjected to physical or mechanical damage.
  - 2) Connectors and splices shall be installed in accordance with industry standards.
  - 3) The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
  - 4) Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available.
  - 5) Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.
7. LAN cable testing:
  - a. Visual and mechanical inspections:
    - 1) Compare cable type and connections with that indicated on the Drawings and specified in the Specifications.
    - 2) Inspect cable and connectors for physical and mechanical damage.
    - 3) Verify that all connectors are correctly installed.
  - b. Pre-testing:
    - 1) Test individual cables before installation:
      - a) Before physical placement of the cable, test each cable while on the spool with a LAN certification test device.
      - b) Before the cable is installed, verify that the cable conforms to the manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.
      - c) The test shall be fully documented, and the results submitted to the Engineer, including a hard copy of all traces, before placement of the cable.
      - d) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.
  - c. Electrical tests:
    - 1) Perform cable end-to-end testing on all installed cables after installation of connectors from both ends of the cable.

- 2) Test shall include cable system performance tests and confirm the absence of wiring errors.
- d. Test results:
  - 1) Cables shall meet or exceed TIA standards the category of cable installed.
- e. Test equipment:
  - 1) LAN certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:
    - a) Near end cross talk.
    - b) Attenuation.
    - c) Equal level far end cross talk.
    - d) Return loss.
    - e) Ambient noise.
    - f) Effective cable length.
    - g) Propagation delay.
    - h) Continuity/loop resistance.
  - 2) LAN certification test equipment shall be able to store and produce plots of the test results.
  - 3) Manufacturers: The following or equal:
    - a) Agilent Technologies, WireScope 350.
8. Direct-current systems, batteries, flooded lead-acid:
  - a. Visual and mechanical inspection:
    - 1) Verify that battery area ventilation system is operable.
    - 2) Verify existence of suitable eyewash equipment.
    - 3) Compare equipment nameplate data with the Contract Documents.
    - 4) Inspect physical and mechanical condition.
    - 5) Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
    - 6) Verify electrolyte level. Measure electrolyte specific gravity and temperature levels.
    - 7) Verify presence of flame arresters.
    - 8) Verify the units are clean.
    - 9) Inspect spill containment installation.
    - 10) Verify application of an oxide inhibitor on battery terminal connections.
    - 11) Inspect bolted electrical connections for high resistance using one of the following methods:
      - a) Use of low resistance ohmmeter.
      - b) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
        - (1) Refer to manufacturer's instructions for proper foot-pound levels NETA ATS tables.
  - b. Electrical tests:
    - 1) Perform resistance measurements through all bolted connections with a low-resistance ohmmeter.
    - 2) Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
    - 3) Verify all charger functions and alarms.
    - 4) Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
    - 5) Measure intercell connection resistances.



- 6) Perform internal ohmic measurement tests.
- 7) Perform a load test in accordance with manufacturer's published data or IEEE 450.
- 8) Measure the battery system voltage from positive-to-ground and negative-to-ground.
- c. Test values:
- d. Electrolyte level and specific gravity shall be within normal limits.
  - 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Bolt-torque levels shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
- e. Test values - electrical:
  - 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Charger float and equalize voltage levels shall be in accordance with battery manufacturer's published data.
  - 3) The results of charger functions and alarms shall be in accordance with manufacturer's published data.
  - 4) Cell voltages shall be within 0.05 volt of each other or in accordance with manufacturer's published data.
  - 5) Cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical cells in a fully charged state.
  - 6) Results of load tests shall be in accordance with manufacturer's published data or IEEE 450.
  - 7) Voltage measured from positive to ground shall be equal in magnitude to the voltage measured from negative to ground.
9. Direct-current systems, chargers:
  - a. Visual and mechanical inspection:
    - 1) Compare equipment nameplate data with the Contract Documents.
    - 2) Inspect for physical and mechanical condition.
    - 3) Inspect anchorage, alignment, and grounding.
    - 4) Verify the unit is clean.
    - 5) Inspect all bolted electrical connections for high resistance using one of the following methods:
      - a) Use of low resistance ohmmeter.
      - b) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
        - (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    - 6) Inspect filter and tank capacitors.
    - 7) Verify operation of cooling fans and presence of filters.
  - b. Electrical tests:
    - 1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

- 2) Verify float voltage, equalize voltage, and high voltage shutdown settings.
  - 3) Verify current limit.
  - 4) Verify correct load sharing (parallel chargers).
  - 5) Verify calibration of meters as specified in this Section.
  - 6) Verify operation of alarms.
  - 7) Measure and record input and output voltage and current.
  - 8) Measure and record ac ripple current and voltage imposed on the battery.
  - 9) Perform full-load testing of charger.
- c. Test values:
- 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Bolt-torque levels shall be in accordance with manufacturer's published data:
    - a) Refer to NETA ATS tables in the absence of manufacturer's published data.
- d. Test values - electrical:
- 1) Compare bolted connection resistance values to values of similar connections:
    - a) Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Float and equalize voltage settings shall be in accordance with the battery manufacturer's published data.
  - 3) Current limit shall be within manufacturer's recommended maximum.
  - 4) Results of load sharing between parallel chargers shall be in accordance with system design specifications.
  - 5) Results of meter calibration shall be as specified in this Section.
  - 6) Results of alarm operation shall be in accordance with manufacturer's published data and system design.
  - 7) Input and output voltage shall be in accordance with manufacturer's published data.
  - 8) AC ripple current and voltage imposed on the battery shall be in accordance with manufacturer's published data.
  - 9) Charger shall be capable of manufacturer's specified full load.

### **3.08 FIELD QUALITY CONTROL (NOT USED)**

### **3.09 ADJUSTING (NOT USED)**

### **3.10 CLEANING**

- A. As specified in Section 16050 - Common Work Results for Electrical.
- B. After the acceptance tests have been completed, dispose of all testing expendables, vacuum all cabinets, and sweep clean all surrounding areas.

### **3.11 PROTECTION**

- A. As specified in Section 16050 - Common Work Results for Electrical.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION



## SECTION 17050

### COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

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## **PART 1    GENERAL**

### **1.01    SUMMARY**

- A. Section includes:
  - 1. General requirements applicable to all Process Control and Instrumentation Work.
  - 2. General requirements for process control and instrumentation submittals.
  - 3. As specified in this Section, some PLC programming and SCADA/HMI software configuration will be provided by the Owner.
- B. Interfaces to equipment, instruments, and other components:
  - 1. Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
  - 2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished:
    - a. Make all changes necessary to meet the manufacturer's wiring requirements.
  - 3. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation, control systems, and related services are provided. Include any items indicated on the Drawings or in Specifications from other disciplines in the scope of Work.
  - 4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items indicated on the Drawings or in Specifications from another discipline in the scope of Work:
    - a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
- C. All instrumentation, and control equipment and systems for the entire project to comply with the requirements specified in the Instrumentation and Control Specifications, whether referenced in the individual Equipment Specifications or not:
  - 1. The requirements of the Instrumentation and Control Specifications apply to all Instrumentation and Control Work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.
  - 2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of the Instrumentation and Control Specifications.
  - 3. The Owner is not responsible for any additional costs due to the failure of the Contractor to notify all subcontractors and suppliers of the Instrumentation and Control Specifications' requirements.

D. Contract Documents:

1. General:
  - a. The drawings and specifications are complementary and are to be used together in order to fully describe the Work.
2. Specifications:
  - a. Documents 00700 - General Conditions and 00800 - Supplementary Conditions of the Contract Documents govern the Work.
  - b. These requirements are in addition to all General Requirements.
3. Contract drawings:
  - a. The Instrumentation and Control Drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the Instrumentation Work. Follow the drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire drawing set for construction purposes.
  - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only, exercise professional judgment in executing the Work to ensure the best possible installation:
    - 1) The equipment locations and dimensions indicated on the Drawings and elevations are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
    - 2) The Contractor has the freedom to select any of the named manufacturers as identified in the individual Specifications; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
  - c. Installation details:
    - 1) The Contract Drawings include installation details showing means and methods for installing instrumentation and control equipment. For cases where typical details are not provided or compatible with an installed location, develop installation details that are necessary for completing the Work, and submit these details for review by the Engineer.
  - d. Schematic diagrams:
    - 1) All controls are shown de-energized.
    - 2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
    - 3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
    - 4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.



- 5) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences indicated on the Drawings or in the Specifications. Combine all information and furnish a coordinated and fully functional control system.

E. Alternates/Alternatives:

1. Substitute item provisions as specified in Document 00700 - General Conditions.

F. Changes and change orders:

1. As specified in Document 00700 - General Conditions.

## 1.02 REFERENCES

A. Code compliance:

1. As specified in Section 01410 - Regulatory Requirements:
  - a. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
2. The following codes and standards are hereby incorporated into this Section:
  - a. American National Standards Institute (ANSI).
  - b. American Petroleum Institute (API):
    - 1) RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
    - 2) RP 551 - Process Measurement Instrumentation.
  - c. International Organization for Standardization (ISO):
    - 1) 9001 - Quality Management Systems - Requirements.
  - d. International Society of Automation (ISA):
    - 1) 5.1 - Instrumentation Symbols and Identification.
    - 2) 5.4 - Instrument Loop Diagrams.
    - 3) 20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
  - e. National Electrical Manufacturers Association (NEMA):
    - 1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
  - f. National Fire Protection Association (NFPA).
  - g. National Institute of Standards and Technology (NIST).
  - h. Underwriters Laboratories, Inc. (UL):
    - 1) 508 - Standard of Safety for Industrial Control Equipment.
    - 2) 508A - Standard of Safety for Industrial Control Panels.

B. Compliance with Laws and Regulations:

1. As specified in Document 00700 - General Conditions.

## 1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations in accordance with:

1. Factory Mutual (FM).
2. International Electrotechnical Commission (IEC).
3. Institute of Electrical and Electronics Engineers (IEEE).
4. International Society of Automation (ISA).
5. International Organization for Standardization (ISO).

6. National Electrical Code (NEC).
7. National Electrical Manufacturers Association (NEMA).
8. InterNational Electrical Testing Association (NETA).
9. National Fire Protection Association (NFPA).
10. National Institute of Standards and Technology (NIST).
11. Underwriters Laboratories (UL).

B. Specific definitions:

1. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
2. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.
3. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
4. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
5. Powered transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24 VDC signal, a digital bus communications signal, or both.
6. RS-232: RS-232 is also known as TIA-232 or EIA-232, is a standard for serial communication transmission of data. When compared to RS-485 it has lower transmission speed, short maximum cable length, large voltage swing, large standard connectors and no multipoint capability. USB has displaced RS-232 from most of its peripheral interface roles.
7. RS-485: RS-485 is also known as TIA-485 or EIA-485, is a standard defining the electrical characteristics of drivers and receivers for use in serial communications system. Electrical signaling is balanced, and multipoint systems are supported, can be used with data rates up to 10 Mbit/s or at lower speeds distances up to 1,000 m (4,000 ft).
8. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.
9. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions, and diagnostic information.
10. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24 VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
  - a. Fieldbus communications signal or both.
11. USB: Universal Serial Bus is an industry standard that establishes specifications for cables, connectors, and protocols for connection, communication, and power supply interfacing between computer, peripherals, and other computers, it has largely replaced interfaces such as serial and parallel ports.

C. NEMA:

1. Type 1 enclosure in accordance with NEMA 250.
2. Type 2 enclosure in accordance with NEMA 250.
3. Type 3 enclosure in accordance with NEMA 250.
4. Type 3R enclosure in accordance with NEMA 250.
5. Type 3S enclosure in accordance with NEMA 250.
6. Type 3X enclosure in accordance with NEMA 250.
7. Type 3RX enclosure in accordance with NEMA 250.
8. Type 3SX enclosure in accordance with NEMA 250.
9. Type 4 enclosure in accordance with NEMA 250.
10. Type 4X enclosure in accordance with NEMA 250.
11. Type 5 enclosure in accordance with NEMA 250.
12. Type 6 enclosure in accordance with NEMA 250.
13. Type 6P enclosure in accordance with NEMA 250.
14. Type 7 enclosure in accordance with NEMA 250.
15. Type 12 enclosure in accordance with NEMA 250.
16. Type 12K enclosure in accordance with NEMA 250.
17. Type 13 enclosure in accordance with NEMA 250.

D. Acronym definitions:

1. ACB: Automatic current balance.
2. ATS: Automatic Transfer Switch.
3. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software and functions.
4. DPDT: Double-pole, double-throw.
5. ECP: Electronic circuit protector.
6. ES: Ethernet Switch.
7. FAT: Factory acceptance test also known as Source Test.
8. HART: Highway addressable remote transducer.
9. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped, and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
10. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically, information is displayed in a graphical format.
11. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
12. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace, or relocate instrument signals.
13. I/O: Input/Output.
14. IP: Internet protocol or ingress protection.

15. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
16. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.
17. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
18. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
19. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO, etc.
20. P&ID: Process and instrumentation diagram.
21. PC: Personal computer.
22. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.
23. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
24. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
25. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
26. PLC: Programmable logic controller.
27. PS: Power supply.
28. RIO: Remote I/O device for the PLC consisting of remote I/O racks or remote I/O blocks.
29. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
30. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations, etc.
31. SELV: Safety extra-low voltage.
32. SFP: Small form-factor pluggable.
33. SPDT: Single-pole, double-throw.
34. SPST: Single-pole, single-throw.
35. UPS: Uninterruptible power supply.

36. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
37. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

#### **1.04 SUBMITTALS**

- A. Furnish submittals as specified in Section 01330 - Submittal Procedures and this Section.
- B. General:
  1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
  2. Furnish the submittals required by each section in the Instrumentation Specifications.
  3. Adhere to the wiring numbering scheme specified in Section 16075 - Identification for Electrical Systems throughout the Project:
    - a. Uniquely number each wire.
    - b. Wire numbers must appear on all Equipment Drawings.
  4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.
- C. Submittal requirements:
  1. Furnish submittals that are fully indexed with a tabbed divider for every component.
  2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
  3. Furnish submittals in the following general order, each in a separate bound set:
    - a. Product Data.
    - b. After Engineer acceptance of the Product Data, submit the Project Shop Drawing submittals.
    - c. The Process Control Hardware Submittal.
    - d. Testing, Calibration and Process Start-Up procedures.
    - e. Operation and Maintenance Data.
    - f. Record Documents.
  4. Where multiple submittals are required, provide a separate submittal for each specification section.
    - a. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
      - 1) The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section.
      - 2) For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.

5. Edit submittals so that the submittal specifically applies to only the equipment furnished.
6. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
7. Prepare submittals in the English language. Do not include information in other languages.
8. Present measurements in customary American units (feet, inches, pounds, etc.).
9. Must be clear and legible, and of sufficient size for presentation of information.
10. Minimum page size will be 8 1/2 inches by 11 inches:
11. Maximum page size will be 11 inches by 17 inches.
12. If submittal is more than 80 pages, additionally provide hardcopy.
13. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
14. Provide submittal information from only 1 manufacturer for a specified product. Submittals with multiple manufacturers for 1 product will be rejected without review.
15. Indicate project designated equipment tag numbers from P&IDs for submittal of devices, equipment, and assemblies.

D. Submittal preparation:

1. During the period of preparation of submittals, the Contractor shall authorize direct, informal liaison between the ICSC and the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions may be authorized informally by the Engineer, which do not alter the scope of Work or cause increase or decrease in the Contract price or times. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant exception to, or variation from, these Contract Documents.
2. In these Contract Documents, some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
  - a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals.
  - b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, suppliers, or subcontractor's standard methods with those identified in this Section and indicated on the Drawings.

E. Specific submittal requirements:

1. Shop drawings:
  - a. Required for materials and equipment listed in this and other sections.
  - b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
  - c. Shop drawings requirements:
    - 1) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
    - 2) Locations of conduit entrances and access plates.
    - 3) Component layout and identification.

- 4) Schematic and wiring diagrams with wire numbers and terminal identification.
  - 5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
  - 6) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
  - 7) Weight.
  - 8) Finish.
  - 9) Nameplates:
    - a) As specified in Section 16075 - Identification for Electrical Systems or as indicated on the Drawings.
  - 10) Temperature limitations, as applicable.
  - d. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
  - e. Adhere to wiring numbering scheme outlined in Section 16075 - Identification for Electrical Systems throughout the Project:
    - 1) Uniquely number each wire per the Specifications.
  - f. Wire numbers must appear on all equipment drawings.
  - g. Organize the shop drawing submittals for inclusion in the Operation and Maintenance Manuals:
    - 1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose-leaf, vinyl plastic, hard-cover binders suitable for bookshelf storage.
    - 2) Binder ring size: 2 inches.
  - h. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
    - 1) The firm's registered business name.
    - 2) Firm's physical address, email address, and phone number.
    - 3) Owner's name.
    - 4) Project name and location.
    - 5) Drawing name.
    - 6) Revision level.
    - 7) Personnel responsible for the content of the drawing.
    - 8) Date.
  - i. The work includes modifications to existing circuits:
    - 1) Clearly show all modifications to existing circuits.
    - 2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
2. Product data:
- a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
  - b. Include:
    - 1) Catalog cuts.
    - 2) Bulletins.
    - 3) Brochures.
    - 4) Quality photocopies of applicable pages from these documents.
    - 5) Identify on the data sheets the Project name, applicable specification section, and paragraph.
    - 6) Identify model number and options for the actual equipment being furnished.

- 7) Neatly cross out options that do not apply or equipment not intended to be supplied.
    - c. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
    - d. Adhere to wiring numbering scheme outlined in Section 16075 - Identification for Electrical Systems throughout the Project:
      - 1) Uniquely number each wire per the Specifications.
    - e. Wire numbers must appear on all equipment drawings.
  3. Detailed sequence of operation for all equipment or systems.
  4. Operation and maintenance manuals:
    - a. As specified in Section 01782 - Operation and Maintenance Manuals.
    - b. Organize the operation and maintenance manuals for each process in the following manner:
      - 1) Section A - Sizing Calculations.
      - 2) Section B - Test Results.
      - 3) Section C - Operational Manual.
      - 4) Section D - Spare Parts List.
  5. Material and equipment schedules:
    - a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
      - 1) Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
  6. Control panel hardware submittal:
    - a. Submit the following in 1 submittal package.
    - b. Complete and detailed bills of materials:
      - 1) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
      - 2) Include all items within an enclosure.
    - c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
    - d. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium-voltage power cables.
    - e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
    - f. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
      - 1) The manufacturer's model number or other identifying product designation.
      - 2) Tag and loop number.
      - 3) System to which it belongs.
      - 4) Site to which it applies.
      - 5) Input and output characteristics.
      - 6) Requirements for electric power.
      - 7) Device ambient operating requirements.
      - 8) Materials of construction.
  7. Installation recommendations:
    - a. Submit the manufacturer's printed recommendations for installation of instrumentation equipment.
  8. Project Record documents:
    - a. Furnish as specified in Section 01770 - Closeout Procedures.



- b. Record Drawing requirements:
  - 1) Provide Project Record Drawing of all Instrumentation Drawings.
  - 2) Update Record Drawings weekly.
  - 3) Record Drawings must be fully updated as a condition of the monthly progress payments.
  - 4) Clearly and neatly show all changes including the following:
    - a) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
- 9. Control Panel Drawings:
  - a. Layout Drawings:
    - 1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
    - 2) As a minimum, include the following information:
      - a) To scale front, side, and plan views.
      - b) Dimensions.
      - c) Interior and exterior arrangements.
      - d) Mounting information, including conduit entrance location.
      - e) Finish data.
      - f) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
      - g) Nameplate legend including text, letter size, materials, and colors.
  - b. Wiring and piping diagrams:
    - 1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
    - 2) Include the following information:
      - a) Name of panel.
      - b) Wiring and piping sizes and types.
      - c) Terminal strip numbers.
      - d) Wire tags and labels.
      - e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
      - f) Electrical control schematics in accordance with ANSI standards.
  - c. Installation drawings:
    - 1) Provide site-specific installation drawings for all control equipment panels, including dimensions.
    - 2) Provide scaled drawings and show the position of the equipment at its intended installation location.
    - 3) Show the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
    - 4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.
- 10. Schematic Diagrams:
  - a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
  - b. Include device and field connection terminal numbers on all schematic diagrams.
  - c. Incorporate equipment manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.

11. Test Procedure Submittals:
  - a. Submit the proposed procedures to be followed during tests of the PCS and its components in 2 parts:
    - 1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
    - 2) Detailed Submittal: After successful review of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. Include a statement of test objectives with the test procedures.
12. Test reports:
  - a. As specified in Section 01330 - Submittal Procedures.
13. Meetings as specified in this Section:
  - a. Agenda.
  - b. Meeting minutes.

## **1.05 QUALITY ASSURANCE**

- A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.
- B. ICSC qualifications:
  1. General information on the proposing company:
    - a. Document that the ICSC Company has been actively involved in the instrumentation, PLC-based control systems business for a minimum of five years and has adequate facilities, organization structure, manpower, and technical and managerial expertise to properly perform the Work as specified in these Specifications.
  2. Document that the ICSC has a qualified permanent service facility:
    - a. Said facility shall be staffed with permanent employees and equipped with the tools and test equipment necessary to calibrate, test, and process start-up all of the instrumentation, control, telemetry, SCADA and control systems hardware and software furnished under this Contract, including remote diagnostic capability.
    - b. Document in-house resource of permanent personnel experienced in the design and programming of equipment and systems as specified in these Specifications.
  3. Determination of the proposed ICSC qualifications is at the sole discretion of the Engineer.
- C. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.
- D. The ICSC must have their own operating UL listed panel fabrication facility. All panels must be fabricated at this facility and meet all UL 508/508A requirements.
- E. ICSC:
  1. Contractor, through the use of a qualified ICSC, is responsible for the implementation of the PCIS and the integration of the system with other required instrumentation, control devices, and software.
  2. The ICSC assumes full responsibility, through the Contractor, to perform all work to select, furnish, install, test, calibrate, and place into operation all instrumentation, controls, telemetry equipment, control panels, and control system, for a complete, integrated and functional PCIS system.

3. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these Specifications that the ICSC be responsible for the integration of the PCIS with existing devices and devices provided under the Contract Documents with the objective of providing a completely integrated control system.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 01600 - Product Requirements.
- B. Shipping precautions:
  1. After completion of shop assembly, successful Source Test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
  2. Place dehumidifiers when required, inside the polyethylene coverings.
  3. Skid-mount the equipment for final transport.
  4. Provide lifting rings for moving without removing protective covering.
  5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- C. Special instructions:
  1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
- D. Tagging:
  1. Tag each component and/or instrument to identify its location, instrument tag number, and function in the system.
  2. Firmly attach a permanent tag indelibly machine marked with the instrument tag number, as given in the tabulation, on each piece of equipment constituting the PCS.
  3. Tag instruments immediately upon receipt in the field.
  4. Prominently display identification on the outside of the package.
  5. Utilize the Tag and Loop Number identifications shown on the P&IDs.
- E. Delivery and inspection:
  1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.

## **1.07 PROJECT OR SITE CONDITIONS**

- A. Site conditions:
  1. Provide a PCS, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
  2. Seismic classification:
    - a. Provide all equipment and construction techniques suitable for the seismic requirements for the site, as specified in Section 01612 - Seismic Design Criteria.
  3. Wind:
    - a. Provide all equipment and construction techniques suitable for the site wind loading criteria, as specified in Section 01614 - Wind Design Criteria.

4. Altitude, temperature and humidity:
  - a. As specified in Section 01610 - Project Design Criteria.
  - b. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
  - c. Provide additional temperature conditioning equipment to maintain all equipment and instrumentation in non-conditioned spaces or outdoors subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment manufacturer's guidelines:
    - 1) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not indicated on the Drawings.
5. Area classifications:
  - a. Furnish enclosures that match the area classifications as specified in Section 16050 - Common Work Results for Electrical.

## **1.08 SEQUENCING**

- A. General:
  1. As specified in Section 01312 - Project Meetings and Section 01756 - Commissioning.
  2. Testing requirements are specified in Section 01756 - Commissioning and Section 17950 - Commissioning for Instrumentation and Controls.
  3. General scheduling requirements are specified in Section 01321 - Schedules and Reports.
  4. Work restrictions and other scheduling requirements are specified in Section 01140 - Work Restrictions.
  5. Commissioning requirements as specified in Section 01756 - Commissioning.
- B. Submit proposed ICSC statement of qualifications:
  1. The ICSC must be accepted by the Engineer before any other Work commences.
- C. General Field Start-Up and testing procedures:
  1. As specified in Section 01756 - Commissioning.
- D. Installation testing:
  1. As specified in Section 01756 - Commissioning.
  2. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
  3. Acceptance of the PCIS Installation testing must be provided in writing by the Owner before the performance testing may begin.
- E. Functional testing:
  1. Representatives from each of the following groups shall be in attendance during the functional Testing: Owner, ICSC. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.

2. As specified in Section 17950 - Commissioning for Instrumentation and Controls.
  - a. Notify the Owner of scheduled tests a minimum of 21 days before the estimated completion date of installation and wiring of the PCIS.
  - b. The Owner will assist with Functional Testing for PLCs programmed by the Owner, as specified in Section 17950 - Commissioning for Instrumentation and Controls.
- F. Provide all special tools and spare parts, as specified in the Maintenance paragraph of this Section, before Process Operational Period commences, suitably wrapped, and identified.
- G. Process Operational Period:
  1. Upon completion of the Process Operational Period, conduct an Instrumentation and Controls Process Performance Test as a condition for Project final completion.

## **1.09 SCHEDULING (NOT USED)**

## **1.10 WARRANTY**

- A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in Documents 00700 - General Conditions and 00800 - Supplementary Conditions.

## **1.11 SYSTEM PROCESS START-UP (NOT USED)**

## **1.12 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.13 MAINTENANCE**

- A. Before Substantial Completion, perform all maintenance activities required by the Contract Documents including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
- B. Furnish all spare parts as required by the Contract Documents.
- C. Provide additional spare parts specified in other sections of the Instrumentation and Control Specifications.
- D. Submit all special tools and spare parts, suitably wrapped and identified, before Process Operational Period commences.

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. Provide similar items from a single manufacturer throughout the PCIS portion of the Project.

- B. Allowable manufacturers are specified in individual instrument and equipment specifications.

## 2.02 SYSTEM DESCRIPTION

- A. General requirements:
  - 1. The Work includes everything necessary for and incidental to executing and completing the instrumentation and control system work indicated on the Drawings and specified in the Specifications and reasonably inferable there from including but not limited to:
    - a. Design, develop, and draft control panel designs, and all other drawing submittals specified in the Instrumentation and Control Specifications.
    - b. Prepare the test plan.
    - c. Procure all hardware.
    - d. Provide all PCS system hardware.
    - e. Fabricate panels.
    - f. Perform factory tests on panels.
    - g. Installation Testing.
    - h. Oversee and document Functional Testing.
    - i. Provide Record Drawings associated with Instruments and equipment:
      - 1) As specified in the Contract Documents.
      - 2) For Owner furnished items.
      - 3) For interfaces with existing equipment.
    - j. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
    - k. Perform all required corrective and preventative maintenance.
  - 2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others, as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
  - 3. Provide the complete operating PCS to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the PCS requirements.
  - 4. Coordinate all aspects of the Work between Contractor and all subcontractors before bidding to ensure that all costs associated with a complete installation are included. Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the ICSC, the other subcontractors, or suppliers.
  - 5. Furnish detailed, complete, and thorough operations and maintenance documentation, including but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, and all other documentation required to operate, modify, and maintain all parts of the PCS.
  - 6. Where demolition is indicated on the Drawings, the electrical subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC is responsible for physically removing all instrumentation to be demolished and return it either to the Owner or dispose of it as directed by the Owner's representative. The ICSC shall be responsible

for any program modifications needed based on the demolition of the equipment, both for the loops directly and indirectly affected.

7. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment.
  - a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before performing any Work.
  - b. Provide and document interface with, modifications to, upgrade, or replacement of existing circuits, power systems, controls, and equipment.
8. Revise in a manner as directed by the Engineer all I/O and addressing that the Engineer determines to be unacceptable as a result of a lack of Contractor coordination between Contract Documents and all suppliers.
9. Defective Work:
  - a. As specified in Document 00700 - General Conditions.

B. Existing system:

1. The existing Standby Generator No. 1 in the Generator Building will be replaced in this project.
2. Control System:
  - a. The existing control system includes GE RX3i PLCs located throughout the treatment plant with GE iFIX HMI software.
  - b. An existing control panel in the Generator Building will be replaced in this project. The panel includes the following existing equipment.
    - 1) GE Versamax PLC.
    - 2) Ethernet switch.
    - 3) Generator No. 1 vendor control equipment.
    - 4) Door access hardware.
    - 5) Fiber optic patch panel.

C. New system:

1. Owner will provide PLC and SCADA programming and integration.
2. Fiber optic installation including new single mode fiber optic cable between
3. New PLC enclosure PCM-3510 in the Generator Building with the following:
  - a. GE RX3i PLC.
  - b. Rack-mounted Ethernet switch.
  - c. Fiber optic patch panel.
  - d. UPS.
  - e. Door access hardware, provided and installed by Owner.
4. New vendor control panel provided with new Standby Generator No. 1.
  - a. Vendor control panel will communicate with Ethernet switch in PCM-3510 via Modbus TCP protocol.

D. Operating facility:

1. As specified in Section 01140 - Work Restrictions.
2. Portions of this existing facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
  - a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction to meet the requirements of the Owner.

- b. As weather and facility demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
  - c. Where portions of the Work are in existing facilities and require interface to existing circuits, power systems, controls and equipment, perform comprehensive and detailed field investigations of existing conditions. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
- 3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
- 4. Where shown or specified, replace existing field instruments with new.
- 5. Contractor is responsible for the integrity and measurement accuracy of all loops.
- 6. Any defect found in existing equipment is the responsibility of the Owner. Contractor is not responsible for defects on existing Owner components.
- 7. The standards of documentation, instrument tagging, cable and conductor termination, terminal identification and labeling that apply to the new installation apply equally to the existing installation.

## **2.03 EXISTING PRODUCTS (NOT USED)**

## **2.04 MATERIALS**

- A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the Specifications.
- B. Provide materials complying with the applicable industrial standard as specified in the Contract Documents.

## **2.05 MANUFACTURED UNITS (NOT USED)**

## **2.06 EQUIPMENT (NOT USED)**

## **2.07 COMPONENTS**

- A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.
- B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.
- C. Signal transmission:
  - 1. Analog signals:
    - a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
    - b. Furnish electrical analog signals outside control panels that are 4-to-20 milliamperes 24 VDC, except as indicated.
    - c. Electrically or optically isolate all analog signals from other signals.



- d. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
    - e. Maintain the total 4-to-20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
    - f. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
  - 2. Pneumatic signals:
    - a. All pneumatic signals: 3-to-15 pounds per square inch gauge.
  - 3. Discrete input signals:
    - a. As indicated in the controller hardware specification.
  - 4. Discrete output signals:
    - a. As indicated in the controller hardware specification.
    - b. Provide interposing relays as required for functionality of the control circuit.
- D. Discrete circuit configuration:
- 1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
  - 2. Alarm contacts: Fail to the alarm condition.
  - 3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.
- E. Grounding:
- 1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
  - 2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable.
  - 3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
  - 4. Terminate the signal cable shield on a dedicated grounding terminal block.
  - 5. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

## 2.08 ACCESSORIES

- A. Nameplates:
- 1. Provide a nameplate for each controller, instrument transducer, instrument power supply, solenoid, or any other control device located either in the field or within panels.
  - 2. All nameplates shall be of identical style, color, and material throughout the facility.
  - 3. Device nameplates shall include:
    - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
      - 1) Device tag and loop number ID (e.g., FIT-60.011).
      - 2) PLC ID (e.g., PLC-11).
      - 3) Power information (e.g., PCM-11, 120 VAC).
    - b. White lettering on a black background, laminated plastic.
  - 4. All instruments shall be equipped with Type 316 stainless steel nameplate with the instrument tag stamped in 3/8-inch letters and connected to the instrument using Type 316 stainless steel wire.

## **2.09 MIXES (NOT USED)**

## **2.10 FABRICATION (NOT USED)**

## **2.11 FINISHES (NOT USED)**

## **2.12 SOURCE QUALITY CONTROL**

- A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.
- B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the Owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
  - 1. Equipment includes the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.
- C. Source Test is specified in Section 17950 - Commissioning for Instrumentation and Controls.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. The ICSC is encouraged to visit the site and examine the premises completely before bidding. It is the ICSC's responsibility to be fully familiar with the existing conditions and local requirements and regulations.
- B. Review the existing Site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.
- C. Provide a complete instrumentation and control system:
  - 1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, and process control and instrumentation system.

### **3.02 PREPARATION (NOT USED)**

### **3.03 INSTALLATION**

- A. Equipment locations indicated on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
  - 1. Verify all dimensions as indicated on the Drawings:
    - a. Actual field conditions govern all final installed locations, distances, and levels.
  - 2. Review all information indicated on the Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical, instrumentation, and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.

3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
- B. Perform all related Electrical Work in accordance with the applicable sections of the Electrical Specifications.
- C. The PCIS configurations are diagrammatic:
  1. The locations of equipment are approximate unless dimensioned.
  2. Where Project conditions require, make reasonable changes in locations and arrangements.
- D. Equipment tie-downs:
  1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the Site.
  2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., shall be permanently mounted and tied down to structures.
- E. Instrument tagging:
  1. As specified in Section 16075 - Identification for Electrical Systems.
  2. Provide all back of panel instruments with nameplates:
    - a. Engraved with the instrument's full tag number as indicated on the Drawings:
  3. Provide all front of panel instruments with a nameplate:
    - a. Engraving to include the following:
      - 1) Instrument's full tag number.
      - 2) Service description.
    - b. Nameplates:
      - 1) Secure nameplates to the panel with stainless steel screws.
      - 2) Use an accepted adhesive if screws would violate the NEMA or other ratings of the enclosure.
- F. Cable and conductor termination:
  1. Terminate all cables and conductors on terminal blocks.
  2. Terminal block enclosures:
    - a. Suitable for the area classification as specified in Section 16050 - Common Work Results for Electrical.
- G. Surge protection:
  1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments and the panel.
  2. Individually fuse each 4 to 20 milliamperes direct current loop with a 1/2-ampere fuse between power supplies and receiver surge protectors.
  3. Provide voltage surge protection for 4 wire transmitters and analyzers:
    - a. Protect both power source and signal loop.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 COMMISSIONING**

A. As specified in Section 01756 - Commissioning.

### **3.08 FIELD QUALITY CONTROL**

A. Inspection:

1. Allow for inspection of PCIS installation as specified in Section 01450 - Quality Control.
2. Provide any assistance necessary to support inspection activities.
3. Engineer inspections may include, but are not limited to, the following:
  - a. Inspect equipment and materials for physical damage.
  - b. Inspect installation for compliance with Drawings and Specifications.
  - c. Inspect installation for obstructions and adequate clearances around equipment.
  - d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
  - e. Inspect equipment nameplate data to verify compliance with design requirements.
  - f. Inspect cable terminations.
  - g. Inspect/witness instrument calibrations/verifications.
4. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 17950 - Commissioning for Instrumentation and Controls.

B. Installation supervision:

1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum, the ICSC shall provide the following services:
  - a. Installation resources:
    - 1) Coordinate with the Contractor regarding installation requirements of the Contract Documents.
  - b. Provide technical assistance to installation personnel by telephone:
    - 1) Furnish installation personnel with at least 1 copy of the accepted submittals, including all installation details.
  - c. Periodic inspections during the construction period.
  - d. A complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the Contract Documents.
  - e. Field verify accuracy and calibration of all instruments.

### **3.09 ADJUSTING (NOT USED)**

### **3.10 CLEANING**

- A. As specified in Section 01770 - Closeout Procedures.
- B. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.
- C. Clean all panel surfaces.
- D. Return to new condition any scratches and/or defects.
- E. Wipe all instrument faces and enclosures clean.
- F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:
  - 1. Neatly coil and label all spare wiring lengths.
  - 2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.
- G. As specified in other sections of the Contract Documents.

### **3.11 PROTECTION**

- A. Protect all Work from damage or degradation until date of Substantial Completion.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION



## SECTION 17710

### CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

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## **PART 1 GENERAL**

### **1.01 SUMMARY**

- A. Section includes:
  - 1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
    - a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
    - b. Control components.
    - c. Control panel installation.
- B. Provide all control panels identified in Contract Documents.

### **1.02 REFERENCES**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
  - 2. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
  - 3. 802.3at - Standard for Information Technology -- Local and Metropolitan area networks -- Specific requirements -- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.
- C. International Electrotechnical Commission (IEC):
  - 1. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
  - 2. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.
- D. Underwriters Laboratories Inc. (UL):
  - 1. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.
  - 2. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
  - 3. 508 - Standard for Industrial Control Equipment.
  - 4. 508A - Standard for Industrial Control Panel.
  - 5. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
  - 6. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.
  - 7. 1077 - Standard for Supplementary Protectors for Use in Electrical Equipment.

8. 1283 - Standard for Electromagnetic Interference Filters.
9. 1449 - Standard for Surge Protective Devices.

### **1.03 DEFINITIONS**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
  1. The term "panel" in this Section is interchangeable with the term "enclosure."

### **1.04 SUBMITTALS**

- A. Provide submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:
  1. Product data:
    - a. Enclosure construction details and NEMA type.
    - b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
  2. Shop drawings:
    - a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
      - 1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
    - b. Complete nameplate engraving schedule.
    - c. Structural details of fabricated panels.
  3. Calculations:
    - a. Provide installation details based on calculated shear and tension forces:
      - 1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
    - b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
      - 1) Weight including panel internal components.
      - 2) Seismic forces and overturning moments.
      - 3) Shear and tension forces in connections.
    - c. Cooling calculations, including but not limited to:
      - 1) Highest expected ambient temperature for the enclosure's location.
      - 2) Internal heat load.
      - 3) Exposure to direct sunlight.
      - 4) Dimensions of the enclosure in inches.
      - 5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

- C. Seismic design:
  - 1. Seismic panel construction:
    - a. Seismic anchorage: Provide seismic design calculations and installation details for anchorage of all panels, enclosures, consoles, etc. to meet seismic requirements in Section 01612 - Seismic Design Criteria:
      - 1) Stamped by a Professional Engineer registered in the state where the project is being constructed.
    - b. For floor-mounted freestanding panels weighing 200 pounds or more (assembled, including contents), submit calculations, data sheets, and other information to substantiate that panel, base, and framing meet minimum design strength requirements and seismic requirements as specified in Section 01612 - Seismic Design Criteria. Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

## **1.05 QUALITY ASSURANCE**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Assemble panels and enclosures along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
  - 1. Provide all components and equipment with UL 508 listing.
  - 2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
    - a. Non-listed, complex, and unique equipment may be evaluated and approved by a third-party testing agency, with prior approval by the Owner. Provide report documenting the testing standard, specification, method of testing, and that the equipment and materials meet appropriate designated standards or have been tested and found suitable for use in a specified manner.
  - 3. Provide fuses for all equipment that is not UL or UR listed.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Project environmental conditions as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
  - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

## **1.07 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation.

## **1.08 SEQUENCING (NOT USED)**

## **1.09 SCHEDULING (NOT USED)**

## **1.10 WARRANTY**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.11 SYSTEM START-UP (NOT USED)**

## **1.12 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.13 COMMISSIONING (NOT USED)**

## **1.14 MAINTENANCE (NOT USED)**

# **PART 2 PRODUCTS**

## **2.01 MANUFACTURERS**

- A. As listed below in the individual component paragraphs.
- B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

## **2.02 SYSTEM DESCRIPTION**

- A. Panel dimensions:
  - 1. Minimum dimensions are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:
    - a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
    - b. Maximum panel depth: 30 inches, unless otherwise indicated.
- B. Structural design:
  - 1. Completed and installed panel work shall safely withstand seismic requirements at the project site as specified in Section 16050 - Common Work Results for Electrical. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

## **2.03 EXISTING PRODUCTS (NOT USED)**

## **2.04 MATERIALS**

- A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
  - 1. Enclosures shall have the following properties:
    - a. NEMA Type 1: Steel.
    - b. NEMA Type 4: Steel with gasketed door, raintight.
    - c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
    - d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.

- e. NEMA Type 12: Steel with gasketed door, dusttight.
- f. NEMA Type 7: Cast aluminum.

B. Bolting material:

- 1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
- 2. Carriage bolts for attaching end plates.
- 3. All other bolted joints shall have S.A.E. standard lock washers.

## 2.05 MANUFACTURED UNITS

A. Panels/enclosures:

- 1. Manufacturers: One of the following or equal:
  - a. Rittal.
  - b. nVent/Hoffman.
  - c. Saginaw Control & Engineering.
- 2. Panel assembly:
  - a. General guidelines for panel fabrication include:
    - 1) Continuous welds ground smooth.
    - 2) Exposed surfaces free of burrs and sharp edges.
    - 3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
  - b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

- 1) Use heavier sheet metal to meet seismic requirements at the project site or when required due to equipment requirements.
- c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.
- d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
- e. Door construction:
  - 1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.

- 2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
  - 3) Heavy-gauge stainless steel hinges.
  - 4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
  - 5) Gasket installed to seal against roll lip on the enclosure opening.
  - f. Latches:
    - 1) For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
      - a) Provide padlock for each enclosure with padlock provisions.
    - 2) Include an oiltight key-locking, 3-point latching mechanism on each door:
      - a) Provide 2 keys per panel.
      - b) All locks keyed alike.
    - 3) For cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.
  - g. Panel cut-outs:
    - 1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
    - 2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
    - 3) Reinforce around cut-outs with steel angles or flat bars for the following:
      - a) Large panel cutouts; for example, openings for local operator interfaces.
      - b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.
  3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
    - a. Minimum 14-gauge, Type 304 stainless steel.
    - b. Captive stainless steel cover screws threaded into sealed wells.
    - c. Inside finish: White polyester powder coating.
    - d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.
  4. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
    - a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
    - b. Door hardware: Stainless steel.
    - c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.
    - d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.
- B. Arrangement of components:
1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
  2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices.

3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
- C. Overcurrent protection:
1. Main overcurrent device:
    - a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
      - 1) Door-mounted disconnect handles are not acceptable.
      - 2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
      - 3) Provide means to defeat the interlock.
      - 4) Lockable in the off position.
    - b. Control panels supplied with 120 VAC:
      - 1) Provide an internal breaker with the line side terminals covered by a barrier.
      - 2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
      - 3) Provide a nameplate prominently positioned on the control panel stating "CAUTION Risk of Electric Shock – UPS equipment outputs remain energized with main disconnect in off position" for any panel containing a UPS.
  2. Provide circuit breakers as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
  3. Selection and ratings of protective devices:
    - a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
    - b. Voltage rating: Not less than the voltage of the application.
    - c. Select current rating and trip characteristics to be suitable for:
      - 1) Maximum normal operating current.
      - 2) Inrush characteristics.
      - 3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
    - d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant.
      - 1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
      - 2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
      - 3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.
  4. Provide a separate protective device for each powered electrical device:
    - a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.

- b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
        - 1) Size external fuse to open before any I/O-card-mounted fuses.
      - c. Individual discrete inputs shall use a 1/2-ampere fuse.
      - d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
    - 5. Fuses for 4 to 20 milliamperes signals:
      - a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
        - 1) Label shall not cover or interfere with equipment manufacturer's instructions.
      - b. An individual 1/2-ampere fuse for each 4-to-20 milliamperes analog loop powered from the control panel.
      - c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
      - d. Manufacturers: One of the following or equal:
        - 1) Ferraz Shawmut.
        - 2) Littelfuse.
        - 3) Bussmann.
    - 6. Fuse holders:
      - a. Modular type:
        - 1) DIN rail mounting on 35-millimeter rail.
        - 2) Touch-safe design: All connection terminals to be protected against accidental touch.
        - 3) Incorporates blown-fuse indicator.
        - 4) Plug-in style fuse terminals and fuse plugs are not acceptable.
      - b. Provide nameplate identifying each fuse:
        - 1) As specified in Section 16075 - Identification for Electrical Systems.
      - c. Manufacturers: One of the following or equal:
        - 1) Phoenix Contact, UT4-HESI Series.
        - 2) Allen-Bradley, 1492-FB Series B.
    - 7. Control circuit breakers:
      - a. DIN rail mounting on 35-millimeter rail.
      - b. Manual OPEN-CLOSE toggle switch.
      - c. Rated for 250 VAC.
      - d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
      - e. Current ratings: As required for the application.
      - f. Provide nameplate identifying each circuit breaker:
        - 1) As specified in Section 16075 - Identification for Electrical Systems.
      - g. Manufacturers: One of the following or equal:
        - 1) Phoenix Contact, TMC Series.
        - 2) ABB.
        - 3) Allen-Bradley.
        - 4) Square D.
  - D. Conductors and cables:
    - 1. Power and control wiring:
      - a. Materials: Stranded, soft annealed copper.
      - b. Insulation: 600 volts type MTW.
      - c. Minimum sizes:
        - 1) Primary power distribution: 12 AWG.



- 2) Secondary power distribution: 14 AWG.
- 3) Control: 16 AWG.
- d. Color:
  - 1) AC power (line and load): Black.
  - 2) AC power (neutral): White.
  - 3) AC control: Red.
  - 4) AC control: Orange for foreign voltages.
  - 5) DC power and control (ungrounded): Blue.
  - 6) DC power and control (grounded): White with Blue stripe.
  - 7) Ground: Green.
- 2. Signal cables:
  - a. Materials: Stranded, soft annealed copper.
  - b. Insulation: 600 volts, PVC outer jacket.
  - c. Minimum size: 18 AWG paired triad.
  - d. Overall aluminum shield (tape).
  - e. Copper drain wire.
  - f. Color:
    - 1) 2-Conductor:
      - a) Positive (+): Black.
      - b) Negative (-): White and red.
    - 2) 3-Conductor:
      - a) Positive (+): Black.
      - b) Negative (-): Red.
      - c) Signal: White.
  - g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:

- 1. Identify each conductor and cable with unique wire numbers as specified in Section 16075 - Identification for Electrical Systems.
- 2. Readily identified without twisting the conductor.

F. General wiring requirements:

- 1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
- 2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
- 3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
- 4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
- 5. Provide power surge protection for all control panels.
- 6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
- 7. Provide non-metallic ducts for routing and organization of conductors and cables:
  - a. Provide wiring separation plan.
  - b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.

- c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
      - 1) 120 VAC: Grey colored ducts.
      - 2) 24 VDC: White colored ducts.
  - 8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
    - a. Screw-on cable tie mounts.
    - b. Hammer-on cable-tie mounting clips.
    - c. Fingers of the nonmetallic duct.
  - 9. Wire ties:
    - a. No wire ties inside wire duct.
    - b. Use Panduit Cable tie installation tool, with tension control/cutoff.
    - c. Verify cut ends are cut flush filed smooth after installed.
  - 10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
  - 11. Support panel conductors where necessary to keep them in place.
  - 12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
  - 13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
    - a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
  - 14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
    - a. Solenoid valves.
    - b. Instruments both mounted in the control panel and remotely connected to the control panel.
- G. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with the PLC and Instrument Power wiring diagrams Indicated on the Drawings or as specified.

## **2.06 EQUIPMENT (NOT USED)**

## **2.07 COMPONENTS**

- A. Thermal management:
  - 1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 17050 - Common Work Results for Process Control and Instrumentation.
  - 2. Enclosure temperature switch:
    - a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
    - b. Sensor and electronic enclosure.
    - c. Accuracy: Within 2 degrees Fahrenheit.
    - d. Single contact:
      - 1) Manufacturers: One of the following or equal:
        - a) nVent/Hoffman ATEMNC.
        - b) Pfannenberger FLZ.

- e. Dual contact:
    - 1) Manufacturers: The following or equal:
      - a) nVent/Hoffman ADLTEMP.
  - 3. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
    - a. Provide as indicated on the Drawings or as specified.
  - 4. Fan ventilation:
    - a. Provide nVent/Hoffman fan speed control:
      - 1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
      - 2) Provide finger-guard kit.
      - 3) Filter kit with 2 spare filters for each intake fan.
      - 4) Provide bezel and gasket kit.
      - 5) Provide fan shroud.
      - 6) Automatically adjust fan speed depending on remote temperature sensor input.
      - 7) 120 VAC, 60 hertz.
      - 8) NEMA Type 5-15R cord connections.
- B. Signal isolators and converters:
- 1. Furnish signal isolators that provide complete isolation of input, output, and power input:
    - a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
    - b. Adjustable span and zero.
    - c. Accuracy: Within 1.0 percent of span.
    - d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.
  - 2. Manufacturers: One of the following or equal:
    - a. Phoenix Contact, Mini Analog Pro.
    - b. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.
    - c. Action Instruments, Q500 Series or Ultra SlimPakII.
    - d. AGM Electronics, Model TA-4000.
    - e. Moore Industries, MIT 4-Channel.
- C. Relays:
- 1. General:
    - a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
    - b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
    - c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
  - 2. General purpose:
    - a. Magnetic control relays.
    - b. NEMA ratings:
      - 1) 300 volts.
      - 2) 10 Amps thermal continuous test current.
      - 3) 60 Amps make.
      - 4) 6 Amps break.
    - c. Plug-in type.
    - d. LED indication for energization status.
    - e. Coil voltages: As required for the application.
    - f. Minimum poles: DPDT.

- g. Touch-safe design: All connection terminals to be protected against accidental touch.
  - h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
  - i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
  - j. Relays with screw-type socket terminals.
  - k. Provide additional (slave/interposing) relays when the following occurs:
    - 1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
    - 2) Higher contact rating is required in order to interface with starter circuits or other equipment.
  - l. DIN rail mounting on 35-millimeter rail.
  - m. Ice-cube-type relays with retainer clips to secure relay in socket.
  - n. Integrated label holder for device labeling.
  - o. Manufacturers: One of the following or equal:
    - 1) Potter and Brumfield: Type KRP or KUP.
    - 2) IDEC: R\* Series (\* = H, J, R, S, U).
    - 3) Allen-Bradley: Type 700 HC.
    - 4) Square D: Type K.
3. Terminal block relays:
- a. Magnetic control relays.
  - b. For use as an interposing relay for PLC based discrete I/O signals.
  - c. NEMA ratings:
    - 1) 250 volts.
    - 2) 6 Amps continuous.
    - 3) 1,500 volt-amperes make.
  - d. Plug-in type.
  - e. LED indication for energization status.
  - f. Coil voltages: As required for the application.
  - g. Minimum poles: SPDT.
  - h. Touch-safe design: All connection terminals to be protected against accidental touch.
  - i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
  - j. Relays with screw-type socket terminals.
  - k. DIN rail mounting on 35-millimeter rail.
  - l. Integrated label holder for device labeling.
  - m. Manufacturer: One of the following or equal:
    - 1) Phoenix Contact PLC Series.
    - 2) Eaton XR TBR Series.
    - 3) IDEC RV8H Series.
    - 4) Allen-Bradley Type 700 HL TBR Series.
4. Latching:
- a. Magnetic-latching control relays.
  - b. NEMA ratings:
    - 1) 300 volts.
    - 2) 5 Amps continuous.
    - 3) 360 volt-amperes make.
    - 4) 320 volt-amperes break.
  - c. Plug-in type.
  - d. DIN rail mounting on 35-millimeter rail.
  - e. Coil voltage: As required for the application.

- f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare pole.
- g. Touch-safe design: All connection terminals to be protected against accidental touch.
- h. Clear cover for visual inspection.
- i. Provide retainer clip to secure relay in socket.
- j. Manufacturers: One of the following or equal:
  - 1) Square D, 8501, Type K.
  - 2) IDEC, RR2KP Series.

D. Terminal blocks:

- 1. DIN rail mounting on 35-millimeter rail.
- 2. Rated for 15 amperes at 600 volts.
- 3. Screw terminal type.
- 4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
- 5. Finger-safe protection for all terminals for conductors.
- 6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
- 7. Terminals: Plainly identified to correspond with markings on the diagrams:
  - a. Permanent machine-printed terminal identification.
- 8. Disconnect-type field signal conductor terminals with socket/screw for testing.
- 9. Identify terminals suitable for use with more than 1 conductor.
- 10. Position:
  - a. So that the internal and external wiring does not cross.
  - b. To provide unobstructed access to the terminals and their conductors.
- 11. Provide minimum 25-percent spare terminals.
- 12. Manufacturers: One of the following or equal:
  - a. Phoenix Contact, UT4 Series.
  - b. Phoenix Contact UT6 Series.
  - c. Allen-Bradley Bulletin 1492 Double-level.
  - d. Weidmuller Klippon W-series, multi-level (screw terminal) terminal blocks.

E. DIN rail grounding:

- 1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
  - a. Mount to DIN rail via grounding foot with mounting screw.
  - b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
  - c. Not be used for grounding signal cable shields.
- 2. Screw terminal type.
- 3. DIN rail mounting on 35-millimeter rail.
- 4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
- 5. Finger-safe protection for all terminals for conductors.
- 6. Terminals: Plainly identified to correspond with markings on the diagrams:
  - a. Permanent machine-printed terminal identification.
- 7. Manufacturers: One of the following or equal:
  - a. Phoenix Contact, USKLG Series.
  - b. Allen-Bradley, 1492-JG Series.

- F. Wire duct:
1. Provide flame retardant plastic wiring duct, slotted with dust cover.
  2. Type:
    - a. Wide slot.
    - b. Narrow slot.
    - c. Round hole.
  3. Manufacturers: The following or equal:
    - a. Panduit.
    - b. Phoenix Contact.
    - c. Thomas & Betts.
    - d. Iboco.
- G. DIN rail:
1. Perforated steel.
  2. 35 mm width.
  3. 15 mm deep.
  4. Provide 2-inch offset using one of the following:
    - a. Offset brackets.
    - b. Preformed standoff DIN Rail Channel.
- H. Surge protection devices (SPD):
1. 120 VAC control panel power SPD:
    - a. Provide SPD for panel 120 VAC power entrances:
      - 1) Non-faulting and non-interrupting design.
      - 2) Provide line to neutral and neutral to ground surge protection.
    - b. Provide surge protection at secondary of main circuit breaker:
      - 1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
      - 2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
    - c. DIN rail mounting.
    - d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
      - 1) Gastight connections.
      - 2) Visual status indication of MOV status on the input and output circuits.
      - 3) Dry contact rated for remote status indication.
    - e. Approvals:
      - 1) Tested in accordance with IEC 61643-11.
      - 2) Tested in accordance with UL 1283.
      - 3) Tested in accordance with UL 1449.
      - 4) Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20  $\mu$ s waveform in accordance with IEEE C62.41.1 Category C Area.
    - f. Manufacturers: One of the following or equal:
      - 1) Phoenix Contact, Type SFP Filter.
      - 2) Sola HD, STFE Elite series.
      - 3) Rockwell, 4983-DC series.
      - 4) ASCO, Model 277.
  2. 24 VDC control panel power SPD:
    - a. Provide SPD for 24VDC power circuits.
    - b. Provide surge protection at DC power supply output.

- c. DIN rail mounting.
  - d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
    - 1) Optical status indicator.
    - 2) Dry contact rated for remote status indication.
  - e. Approvals:
    - 1) Tested in accordance with IEC 61643-11.
  - f. Manufacturers: One of the following or equal:
    - 1) Emerson model 265 (SLAC) series, Phoenix Contact, Plugtrab PLT-SEC-T3-24-FM-UT, or similar for field instruments that require auxiliary power (24VDC/VAC, 120VAC, 230VAC panel mounted surge protection device).
    - 2) Emerson/Edco model SS65-036-2, or similar for loop powered field instruments (field mounted surge protection device).
3. Panel mounted control, signal, and data line SPD:
- a. General:
    - 1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
    - 2) Approvals:
      - a) Tested in accordance with IEC 61643-21.
      - b) Tested in accordance with UL 497B.
    - 3) SPD shall consist of 2 parts:
      - a) Base module:
        - (1) DIN rail mounting.
        - (a) Grounded to DIN rail via mounting rail foot.
      - b) Plug protection module:
        - (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
    - 4) Provide indirect shield ground style SPD unless otherwise noted.
    - 5) Provide ability to locally identify and indicate SPD health.
    - 6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
    - 7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
    - 8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.
  - b. Manufacturers: One of the following or equal:
    - 1) Phoenix Contact, Plugtrab PT-IQ Series.
    - 2) Dehn, Blitzductor XTU Series.
4. Copper Ethernet SPD:
- a. Protects network equipment from lightning or other surge events.
  - b. Suitable for Gigabit networks.
  - c. Shielded RJ-45 ports.
  - d. Compliant with PoE standards IEEE 802.3af and 802.3at.
  - e. Nominal discharge surge current: 10 kA.
  - f. Approvals:
    - 1) Tested in accordance with IEC 61643-21.
    - 2) Tested in accordance with UL 497B.
  - g. Manufacturers: One of the following or equal:
    - 1) Phoenix Contact, DT-LAN-CAT6+.
    - 2) Citel, MJ8-C6A.
    - 3) Weidmuller, VDATA CAT6.

- 4) Eaton/MTL, ZoneBarrier High Energy Ethernet.
5. Field device mounted SPD:
  - a. Conduit entry mounting.
    - 1) Provide parallel or through wiring configurations as required by the application.
      - a) Use parallel wiring configuration if there is an available cable gland at the device.
      - b) Use through wiring configuration if there is no available cable gland at the device.
    - 2) Provide Screw connections compatible with field device.
  - b. NEMA 4X stainless steel material housing.
  - c. Approvals:
    - 1) Tested in accordance with IEC 61643-21.
  - d. 4-wire field device:
    - 1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
      - a) Maximum continuous voltage:
        - (1) DC:
          - (a) Signal: 32 VDC.
          - (b) Power supply: 255 VDC.
        - (2) AC:
          - (a) Signal: 22.6 VAC.
          - (b) Power supply: 255 VAC.
      - 2) Manufacturers: The following, engineer knows of no equal:
        - a) Endress+Hauser, HAW569-CB2C.
    - e. 2-wire or 3-wire field device:
      - 1) Module shall provide protection for the signal cable, communication bus or data line.
      - 2) Manufacturers: One of the following or equal:
        - a) Endress+Hauser, HAW569 Series.
        - b) Phoenix Contact, Surgetrab S-PT Series.
        - c) Eaton/MTL, TP Series.
  - I. Power supplies:
    1. Design power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.
    2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.
    3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
    4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
      - a. Provide automatic switchover upon module failure.
      - b. Alarm contacts monitored by the PLC.
    5. Provide protective isolation between power supply units either by means of Diodes, Diode Modules, MOSFET Modules, or use power supplies with built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
    6. Sized to provide 40-percent excess rated capacity.
    7. UL 508C listed to allow full-rated output without de-rating.



8. Provide fuse or short-circuit protection.
9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.
10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
12. Touch-safe design: All connection terminals to be protected against accidental touch.
13. DIN rail mounting on 35-millimeter rail:
  - a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
15. Manufacturers: One of the following or equal:
  - a. Fully redundant:
    - 1) Phoenix Contact, Quint Power Supply with SFB technology.
      - a) Phoenix Contact, Quint.
    - 2) IDEC, PS5R Series:
    - 3) Sola.
    - 4) PULS.
  - b. Redundancy module:
    - 1) Phoenix contact, o-ring redundancy module.

## 2.08 ACCESSORIES

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.
- C. Provide floor stands or legs with a minimum height of 12 inches where needed or as indicated on the Drawings.
- D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.
- E. Provide nameplate to each panel as indicated on the Drawings:
  1. Provide as specified in Section 16075 - Identification for Electrical Systems on all internal and external instruments and devices.
  2. Provide a nameplate with the following markings that is plainly visible after installation:
    - a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
    - b. Supply voltage, phase, frequency, and full-load current.
    - c. Power source or circuit ID.
    - d. Short-circuit current rating of the panel based on one of the following:
      - 1) Short-circuit current rating of a listed and labeled assembly.

- 2) Short-circuit current rating established utilizing an approved method.
- F. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
1. Safety plate glass.
  2. Secured by rubber locking seal.
  3. Allow full viewing of devices issuing visual process data or diagnostics.
- G. Lighting:
1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
    - a. Covered or guarded.
    - b. Provide On-Off door-activated switches where indicated on the Drawings.
    - c. 120-volt, single-phase, 15-amp style plug.
    - d. Provide 4,000 K, 900 Lumens - LED fixture.
      - 1) Provide additional fixtures for every 36 inches of width.
- H. Receptacles:
1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
  2. GFCI, 120-volt, single-phase, 15-amp style plug.
  3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.
- I. Grounding:
1. Provide the following:
    - a. Grounding strap between enclosure doors and the enclosure.
    - b. Equipment grounding conductor terminals.
    - c. Provide equipment grounding busbar with lugs for connection of all equipment grounding wires.
    - d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
  2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND," the letter "G," or the color green.
  3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
  4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
  5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
  6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
  7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
  8. Unless otherwise noted, connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
  9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
- J. Provide sunshades and insulation for all outdoor installations.

## 2.09 MIXES (NOT USED)

## **2.10 FABRICATION (NOT USED)**

## **2.11 FINISHES**

### **A. Finishes:**

#### **1. Metallic (non-stainless):**

- a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
- b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
- c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
- d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.

#### **2. Stainless steel:**

- a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

### **B. Colors:**

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

## **2.12 SOURCE QUALITY CONTROL**

- ### **A.**
- As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- ### **A.**
- Examine the installation location for the instrument and verify that the instrument will work properly when installed.
1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

### **3.02 PREPARATION (NOT USED)**

### **3.03 INSTALLATION**

- ### **A.**
- Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.
- ### **B.**
- Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.
- ### **C.**
- Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.

- D. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.
- E. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.
- F. Protect all wiring from sharp edges and corners.
- G. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.
- H. Side panels:
  - 1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

#### **3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)**

#### **3.05 REPAIRS/RESTORATION (NOT USED)**

#### **3.06 RE-INSTALLATION (NOT USED)**

#### **3.07 FIELD QUALITY CONTROL**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

#### **3.08 ADJUSTING (NOT USED)**

#### **3.09 CLEANING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

#### **3.10 DEMONSTRATION AND TRAINING (NOT USED)**

#### **3.11 PROTECTION**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

#### **3.12 SCHEDULES (NOT USED)**

END OF SECTION

## **SECTION 17712**

### **CONTROL SYSTEMS: UNINTERRUPTIBLE POWER SUPPLIES 10 KVA AND BELOW**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Single-phase double conversion uninterruptible power supplies rated 10 kVA and below.

##### **1.02 REFERENCES**

- A. As specified in Sections 16050 - Common Work Results for Electrical and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Federal Communications Commission (FCC):
  - 1. FCC Part 15, Class A.
  - 2. FCC Part 15, Class B.
- C. Institute of Electrical and Electronic Engineers (IEEE):
  - 1. 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
  - 2. 1184 - IEEE Guide for Batteries for Uninterruptible Power Supply Systems.
  - 3. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- D. National Electrical Manufacturers Association (NEMA):
  - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
- E. Underwriters Laboratories, Inc. (UL):
  - 1. UL 1778 - Standard for Uninterruptible Power Supply Systems and Equipment.

##### **1.03 DEFINITIONS**

- A. As specified in Sections 16050 - Common Work Results for Electrical and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
  - 1. Critical load: Load supplied by the UPS.
  - 2. MOV: Metal oxide varistor.

##### **1.04 SYSTEM DESCRIPTION**

- A. Provide complete, factory-assembled, wired, and tested, true on-line double conversion UPS equipment including, but not limited to, rectifier, DC bus, inverter, battery charger, batteries, automatic bypass, and ancillary components as specified in this Section and as indicated on the Drawings.

## 1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
  - 1. Manufacturer and model number.
  - 2. Catalog data.
  - 3. Dimensions:
    - a. Height.
    - b. Width.
    - c. Depth.
    - d. Weight.
  - 4. Ratings:
    - a. Input voltage.
    - b. Output voltage.
    - c. Input/output power factor.
    - d. Efficiency.
    - e. Harmonic distortion.
    - f. Runtime.
  - 5. Noise specifications.
  - 6. Heat dissipation.
  - 7. Warranties and maintenance contracts:
  - 8. All communications requirements such as software, cards, etc.
  - 9. Alarms and status available for remote monitoring and system health.
- C. Shop drawings:
  - 1. Power distribution block diagrams.
  - 2. Front and rear views of equipment enclosures:
    - a. Front elevation including all control and indicating devices.
  - 3. Support points and weight of overall equipment.
  - 4. Schematic and control wiring diagrams including, but not limited to:
    - a. Line and load terminals.
    - b. Alarm and status terminals.
    - c. Manual maintenance bypass switch terminals.
    - d. External Battery or Step-down/Step-up Transformers if any.
    - e. External wiring requirements for all communication signals.
  - 5. Switching and overcurrent protective devices.
- D. Calculations:
  - 1. Include derating for temperature and elevation as necessary.
  - 2. UPS sizing computation:
    - a. Apply safety factors as specified in this Section.
    - b. Provide itemized list of critical loads, including individual VA and watt ratings.
  - 3. Battery time calculation based on specified runtime for total load with the safety factor multiplied to it. Table/graph for back-up time calculation.
  - 4. Load calculation shall include power for all control system equipment, which include but not limited to PLC power supply, Ethernet switches, and I/O modules. Refer to Network Drawings for additional information and notes.
  - 5. Total battery recharge time as a function of capacity utilized.

- E. Design data:
  - 1. Design mounting and anchorage for seismic design criteria specified in Section 01612 - Seismic Design Criteria:
    - a. Provide seismic kits as required to meet design criteria.
- F. Record documents:
  - 1. Provide Record Drawings of installed unit(s) including layout and wiring.
- G. Manufacturer's field reports.
- H. Operation and maintenance manuals:
  - 1. System instruction manuals that describe troubleshooting, installation, operations, and safety procedures.
  - 2. Recommendations for maintenance procedures and intervals.
  - 3. Battery data/replacement information.
  - 4. Parts list.

## **1.06 QUALITY ASSURANCE**

- A. Manufacturer qualifications:
  - 1. A minimum of 10 years' experience in the design, manufacture, and testing of solid-state UPS systems.
  - 2. ISO 9001 certified.
- B. Regulatory requirements for complete UPS system:
  - 1. UL listed per UL Standard 1778.
  - 2. IEEE C62.41, Categories B.
  - 3. FCC 15:
    - a. Greater than 2,000 VA - Class A.
    - b. Less than 2,000 VA - Class B.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.12 SYSTEM START-UP (NOT USED)**

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

#### **1.14 COMMISSIONING (NOT USED)**

#### **1.15 MAINTENANCE (NOT USED)**

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Double conversion true online UPS system:
  - 1. One of the following or equal:
    - a. Vertiv, Liebert GXT5 Series.
    - b. Eaton, 9PX Series.

#### **2.02 EXISTING PRODUCTS (NOT USED)**

#### **2.03 MATERIALS (NOT USED)**

#### **2.04 MANUFACTURED UNITS**

- A. Design requirements:
  - 1. The minimum VA rating of the UPS shall be greater than or equal to the safety factor (as indicated in the UPS schedule) times the connected load or 700 VA, whichever is greater.
  - 2. UPS System Input:
    - a. Input Voltage:
      - 1) Less than or equal to 3 kVA UPS:
        - a) 120VAC within 3 percent, single-phase, 2-wire plus ground (L1, N, G).
      - 2) Frequency: 60 hertz.
        - a) Auto sensing on initial power up.
        - b) User configurable.
    - b. Input current harmonic distortion (THDi%):
      - a) Less than or equal to 5 percent at full load operation.
    - c. Input power factor:
      - a) Greater than or equal to 0.99 lagging at rated load.
    - d. Input connections:
      - 1) As specified and as indicated on the Drawings.
  - 3. UPS Inverter:
    - a. Output Voltage:
      - 1) Less than or equal to 3kVA UPS:
        - a) Standard:
          - (1) 120VAC.
        - b) User selectable:
          - (1) 100VAC, 110VAC, 120VAC, 125VAC.
      - b. AC-AC Efficiency:
        - 1) Greater than or equal to 89 percent at full rated resistive linear load.
      - c. Transient recovery time:
        - 1) To nominal voltage within 100 milliseconds.
      - d. Voltage regulation:
        - 1) Within 1 percent steady state.
      - e. Output Voltage Distortion (THDV%):
        - 1) Linear load: Less than 2 percent.



- 2) Non-linear load: Less than 5 percent.
- f. Output power factor:
  - 1) The load power factor range shall be 0.65 lagging to 1.0 (unity) leading without power derating.
- g. Current overload capability:
  - 1) The UPS shall attempt to clear overloads while maintaining normal operation before transferring to bypass.
  - 2) Bypass transfer thresholds shall follow inverse time-current characteristic that operates when the load exceeds the nameplate rating of the UPS.
  - 3) Transfer load to bypass when overload capacity is exceeded.
- 4. Batteries:
  - a. Internal battery shall utilize valve-regulated, non-spillable, lead acid (VRLA) cells.
  - b. UPS shall have capability for connection of external battery modules to extend total available run time. External batteries shall match the UPS in aesthetics and color.
- 5. Mounting:
  - a. Configurable for tower mounting applications.
  - b. Provide mounting brackets as required and as indicated on the Drawings.
- 6. Cooling:
  - a. UPS shall have integral forced air cooling.
- 7. Output connections:
  - a. Receptacles:
    - 1) Less than or equal to 3kVA UPS:
      - a) Provide a minimum of four NEMA Type 5-15R or Type 5-20R receptacles.
      - b) Provide at least one NEMA Type L5-30R receptacle.
    - 2) Greater than 3kVA UPS:
      - a) Provide a minimum of four NEMA Type 5-20R receptacles.
      - b) Provide at least one NEMA Type L14-30R receptacle.
    - 3) Provide hardwired connections as required and as indicated on the Drawings.

B. Environmental requirements:

- 1. Operating ambient temperature:
  - a. UPS module: 50 degrees Fahrenheit to 104 degrees Fahrenheit (10 degrees Celsius to 40 degrees Celsius).
  - b. Battery: 68 degrees Fahrenheit to 86 degrees Fahrenheit (20 degrees Celsius to 30 degrees Celsius).
- 2. Operating altitude: 4500 feet.
- 3. Project site conditions as specified in Sections 16050 - Common Work Results for Electrical and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- 4. Surge protection:
  - a. UPS shall confirm to ANSI C62.41, Category B.
- 5. Audible noise:
  - a. Less than 46 dB at 1 meter.

- C. Communications:
  - 1. Relay outputs:
    - a. The UPS shall contain on the rear panel a terminal block to provide low voltage signals for On Battery, Low Battery, Any Mode Shutdown and Battery Mode Shutdown.

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES**

- A. External maintenance bypass:
  - 1. Manufacturers: One of the following or equal:
    - a. Vertiv, Liebert Micropod Series.
    - b. Eaton HotSwap MBP Series.
  - 2. Properties:
    - a. Provides isolation of the UPS for maintenance purposes.
    - b. Provide maintenance bypass from the same manufacturer as the UPS manufacturer.
    - c. UL 1778 listed.
    - d. Provide mounting brackets as required by the application.
    - e. Make-before-break design so that UPS can be isolated from the critical loads by placing these loads on source power without interruption of operation.
    - f. Utility and UPS status indications.
    - g. Rated to carry the full input current of the UPS.
    - h. Connections to match UPS connections.
    - i. Supply necessary input/output cords and receptacles for connections with power source and UPS.

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL (NOT USED)**

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. Install equipment in accordance with manufacturer's instructions.
- B. Do not utilize extension cords, adapters, or other electrical connectors for UPS input.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIRS/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 FIELD QUALITY CONTROL**

- A. Perform inspections and test procedures before UPS startup:
1. Inspect equipment for signs of damage.
  2. Verify installation as indicated on the Drawings and specified in the Specifications.
  3. Inspect cabinets for foreign objects.
  4. Verify neutral and ground conductors are properly sized and terminated.
  5. Inspect battery cases.
  6. Inspect batteries for proper polarity.
  7. Check power and control wiring for tightness.
  8. Check terminal connectors for tightness.
  9. Ensure connection and voltage of the battery string(s).

### **3.08 ADJUSTING (NOT USED)**

### **3.09 CLEANING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

### **3.10 DEMONSTRATION AND TRAINING (NOT USED)**

### **3.11 PROTECTION**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

### **3.12 SCHEDULES**

<b>TAG</b>	<b>MINIMUM RUNTIME</b>	<b>INPUT VOLTAGE / CONNECTION</b>	<b>SAFETY FACTOR</b>	<b>NOTES</b>
PCM-3510 UPS	20 Minutes	120 VAC	1.5	Free-Standing

END OF SECTION



## **SECTION 17720**

### **CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Programmable logic controller (PLC) based control systems hardware.

##### **1.02 REFERENCES**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE).

##### **1.03 DEFINITIONS**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
  - 1. CPU: Central processing unit.
  - 2. I/O: Input/Output.
- C. Specific definitions:
  - 1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
  - 2. Application software: The software that is programmed specifically for the Project.

##### **1.04 SYSTEM DESCRIPTION**

- A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.

##### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
  - 1. CPU:
    - a. Processor type.
    - b. Processor speed.
    - c. Memory.
    - d. Internal processor battery backup time.
  - 2. I/O modules:
    - a. Type.

- b. Standard wiring diagram.

## **1.06 QUALITY ASSURANCE**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.
- C. Additional requirements:
  - 1. Provide PLC system components by a single manufacturer:
    - a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
  - 2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
  - 3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.08 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.09 SEQUENCING (NOT USED)**

## **1.10 SCHEDULING (NOT USED)**

## **1.11 WARRANTY**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.12 SYSTEM START-UP (NOT USED)**

## **1.13 OWNER'S INSTRUCTIONS (NOT USED)**

## **1.14 COMMISSIONING (NOT USED)**

## **1.15 MAINTENANCE**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The following, no equal:
  - 1. General Electric:
    - a. RX3i.

### **2.02 EXISTING PRODUCTS (NOT USED)**

### **2.03 MATERIALS (NOT USED)**

### **2.04 MANUFACTURED UNITS**

- A. Programmable logic controller:
  - 1. Construction:
    - a. Furnish plug-in modular system.
    - b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:
      - 1) Temperature: 0 to 55 degrees Celsius.
      - 2) RFI: 80 to 1,000 MHz.
      - 3) Vibration: 10 to 500 hertz.
      - 4) Humidity: 0 to 95 percent.
    - c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.
    - d. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:
      - 1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
  - 2. CPU:
    - a. CPU Model Number: IC695CPE305, no substitutions allowed.
  - 3. PLC power supply:
    - a. Power Supply Model Number: IC695PSA140, no substitutions allowed.
    - b. Input: 120 VAC.
  - 4. PLC input/output, I/O modules:
    - a. General:
      - 1) Provide I/O modules that:
        - a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
        - b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
        - c) Accept dual-ended inputs.
      - 2) The use of common grounds between I/O points is not acceptable.
      - 3) Provide modules that are removable without having to disconnect wiring terminals:
        - a) Utilize a swing-arm or plug-in wiring connector.
      - 4) Provide at each PLC the I/O modules for the following:
        - a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.

- b) Wire all spares provided to the field terminal strip.
  - 5) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
- b. Discrete input modules:
  - 1) Discrete input module model number: IC695MDL645, no substitutions allowed.
- c. Discrete output modules:
  - 1) Discrete output module model number: IC695MDL940, no substitutions allowed.
- d. Analog input modules:
  - 1) Analog input module model number: IC695ALG616, no substitutions allowed.
- 5. Communications modules:
  - a. Network communications modules:
    - 1) General:
      - a) Install communications modules in the PLC backplane.
    - 2) Ethernet:
      - a) Ethernet module model number: IC695ETM001, no substitutions allowed.
    - 3) Serial:
      - a) Modbus module model number IC695CMM002, no substitutions allowed.
    - 4) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.
- 6. PLC backplane housing:
  - a. Provide 12-slot housing.
  - b. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
  - c. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
  - d. Provide a blank slot filler module for each spare slot.

## **2.05 EQUIPMENT (NOT USED)**

## **2.06 COMPONENTS (NOT USED)**

## **2.07 ACCESSORIES (NOT USED)**

## **2.08 MIXES (NOT USED)**

## **2.09 FABRICATION (NOT USED)**

## **2.10 FINISHES (NOT USED)**

## **2.11 SOURCE QUALITY CONTROL**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.



## **PART 3 EXECUTION**

### **3.01 EXAMINATION (NOT USED)**

### **3.02 PREPARATION (NOT USED)**

### **3.03 INSTALLATION**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
  - 1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.
- C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

### **3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

### **3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 RE-INSTALLATION (NOT USED)**

### **3.07 FIELD QUALITY CONTROL**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

### **3.08 ADJUSTING (NOT USED)**

### **3.09 CLEANING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

### **3.10 DEMONSTRATION AND TRAINING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

### **3.11 PROTECTION**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

### **3.12 SCHEDULES (NOT USED)**

END OF SECTION



## SECTION 17733

### CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes:
  - 1. Materials and equipment used in process control and LAN networks including:
    - a. Network switches.
    - b. Patch panels and other data network hardware.
    - c. Related accessories.

##### 1.02 REFERENCES

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Electronic Industries Alliance/Electronic Components, Assemblies & Materials Association (EIA/ECA):
  - 1. 310-E - Cabinets, Racks, Panels, and Associated Equipment.
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. 802.1X - Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.
  - 2. 802.3 - Standard for Ethernet.
  - 3. 802.11b - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher Speed Physical Layer (PHY) Extension in the 2.4 GHz band.
- D. National Electrical Manufacturers Association (NEMA):
  - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
- E. Telecommunications Industry Association (TIA):
  - 1. 569 - Telecommunications Pathways and Spaces.
  - 2. 607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- F. Underwriters Laboratories, Inc. (UL).

##### 1.03 DEFINITIONS

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## 1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
  - 1. Include information on all network equipment.
  - 2. Manufacturer's operation and installation instructions.
- C. Shop drawings:
  - 1. Complete set of drawings including but not limited to:
    - a. System block diagram showing relationship and connections between devices provided under this Contract and existing equipment. Include manufacturer and model information, and address settings.
    - b. Network riser diagram.
    - c. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
    - d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
    - e. Electrical connection diagrams.
    - f. Complete grounding requirements.
  - 2. Furnish data sheets for each component together with a technical product brochure or bulletin:
    - a. Manufacturer's model number.
    - b. Project equipment tag.
  - 3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
    - a. Quantity.
    - b. Description.
    - c. Manufacturer.
    - d. Part numbers.
- D. Calculations:
  - 1. Cooling calculations, including but not limited to:
    - a. Highest expected ambient temperature for the enclosure's location.
    - b. Internal heat load.
    - c. Exposure to direct sunlight.
    - d. Dimensions of the enclosure in inches.
    - e. Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.
- E. Seismic design:
  - 1. Seismic panel construction:
    - a. Seismic anchorage: Provide seismic design calculations and installation details for anchorage of all cabinets, racks, panels, enclosures, consoles, etc. to meet seismic requirements as specified in Section 01612 - Seismic Design Criteria:
      - 1) Stamped by a Professional Engineer registered in the state where the project is being constructed.
    - b. For freestanding panels weighing 200 pounds or more (assembled, including contents), submit calculations, data sheets, and other

information to substantiate that cabinet, base, and framing meet minimum design strength requirements and seismic requirements as specified in Section 01612 - Seismic Design Criteria. Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

F. Test reports:

1. As specified in Sections:
  - a. 16125 - Fiber Optic Cable and Appurtenances.
  - b. 17950 - Commissioning for Instrumentation and Controls.
2. Signed test results as described in this Section.
3. Test results shall include:
  - a. Narrative describing the test procedures followed.
  - b. Block diagram of test set up.
  - c. Manufacturer's information on test equipment used.
  - d. Detailed test results.
  - e. A narrative summarizing the results of the testing and identifying any further action required.

G. Operating manuals:

1. Complete installation, operation, calibration, and testing manuals as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

H. Record drawings:

1. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

## **1.05 QUALITY ASSURANCE**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.07 PROJECT OR SITE CONDITIONS**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## **1.08 SEQUENCING (NOT USED)**

## **1.09 SCHEDULING (NOT USED)**

## **1.10 WARRANTY**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

**1.11 SYSTEM START-UP (NOT USED)**

**1.12 OWNER'S INSTRUCTIONS (NOT USED)**

**1.13 COMMISSIONING (NOT USED)**

**1.14 MAINTENANCE (NOT USED)**

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS (NOT USED)**

**2.02 SYSTEM DESCRIPTION**

A. Provide all network equipment identified in the Contract Documents.

**2.03 EXISTING PRODUCTS (NOT USED)**

**2.04 MATERIALS (NOT USED)**

**2.05 MANUFACTURED UNITS**

A. Ethernet switches:

1. Managed Enterprise Ethernet switches:

a. Manufacturers: The following, no equal:

1) Cisco Catalyst 9300-58U with C9300 NM-8X network module.

b. Properties:

1) Hardware:

a) 19-inch rack mountable switch.

b) Power supply:

(1) Provide redundant Cisco power supplies, Model PWR-C1-1100WAC-P.

(2) 120 VAC, 60 hertz, 1 phase 1,600 watts.

c) Console management port.

d) Open module slots for the addition of modules as described below.

2) Performance:

a) Switching capacity: 92 Gbps, minimum.

b) Address table size: 8,000 entries, minimum.

c) 10 Gigabit throughput.

3) Environment:

a) Operating temperature range: 32 to 113 degrees Fahrenheit.

b) Humidity: 10 to 90 percent, non-condensing.

4) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:

a) Layer 3 routing.

b) Port Monitoring.

c) Remote switch management.

d) Port Security.

e) Rapid Spanning Tree protocol.

- 5) Connections:
  - a) Copper: RJ-45.
    - (1) Standard: 10 Gbit/sec.
    - (2) Auto-negotiating.
    - (3) Quantity: As required to provide network connections indicated on the Drawings plus 20 percent spare.
  - b) Fiber: SFP port with LC connectors.
    - (1) Quantity: As required to provide network connections indicated on the Drawings plus 20 percent spare, or 4 total, whichever is greater.
- 6) SFP Transceivers:
  - a) Provide 10 Gigabit transceivers unless otherwise indicated, or as required to interface with other equipment:
    - (1) Single mode.

**B. Patch panels:**

- 1. Fiber optic patch panels:
  - a. General:
    - 1) All optical fiber cables shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel and the fiber optic network equipment shall be made via factory tested fiber optic patch cords.
    - 2) All fiber cable strands shall be terminated at the patch panels, no loose fiber strands are allowed.
    - 3) Provide space for excess fiber and provide strain relief for the fiber cable.
    - 4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
  - b. Wall mounted inside PLC control panel:
    - 1) Manufacturers: One of the following or equal:
      - a) Corning.
      - b) Optical Cable Corporation (OCC).
    - 2) Properties:
      - a) Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
      - b) Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
      - c) Wall mounted fiber interconnects shall provide physical protection for all incoming and outgoing cables and patch cords.
    - 3) Accessories:
      - a) Door lock.
      - b) Blanks for unused connector panels.

**2.06 EQUIPMENT (NOT USED)**

**2.07 COMPONENTS (NOT USED)**

## **2.08 ACCESSORIES**

- A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.
- B. Provide dust covers or plugs for all unused ports.

## **2.09 MIXES (NOT USED)**

## **2.10 FABRICATION (NOT USED)**

## **2.11 FINISHES (NOT USED)**

## **2.12 SOURCE QUALITY CONTROL (NOT USED)**

# **PART 3 EXECUTION**

## **3.01 EXAMINATION (NOT USED)**

## **3.02 PREPARATION (NOT USED)**

## **3.03 INSTALLATION**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. All racks shall be level and plumb.
- C. All work shall be performed in a neat and workmanlike manner.
- D. Internal rack wiring:
  - 1. Cables shall be installed avoiding sharp bends.
  - 2. Provide enough working space inside rack or cabinets such that closing enclosure doors does not crush or compress cabling.
  - 3. Bundle cables together in groups of no more than 12.
  - 4. Route cables from both sides of the rack to patch panels. Do not bring all bundles from a single side.
  - 5. No cabling shall obstruct equipment ventilation.
  - 6. Individual pairs will be untwisted less than 1/2-inch at termination points.
  - 7. Ground enclosure and equipment in accordance with TIA-607.
    - a. Individually bond all network equipment chassis to rack's grounding busbar. Do not daisy-chain bonding conductors.
    - b. Size the bonding conductor per network equipment manufacturer's recommendation, or #10 AWG, whichever is larger.
- E. External rack wiring:
  - 1. Do not install fiber cables in non-continuous cable supports such as cable ladders or wire baskets without radius cable supports or solid bottoms.
  - 2. Maintain cable separation in accordance with TIA-569.
    - a. Install cables a minimum of 40 inches away from electrical motors and transformers.
    - b. Install cables a minimum of 12 inches away from fluorescent lighting.



- F. All cables and terminations shall be labeled with cable designations as specified in Section 16075 - Identification for Electrical Systems.
- G. Each data port shall be individually labeled with its patch panel/switch port ID:
  - 1. Labeling must be printed - no handwritten labels will be allowed.
- H. At the completion of the wiring installation, provide the following documentation:
  - 1. A plan-view of the premise(s) showing the jack numbering scheme.
  - 2. A printed certification report for the entire wiring installation showing compliance with all TIA specifications for data cable.
  - 3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

**3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

**3.05 REPAIR/RESTORATION (NOT USED)**

**3.06 RE-INSTALLATION (NOT USED)**

**3.07 FIELD QUALITY CONTROL (NOT USED)**

**3.08 ADJUSTING**

- A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

**3.09 CLEANING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

**3.10 DEMONSTRATION AND TRAINING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

**3.11 PROTECTION (NOT USED)**

**3.12 SCHEDULES (NOT USED)**

END OF SECTION



## **SECTION 17950**

### **COMMISSIONING FOR INSTRUMENTATION AND CONTROLS**

#### **PART 1 GENERAL**

##### **1.01 SUMMARY**

- A. Section includes:
  - 1. Testing requirements that apply to process control and instrumentation systems for the entire Project.

##### **1.02 REFERENCES**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Electronics Industries Alliance (EIA).
- C. Telecommunications Industry Association (TIA).

##### **1.03 DEFINITIONS**

- A. As specified in Sections 01756 - Commissioning and 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
  - 1. Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
  - 2. Loop Validation Tests - Signals are tested from the field device to the PLC.

##### **1.04 SYSTEM DESCRIPTION (NOT USED)**

##### **1.05 SUBMITTALS**

- A. Furnish submittals as specified in Section 01330 - Submittal Procedures.
- B. General:
  - 1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- C. Overall test plan:
  - 1. Develop the PCIS system test submittals in consultation and cooperation with all applicable subcontractors.
  - 2. Develop and submit an overall testing plan for the PCIS. The overall test plan to be reviewed and approved by the Engineer before detailed test plans, procedures, and forms will be reviewed.
  - 3. Describe the test phases as they apply specifically to this Project.

4. Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.
  5. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
  6. Provide examples of proposed forms and checklists.
- D. Test procedures:
1. Provide a statement of test objectives for each test.
  2. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), and how the testing equipment will be used.
  3. Describe the expected role of the Engineer, as well as any requirements for assistance from Owner's staff.
  4. Provide the forms and checklists to be used.
- E. Test forms:
1. Submit completed calibration forms, test forms, and checklists.
    - a. Test forms shall include the detailed test procedures, or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
    - b. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (Engineer and Owner) witnessing the test.
    - c. Sample test forms at the end of this Section show the minimum required content.
      - 1) The sample test forms have not been customized for this Project.
      - 2) Contractor shall develop and submit test forms customized for the Project and meeting the specified test and submittal requirements.
- F. FAT procedure additional minimal requirements:
1. Prepare and submit a FAT procedure which includes:
    - a. Control system testing block diagram.
    - b. Estimated test duration.
- G. Details on the simulator construction, components, and operation. Testing binders:
1. Sub-system to be tested, provide and submit a test binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.
  2. Fill out in advance headings and all other information known before the test.
  3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
  4. Include or list reference material and provide separately at the time of the test.
  5. Record test results and verify that all test requirements and conditions have been met.
- H. Test reports:
1. At the conclusion of each test, submit a complete test report, including all test results and certifications.
  2. Include all completed test binders, forms, and checklists.

3. Submission, review, and acceptance of each test report is required before the start of the sub-system.

**1.06 QUALITY ASSURANCE (NOT USED)**

**1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)**

**1.08 PROJECT OR SITE CONDITIONS (NOT USED)**

**1.09 SEQUENCING (NOT USED)**

**1.10 SCHEDULING**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

**1.11 WARRANTY (NOT USED)**

**1.12 SYSTEM START-UP (NOT USED)**

**1.13 OWNER'S INSTRUCTIONS (NOT USED)**

**1.14 MAINTENANCE (NOT USED)**

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

**3.01 EXAMINATION (NOT USED)**

**3.02 PREPARATION (NOT USED)**

**3.03 INSTALLATION**

- A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
- B. Installation supervision:
  1. Provide as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

**3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)**

**3.05 REPAIR/RESTORATION (NOT USED)**

### **3.06 COMMISSIONING**

#### **A. Installation testing:**

1. General:
  - a. The Owner reserves the right to test any specified function, whether or not explicitly stated in the test submittals.
  - b. Failure testing:
    - 1) In addition to demonstrating correct operation of all specified features, demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
      - a) Equipment failure.
      - b) Operator error.
      - c) Communications sub-system error.
      - d) Power failure.
      - e) Process equipment failure.
      - f) High system loading conditions.
  - c. Conduct testing Monday through Friday during normal working hours for no more than 8 hours per day.
    - 1) Testing at other times requires approval of the Engineer.
2. Sequencing:
  - a. See additional requirements specified in the Sequencing article of Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
3. LAN cable post-testing:
  - a. After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.
  - b. Provide test documentation that includes the cable number, total length of cable, a permanent hard copy, as well as a-USB or CD copy of all traces.
    - 1) After installing connectors:
    - 2) Perform cable end-to-end testing on all installed cables from both ends of the cable. Test shall include cable system performance tests and confirm the absence of wiring errors.
    - 3) Submit a signed test report presenting the results of the cable testing.
    - 4) Repair or replace any portions of the system not meeting ANSI/TIA/EIA standards for a Category 6 installation. Repaired sections shall be retested.

### **3.07 FIELD QUALITY CONTROL (NOT USED)**

### **3.01 RE-INSTALLATION (NOT USED)**

### **3.02 ADJUSTING (NOT USED)**

### **3.03 CLEANING (NOT USED)**

### **3.04 PROTECTION (NOT USED)**

### **3.05 SCHEDULES**

A. Example test forms:

1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of Project-specific test forms for this Project.
2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

END OF SECTION

	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
<b>1. GENERAL INSPECTION</b> <b>A. Structural Inspection</b> <input type="checkbox"/> Verify Lifting Lugs Installed <input type="checkbox"/> Verify enclosure has lock and lock is functional <input type="checkbox"/> Confirm that seismic bracing components are provided per manufacturer's installation instructions <b>B. Exterior Inspection</b> <input type="checkbox"/> Cabinet exterior is clean, scratch, and dent free <input type="checkbox"/> Inspect externally for corrosion and damage <input type="checkbox"/> Verify enclosure door opens and closes easily <input type="checkbox"/> Verify enclosure has a 3-point latch <input type="checkbox"/> Verify enclosure has a flange mounted disconnect (where voltages greater than 120 VAC enter the cabinet) <input type="checkbox"/> Verify enclosure has the appropriate NEMA rating (1, 1G, 12, 3R, 4, 4X, etc.) <input type="checkbox"/> Verify enclosure is the appropriate size (not grossly larger than design, and will still fit in the plant) <b>Nameplates</b> <input type="checkbox"/> Cabinet has identification nameplate <input type="checkbox"/> All door labels are straight, spelled correctly, and match the tagging defined in the Contract <input type="checkbox"/> Cabinet has a nameplate that includes the following: <div style="display: flex; justify-content: space-between; margin-left: 20px;"> <div> <input type="checkbox"/> Power source(s)  <input type="checkbox"/> Circuit ID(s) </div> <div> <input type="checkbox"/> Integrator's Logo  <input type="checkbox"/> Short Circuit KAIC ratings </div> </div> <input type="checkbox"/> If labels are screwed to door, silicone was utilized to cover screw holes (Labels screwed to the door of a NEMA 4/4X panel technically violates the NEMA rating.) <b>Door Devices</b> <input type="checkbox"/> All devices penetrating the outside of panel have gaskets, silicone or both <input type="checkbox"/> All door devices are installed (HMIs, Pilot Devices, etc.) <input type="checkbox"/> Door mounted equipment is mounted straight and square <input type="checkbox"/> All exterior or door mounted equipment present and accounted for, installed and securely fastened <input type="checkbox"/> NEMA classification has not been violated due to penetrations <input type="checkbox"/> Door mounted equipment has the same NEMA rating as the panel <input type="checkbox"/> All door mounted equipment installed at the correct height <input type="checkbox"/> All door mounted equipment installed in the correct positions and order (layout of door mounted equipment is grouped properly and in a logical manner) <input type="checkbox"/> Doors with multiple penetrations have adequate bracing (if needed) <input type="checkbox"/> Visually check condition of indicators , controllers and annunciators <input type="checkbox"/> Check that pilot lights illuminate correctly <input type="checkbox"/> Check the Push-To-Test function <input type="checkbox"/> Ensure correct pilot light color <b>Peripheral Devices</b> <input type="checkbox"/> Horn / Beacon is installed (where required) <input type="checkbox"/> Silence and Reset pushbutton												
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	<b>FACTORY ACCEPTANCE TEST - CONTROL PANELS</b>											
<p><b>1. GENERAL INSPECTION (continued)</b></p> <p><b>C. Interior Inspection</b></p> <p><input type="checkbox"/> Cabinet is cleaned of marks and dirt.</p> <p><input type="checkbox"/> Inspect internally for corrosion and damage.</p> <p><input type="checkbox"/> Back panel is clean of marks and dirt.</p> <p><input type="checkbox"/> Interior of panel vacuumed and shall be free of all debris.</p> <p><input type="checkbox"/> Check that the panel roof is clean and clear of foreign materials.</p> <p><input type="checkbox"/> Bottom of panel has been cut out (where bottom entry is required), with angle iron welded around the bottom perimeter. Re-painting has been performed.</p> <p><input type="checkbox"/> If internal light door limit switch is provided, ensure the light automatically turns "on" when the doors are open.</p> <p><input type="checkbox"/> Check that a document pocket has been provided.</p> <p><input type="checkbox"/> Intrusion alarms (where required).</p> <p><b>Interior Labeling</b></p> <p><input type="checkbox"/> All panel mounted equipment has identification labeling, by using either a Brothers or Phenolic type tags.</p> <p><input type="checkbox"/> Verify that door mounted components are mounted square and symmetrical.</p> <p><input type="checkbox"/> Verify that nameplates are straight, legible, and spelled correctly.</p> <p><input type="checkbox"/> All terminal blocks are identified/labeled with permanent labels including tight end blocks and caps.</p> <p><input type="checkbox"/> All wiring shrink labeled and or phased correctly to the specifications.</p> <p><input type="checkbox"/> All wire labels shrunk completely rotated and aligned alike for easy identification.</p> <p><input type="checkbox"/> All fuses and circuit breakers are labeled with ID and current rating.</p> <p><input type="checkbox"/> System Integrator's label or labels installed on door.</p> <p><input type="checkbox"/> Panel manufacturer model/serial number tag is present.</p> <p><input type="checkbox"/> All required safety/warning tags installed and straight.</p> <p><input type="checkbox"/> Correct UL (typically UL 508) or cUL tag installed and registered and all other associated tags installed and straight (the UL tag might not be installed in the panel at the factory test. If the panel is modified due to changes during the factory test or a punch list generated from the factory test, the UL labeling would need to be re-applied. Some UL shops do not apply the UL label until the panel is released to be shipped.).</p> <p><b>Wireways</b></p> <p><input type="checkbox"/> Plastic wire way covers installed properly.</p> <p><input type="checkbox"/> Plastic wireways have no sharp edges.</p> <p><input type="checkbox"/> No wire Ties inside the wireways.</p> <p><input type="checkbox"/> No sharp edges on wire ties.</p> <p><input type="checkbox"/> Separation: White duct is used for DC voltages, Gray duct is used for AC voltages.</p> <p><input type="checkbox"/> Ensure wiring duct is not over-full, includes provision for 20% more wiring and the cover may easily be installed. Panduit recommends 50% duct fill, but 40% is a better practice.</p>												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
<b>1. GENERAL INSPECTION (continued)</b> <b>C. Interior Inspection (continued)</b> <b>Wiring</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Visually check terminals and condition of internal wirings</li> <li><input type="checkbox"/> Verify that the control panel has been assembled and wired as designed</li> <li><input type="checkbox"/> Verify that all components are operational and perform the functions intended</li> <li><input type="checkbox"/> Verify that all components are sized appropriately for the application</li> <li><input type="checkbox"/> Verify that equipment control circuits function as intended</li> <li><input type="checkbox"/> Back of door wiring is labeled and neatly formed</li> <li><input type="checkbox"/> Back panel to door wiring has sufficient bending radius with spiral wrap</li> <li><input type="checkbox"/> Wire connection has been verified wired to correct points within the panel</li> <li><input type="checkbox"/> Individual wires have been given a pull test to verify a good terminal connection</li> <li><input type="checkbox"/> Wire and cable minimum bending radius have not been violated</li> <li><input type="checkbox"/> All equipment installed straight and square to back panel</li> <li><input type="checkbox"/> Wire colors are correct:               <ul style="list-style-type: none"> <li><input type="checkbox"/> Black and White &gt; AC hot and neutral, respectively</li> <li><input type="checkbox"/> Red &gt; AC control signals</li> <li><input type="checkbox"/> Blue &gt; DC power and control (Blue w/White stripe for DC ground)</li> <li><input type="checkbox"/> Yellow &gt; Foreign voltages (those still present when panel power is disconnected)</li> <li><input type="checkbox"/> Green &gt; AC equipment ground</li> <li><input type="checkbox"/> Black &gt; TSP (+)</li> <li><input type="checkbox"/> White &gt; TSP(-)</li> </ul> </li> <li><input type="checkbox"/> Analog wiring shields are continuous (connected by a dedicated terminal block for such shields)</li> <li><input type="checkbox"/> Analog shield wires are grounded within the panel, where not otherwise grounded at the transmitter itself</li> <li><input type="checkbox"/> Discrete inputs are separately fused or protected by a circuit breaker on a "per loop" basis</li> <li><input type="checkbox"/> Intrinsic Safety Wiring               <ul style="list-style-type: none"> <li><input type="checkbox"/> Ensure wiring associated with intrinsic safety circuits or intrinsic safety barriers is kept away from all other wiring by UL minimum distances or by a physical (grounded metal) barrier preventing non-intrinsically safe wiring from coming in contact with intrinsically safe circuits or wiring</li> </ul> </li> <li><input type="checkbox"/> Verify all spare terminals are installed according to the percentage listed in the specifications</li> </ul> <b>Grounding</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Equipped with "Blackburn" or other grounding type lug</li> <li><input type="checkbox"/> Lug is securely fastened to the panel structure</li> <li><input type="checkbox"/> Verify Grounding bar is installed</li> <li><input type="checkbox"/> Verify Isolated ground bar is installed</li> </ul>												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
<p><b>2. POWER TEST</b></p> <p><b>A. AC Power</b></p> <p><input type="checkbox"/> AC Power is routed correctly within the panel, and is isolated from DC and network wiring.</p> <p><input type="checkbox"/> All fuses are installed and sized properly.</p> <p><input type="checkbox"/> All breakers are installed and sized properly.</p> <p><input type="checkbox"/> 24 VDC Power Supplies are functional.</p> <p><input type="checkbox"/> 24 VDC Power fail contacts are functional.</p> <p><input type="checkbox"/> 24 VDC power supplies are redundant, and have diode modules enabling the hot swap-over between supplies.</p> <p style="padding-left: 20px;"><input type="checkbox"/> 24 VDC supplies are equipped with dry contact failure alarms, wired as PLC inputs to signal failure of any DC power supply. Such alarm inputs to the PLC have been tested as being functional.</p> <p><input type="checkbox"/> Dedicated receptacle is wired to receive a dedicated AC supply.</p> <p><input type="checkbox"/> Verify continuity for all DC commons, ground and AC neutrals.</p> <p><input type="checkbox"/> Verify that the CP temporary input power is connected correctly and is the correct voltage.</p> <p><input type="checkbox"/> Close the CP main circuit breaker(s).</p> <p><input type="checkbox"/> Verify that voltages at subsequent circuit breakers are correct.</p> <p><input type="checkbox"/> Close circuit breakers.</p> <p><input type="checkbox"/> Verify that power feeding interruptible and uninterruptible power supplies is correct.</p> <p><input type="checkbox"/> Turn on power supplies if they are not already on.</p> <p><input type="checkbox"/> Verify that voltages at distribution terminals are correct.</p> <p><input type="checkbox"/> Energize any remaining hardware such as the PLC.</p> <p><b>B. Uninterruptible Power Supply (UPS)</b></p> <p><input type="checkbox"/> Mounted appropriately within the cabinet, on a dedicated shelf, or rear of a swing-out sub panel.</p> <p><input type="checkbox"/> Is equipped with maintenance bypass switch (or at least plug/receptacle means for bypassing the unit).</p> <p><input type="checkbox"/> Test all UPS alarms (on inverter, failure, battery failure etc.)</p> <p><input type="checkbox"/> Turn off the AC power supply and verify that the UPS will be switched on to supply the designated vital loads in the control panel.</p> <p><b>3. CONTROLS &amp; AUXILIARY DEVICES TEST</b></p> <p><input type="checkbox"/> Verify all interposing and auxiliary relays are functioning.</p> <p><input type="checkbox"/> Verify panel lights are functioning.</p> <p><b>Ventilation and Heating</b></p> <p><input type="checkbox"/> If ventilation fans are fitted, check the fans operate correctly any associated air filters are clean and not blocked.</p> <p><input type="checkbox"/> Verify components are installed in the correct orientation for proper air flow.</p> <p><b>4. HARDWIRED INTERLOCK AND SAFETY TEST</b></p> <p><input type="checkbox"/> Verify that hardwired interlocks through the control panel as shown on schematic drawings are functioning. For example, outlet high pressure switch interlock to a pump.</p> <p><input type="checkbox"/> Verify that all hardwired safety devices through the control panel is functioning. For example, the pull cord emergency stops of conveyors.</p>												
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	<b>FACTORY ACCEPTANCE TEST - CONTROL PANELS</b>	
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**5. PLC TEST**

**A. Components**

- ☐ PLC interior High Temperature alarm is installed, wired to the PLC, and is shown to be functional.
- ☐ Relays have transient suppression across their coils. This is particularly important for DC coil relays, where diodes in reverse polarity are often used.
- ☐ TVSS is installed across the main incoming 120 VAC.

**PLC and PLC Rack**

- ☐ Verify all cards are securely seated.
- ☐ Ensure clearance around PLC rack has been met, such that convective heat transfer is not impeded by devices erroneously mounted in the "no encroachment" area. Confirm with manufacturer clearance recommendations.

**B. PLC I/O Test**

- ☐ Furnish **I/O test forms** and test all the listed input and output points as follows:
  - ☐ Discrete Inputs: Simulate a field contact closure by "shorting" across the appropriate terminal blocks. Observe the transition between a logical "0" and "1" in the PLC software.
  - ☐ Discrete Outputs: Force the output bit to toggle between logical "0" and logical "1" using the PLC software. Measure contact resistance at the wired terminal blocks using a digital meter selected for the "ohms" setting.
  - ☐ Analog Inputs: Connect a signal generator to the appropriate terminal blocks. Tailor the connection depending on whether a 2-wire or 4-wire simulation is required. Modulate the 4-20mA signal. Observe the associated PLC internal memory register to transition between 0-65535 or if scaled in engineering units, between 0 and the maximum scaled engineering unit. The latter method is preferred.
  - ☐ Analog Outputs: Force the output register to a value between 0-65535 or 0-100%, if the scaling block can be manipulated. Observe the measured 4-20mA value increment and decrement using a digital ammeter.

**C. Redundant Controllers (where required) Test**

- ☐ Remove Communication cable from primary PLC to verify switching to backup PLC
- ☐ Remove Communication cable from backup PLC to verify switching back to primary PLC
- ☐ Remove Power cable from primary PLC to verify switching to backup PLC
- ☐ Remove Power cable from backup PLC to verify switching back to primary PLC

**D. PLC Control Logic Verification**

- ☐ The PLC control strategy is verified by following the Control Logic Verification Form based on the specifications. Each control strategy will be verified by simulating the process and checking the state or value of PLC outputs. The results of equipment status and alarms and process instrument values and trends shall also be verified on the Plant SCADA graphic screens stored in a temporary SCADA computer. Since all PLC input and output wiring has been verified and some field devices are not available during Factory Acceptance Testing, certain inputs will be simulated either by means of additional hardware and/or software as described below.
  - ☐
  - ☐
  - ☐ DI states are either simulated by hardwired switches or forced inputs using a programming terminal.
  - ☐ For example, when starters and drives are not provided as part of the contract, jumpers may be installed from the output call relays to the running confirmation inputs to simulate the running state of the motors.

  

PROJECT NAME: _____	TEST DATE: _____
FACILITY NAME: _____	TESTED BY: _____
PROCESS AREA: _____	COMPANY: _____
NETWORK ID: _____	PAGE: _____
WITNESSED BY: _____	SIGNATURE: _____

	<b>FACTORY ACCEPTANCE TEST - CONTROL PANELS</b>											
<p><b>5. PLC TEST (continued)</b></p> <p><b>D. PLC Control Logic Verification (continued)</b></p> <p><b>Typical Fault Logic</b></p> <p><input type="checkbox"/> If the fault input is high and the disable (if applicable) for the fault is not high and the common disable (if applicable) is not high begin timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output. If the fault alarm is a shutdown alarm stop the associated motor and latch the alarm so that it remains present even if the condition clears.</p> <p><input type="checkbox"/> The fault condition must return to normal and the alarm must be reset for a latched alarm to clear.</p> <p><b>Typical Fail to Start Logic</b></p> <p><input type="checkbox"/> If the motor is called to run (call output high) and no running feedback is received (running input is low) and the fail to start and common alarm disables (if applicable) are not high start timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output, stop calling the motor and latch the alarm.</p> <p><b>6. HMI OR OIT TEST</b></p> <p><b>HMI / OIT Functionality</b></p> <p><input type="checkbox"/> Communication with PLC</p> <p><input type="checkbox"/> Screen Layouts</p> <p><input type="checkbox"/> Screen Navigation</p> <p><input type="checkbox"/> Set Point Entry</p> <p><input type="checkbox"/> Animation</p> <p><input type="checkbox"/> Color Correctness (Green=Run, Red=Off, Amber=Alarm, or the agreed upon convention)</p> <p><input type="checkbox"/> Alarms</p> <p><input type="checkbox"/> Acknowledge and Reset</p> <p><input type="checkbox"/> Security / Access Levels / Passwords</p> <p><b>7. NETWORK COMMUNICATION TEST</b></p> <p><b>A. Network Components</b></p> <p><input type="checkbox"/> Fiber optic cabling terminates in a patch panel</p> <p><input type="checkbox"/> Media converters are installed and functional</p> <p><input type="checkbox"/> Terminating resistors have been installed for trunk/tap topologies or where required</p> <p><input type="checkbox"/> Wire and cable bending limitations have not been violated</p> <p><b>B. Networking Functions</b></p> <p><input type="checkbox"/> Verify data transfer via the network to different PLCs as shown on the Network Block Diagrams</p> <p><input type="checkbox"/> Verify network traffic rate and error margin is acceptable</p>												
<table style="width: 100%; border: none;"> <tr> <td style="width: 60%;">PROJECT NAME: _____</td> <td style="width: 40%;">TEST DATE: _____</td> </tr> <tr> <td>FACILITY NAME: _____</td> <td>TESTED BY: _____</td> </tr> <tr> <td>PROCESS AREA: _____</td> <td>COMPANY: _____</td> </tr> <tr> <td>NETWORK ID: _____</td> <td>PAGE: _____</td> </tr> <tr> <td>WITNESSED BY: _____</td> <td>SIGNATURE: _____</td> </tr> </table>			PROJECT NAME: _____	TEST DATE: _____	FACILITY NAME: _____	TESTED BY: _____	PROCESS AREA: _____	COMPANY: _____	NETWORK ID: _____	PAGE: _____	WITNESSED BY: _____	SIGNATURE: _____
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	<b>FACTORY ACCEPTANCE TEST - CONTROL PANELS</b>	
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## 8. FAT DOCUMENTATION AND RECORD

### Panel Documentation

- ☐ As-built panel drawings showing actual panel construction and devices arrangement and c/w Bill of Material.
- ☐ Panel schematic and interconnection drawings.
- ☐ P&ID drawings and schematic drawings for the process area controlled by the panel that is to be tested.
- ☐ I/O list test forms of the process area to be tested.
- ☐ FAT procedure of the process area to be tested.
- ☐ Test record forms of the process area to be tested. Forms shall include area for signature of responsible test personnel.
- ☐ Hard copy of the PLC application program of the process area to be tested.
- ☐ Hard copy of the HMI/OIT graphic screens of the process area to be tested.

## 9. FAT TOOLS AND SOFTWARE

- ☐ Simulation software if required
- ☐ Digital volt meter Fluke 87
- ☐ Process meter Fluke 787
- ☐ Laptop computer with PLC application program
- ☐ Temporary SCADA computer with HMI software and applicable graphic screens
- ☐ Jumper wires

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