

# **INVITATION FOR BIDS**



**FOR CONSTRUCTING**

## **SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION**

**CITY CONTRACT NUMBER  
C02201**

**FEMA Public Assistance DR-4344**

**FEMA Public Assistance Project  
Nos: 38691 and 38692**

**ISSUED BY  
CAPITAL PROJECTS ENGINEERING DIVISION  
CITY OF SANTA ROSA, CALIFORNIA**

**2020**

ATTENTION  
Prebid Conference  
See Page 1



STATE OF CALIFORNIA

INVITATION FOR BIDS

CONTAINING:

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SPECIAL PROVISIONS

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CONTRACT

FOR

**SKYFARM 'A' AND HANSFORD COURT LIFT STATION  
RECONSTRUCTION**

City Contract No. **C02201**

**FEMA Public Assistance DR-4344**

**FEMA Public Assistance Project  
Nos: 38691 and 38692**

# SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION

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CITY OF SANTA ROSA  
STATE OF CALIFORNIA

**NOTICE TO BIDDERS**

|   |                                                                                                                                                                                         |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ➤ | For technical questions regarding this project, contact Mark Kasraie at (707) 543-3857.                                                                                                 |
| ➤ | For direct access to plans, specifications and plan holders' lists, go to <a href="http://www.srcity.org/bids">www.srcity.org/bids</a> and click on <u>Bid/Proposal Opportunities</u> . |
| ➤ | For direct access to bid results, go to <a href="http://www.srcity.org/bids">www.srcity.org/bids</a> . Under Link to Capital Projects, click on <u>Capital Projects Contracts</u> .     |

**- IMPORTANT -**  
**REVISED BIDDING PROCEDURES DURING SHELTER IN PLACE ORDER**

Pursuant to Order No. C19-09, the Sonoma County Public Health Officer has extended the Shelter in Place Order, which will continue until it is extended, rescinded, superseded, or amended in writing by the Health Officer or the State Health Officer. City facilities are currently closed to the public and construction meetings will be held by teleconference calls.

All bids shall be submitted and opened according to the following procedure:

**Bid Acceptance Deadline**

Sealed bids will be accepted at the Transportation and Public Works Department, 69 Stony Circle, Santa Rosa, California 95401 until 2:00 p.m., June 15, 2020, for Skyfarm 'A' and Hansford Court Lift Station Reconstruction, Contract No. C02201 (Engineer's Estimate: \$3,795,000).

**Bids tendered after this deadline will not be accepted.** The official time clock for accepting bids will be an electric date and time stamping clock, located in the Transportation and Public Works Department, 69 Stony Circle, Santa Rosa, California. In order to be accepted, bids must be received prior to 2:00 p.m. Therefore, a bid stamped in at 1:59 p.m. will be accepted, but one delivered at or after 2:00 p.m. is late and will not be accepted.

- A. If you choose to mail your Bid Proposal via any of the overnight/express services, such as FedEx, UPS and USPS, the delivery **MUST** be a timed delivery. The delivery service **MUST** deliver the bid prior to the deadline time posted above. The outside envelope **MUST** be clearly marked as follows: [SEALED BID FOR: C02201 Skyfarm 'A' and Hansford Court Lift Station Reconstruction].
- B. If you choose to deliver your Bid Proposal in person, the TIME TO DELIVER BIDS is within the one hour WINDOW FOR DELIVERY prior to deadline posted above. No bids will be accepted outside of this time window.

**Bid Opening Teleconference Call**

Prospective bidders, subcontractors, and materials suppliers are invited to attend the Bid opening teleconference call scheduled to be held at 2:00 p.m., June 15, 2020. The teleconference can be accessed by dialing 1 (707) 543-4700, participant code 7944725#.

### **Pre-Bid Meeting Teleconference Call**

Prospective bidders, subcontractors, and materials suppliers are invited to attend a pre-bid meeting teleconference call scheduled to be held at 10:00 a.m., June 1, 2020. The teleconference can be accessed by dialing 1 (707) 543-4700, participant code 1517301#.

### **Project Description/Scope of Work**

Two lift stations were severely damaged during the Tubbs Fire. One is located on Skyfarm Drive near Saint Andrews Drive and the other is located at the end of Hansford Court. They both must be reconstructed.

### **Subcontractor Information; Department of Industrial Relations Registration**

Bidders shall provide the names, business addresses and license numbers of all subcontractors listed on bidder's List of Subcontractors. No contractor or subcontractor may be listed on a bid for this public works project unless registered with the Department of Industrial Relations (DIR) pursuant to Labor Code section 1725.5. No contractor or subcontractor may be awarded a contract for this public works project unless registered with the DIR pursuant to Labor Code section 1725.5. This public works project is subject to compliance monitoring and enforcement by the DIR.

### **Federal Requirements**

The work to be performed under this Contract will be funded by the Federal Emergency Management Agency (FEMA). Contractor will be required to comply with all Federal Requirements set forth in the Special Provisions. Notwithstanding Section 5-1.02 of the Special Provisions, in the event of a conflict between any Federal Requirement and any other provision in the Contract Documents (as defined below), the more stringent provision shall control and prevail.

### **Contract Award**

This Contract will be awarded to the lowest responsible and responsive contractor possessing the ability to successfully perform under the terms and conditions of the proposed contract, considering such matters as contractor integrity, compliance with public policy, record of past performance and financial and technical resources.

Firms or individuals that develop or draft specifications, requirements, statements of work, or invitations for bids or requests for proposals or quotes may not compete in this procurement.

Contract #: **C02201**

Project Title: **SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION**

| Line # | Description                                        | Units | Quantity |
|--------|----------------------------------------------------|-------|----------|
| 1      | MOBILIZATION AND DEMOBILIZATION                    | LS    | 1        |
| 2      | ALL OTHER WORK INCLUDING SHORING AND BRACING       | LS    | 1        |
| 3      | SKYFARM A LIFT STATION, BUILDING AND APPURTENANCES | LS    | 1        |
| 4      | HANSFORD CT LIFT STATION AND APPURTENANCES         | LS    | 1        |
| 5      | SKYFARM A GENERATOR                                | LS    | 1        |
| 6      | HANSFORD CT GENERATOR                              | LS    | 1        |



The foregoing quantities are approximate only, being given as a basis for the comparison of bids, and the City of Santa Rosa does not expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work, as may be deemed necessary or expedient by the Engineer.

Bids shall be made in accordance with the prevailing hourly rate of per diem wages for this locality and project as determined by the Director of the DIR pursuant to Labor Code sections 1770 *et seq.*

Contractor shall be responsible for compliance with the Immigration Reform Control Act of 1986.

If the project requires the employment of workers in any apprenticeable craft or trade, once awarded, Contractor and subcontractors must apply to the Joint Apprenticeship Council unless already covered by local apprentice standards (see Labor Code section 1777.5).

All bids are to be compared on the basis of the Engineer's estimate of the quantities of work to be performed. No bid will be awarded to a contractor who is not licensed in accordance with the provisions of Chapter 9 of Division 3 of the Business and Professions Code. Contractor must hold a Class A license for this project.

Project plans, bid and contract forms for C02201 Skyfarm 'A' and Hansford Court Lift Station Reconstruction may be obtained through PlanetBids at [www.srcity.org/bids](http://www.srcity.org/bids). These documents can no longer be obtained at the Transportation and Public Works Department.

No bid will be accepted unless it is made on the contract bid forms furnished by the Transportation and Public Works Department through PlanetBids. The original of the completed bid forms bearing original signatures must be submitted. A bid will not be accepted unless the bidder registers as a vendor through PlanetBids at [www.srcity.org/bids](http://www.srcity.org/bids), downloads documents/attachments, and is added to the prospective bidders list for this project. If there is an addendum, bidders must log into PlanetBids and acknowledge the addendum to be eligible for bidding.

The successful bidder will be required to hold a current City of Santa Rosa business tax certificate issued pursuant to Chapter 6.04 of the Santa Rosa City Code before commencing work on this project. For information regarding the business tax, contact Revenue and Collections at (707) 543-3170.

For any moneys earned by Contractor and withheld by the City of Santa Rosa to ensure the performance of the Contract, Contractor may, at its request and expense, substitute securities equivalent to the amount withheld in the form and manner and subject to the conditions provided in Section 22300 of the California Public Contract Code.

The City of Santa Rosa reserves the right to reject any or all bids and the right to waive minor irregularities or informalities in any bid or bond.



MARK KASRAIE, PE  
Supervising Engineer

Date: May 13, 2020

# **SPECIAL PROVISIONS**

## **General Specifications**

### **CITY OF SANTA ROSA, CALIFORNIA**

#### **SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION**

##### **1 GENERAL**

The work described herein shall be done in accordance with the "Contract Documents," which are the:

1. Special Provisions
2. Project Plans, consisting of 63 sheets entitled Skyfarm 'A' and Hansford Court Lift Station Reconstruction, 2019-0024
3. City of Santa Rosa Design and Construction Standards (City Standards)
4. City of Santa Rosa Construction Specifications for Public improvements (City Specifications)
5. State of California Department of Transportation Standard Specifications 2015 and Revised Standard Specifications 2015 (collectively, Standard Specifications), and
6. State of California Department of Transportation Standard Plans 2015 and Revised Standard Plans 2015 (collectively, Standard Plans).

In the event of a conflict in any of these documents, the order of precedence shall be determined by Section 5-1.02 of these Special Provisions.

Whenever the Standard Specifications use the terms State of California, Department of Transportation, Director, Engineer, or Laboratory, the following terms shall be substituted therefor, and any reference to any of the foregoing terms shall be understood and interpreted to mean and refer to such substituted terms as follows:

For State of California - the City of Santa Rosa;

For Department - the City of Santa Rosa Department of Transportation and Public Works or the City of Santa Rosa Water Department;

For Director - the City Engineer of the City of Santa Rosa;

For Engineer - the City Engineer of the City of Santa Rosa or the City Engineer's authorized agents;

For Laboratory – Materials Engineering of the City of Santa Rosa Transportation and Public Works Department, or such other laboratory as may be authorized by the City.

Unless otherwise provided, whenever in these Special Provisions attention is directed to specific provisions in the Standard Specifications, such direction shall not be interpreted as excluding other applicable provisions of the Standard Specifications.

Unless otherwise provided, when sections and subsections of the Standard Specifications are used in these Special Provisions, such use is not exclusive and shall not be interpreted as excluding other applicable provisions of said sections and subsections but is only intended to add to or modify such sections or subsections.

Unless otherwise provided, full compensation for compliance with these Special Provisions is included in the contract price and no additional allowance will be made to Contractor therefor.

The Standard Specifications are hereby modified to delete any reference or incorporation of provisions providing for or requiring arbitration of claims and disputes arising under this Contract.

## 2 BIDDING

**2-1.03 Registration with DIR:** No contractor or subcontractor may be listed on a bid for this public works project unless registered with the Department of Industrial Relations (DIR) pursuant to Labor Code section 1725.5. No contractor or subcontractor may be awarded a contract for this public works project unless registered with the DIR pursuant to Labor Code section 1725.5. This public works project is subject to compliance monitoring and enforcement by the DIR.

**2-1.06 Bid Documents:** Prospective bidders will be furnished with an Invitation for Bids which will state the location and description of the contemplated public works project and will show the approximate estimate of the various quantities and kinds of work to be performed and materials to be furnished with a schedule of items for which unit prices are requested.

**2-1.07 Examination of Project Plans, Specifications, City Standards, Invitation for Bids and Work Site:** Prior to submitting a bid, the bidder shall carefully examine the Invitation for Bids, City Standards and the proposed work site. If any person contemplating submitting a bid for this public works project is in doubt as to the meaning of any part of the Contract Documents, or finds discrepancies in or omissions from the Contract Documents, he or she may submit a written request for interpretation or correction to the Engineer. The written request must be received by the Engineer a minimum of 48 hours prior to bid opening. Any interpretation or correction of the Contract Documents prior to bid opening will be made only by written addendum issued by the City. Notification of addenda will be made through PlanetBids. The listed primary contact will receive an e-mail generated by PlanetBids informing them of a recently uploaded addendum. The City will not be bound by any other explanations or interpretations of the Contract Documents.

**2-1.08 Approximate Estimate:** The quantities given in the Contract Documents are approximate only, being given as a basis for the comparison of bids, and the City does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or part of the work or to omit parts of the work, as may be deemed necessary or advisable by the Engineer.

**2-1.10 Subcontractors:** The Subletting and Subcontracting Fair Practices Act, Public Contract Code sections 4100-4113, inclusive (the "Act") shall apply to all subcontracts in excess of one-half of one percent of the total amount of a bid. The Act requires subcontractors, if used for such work, to be listed in the contractor's bid and prohibits the substitution of subcontractors, except as authorized by the Act. Each bidder shall, with respect to the work of any subcontractor in excess of one-half of one percent of the total amount of the bid, include as part of the bid on the bid form provided:

1. The name, business address and DIR registration number of each subcontractor who will perform work or labor or render services to the Contractor in or about the construction of the work or improvement, or a subcontractor licensed by the State of California who, under subcontract to the Contractor, specially fabricates and installs a portion of the work or improvement according to detailed drawings contained in the Project Plans or other Contract Documents in an amount in excess of one-half of one percent of the Contractor's total bid; and
2. The portion of the work that will be done by each subcontractor. Only one subcontractor shall be listed for each portion.

The purchase of sand, gravel, crushed rock, batched concrete, aggregate, ready-mixed concrete, and/or any other materials produced and furnished by established and recognized commercial plants, together with the delivery of such materials to the work site by the source of the materials or by recognized commercial hauling companies, is not considered as subcontracting under this section.

**2-1.33 Bid Document Completion:** Any references to Opt Out of Payment Adjustments for Price Index Fluctuations in the Standard Specifications are deleted in their entirety.

**2-1.33A Bid Forms:** All bids shall be made on bid forms obtained from PlanetBids at [www.srcity.org/bids](http://www.srcity.org/bids). The bidder shall submit its bid on the original bid forms furnished by the City. Bids submitted on forms other than the forms furnished to the bidder by the City will not be considered.

The bid forms to be submitted at the time of and with the bid are:

1. Unit Price Schedule
2. List of Subcontractors
3. List of Previous Similar Jobs
4. Noncollusion Declaration
5. Bid Bond Affidavit and Bidder's Signature Page
6. Bid Guaranty (Bid Bond or alternate security)
7. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion
8. Certification Regarding Lobbying

All bids shall give the proposed prices and must bear the original signature of the bidder. Bidders shall fill in all blanks on the bid forms where required. A bid will not be accepted unless the bidder registers as a vendor through PlanetBids at [www.srcity.org/bids](http://www.srcity.org/bids) downloads documents/attachments, and is added to the prospective bidders list for this project. If there is an addendum, bidders must log into PlanetBids and acknowledge the addendum to be eligible for bidding.

**2-1.33E Rejection of Bids Containing Alterations, Erasures or Irregularities:** Bids may be rejected if they show any alterations of forms, additions not called for, conditional bids, incomplete bids, erasures or irregularities of any kind.

**2-1.34 Bidders' Security:** All bids shall be presented under sealed cover and shall be accompanied by cash, cashier's or certified check, or by a bidder's bond made payable to the City of Santa Rosa and executed as surety by a corporate surety authorized and admitted to transact a surety business in the State of California in an amount equal to ten percent of the amount of the bid. No bid shall be considered unless such cash, cashiers or certified check, or bidder's bond is enclosed with the bid. Any bidder's bond shall contain provisions for forfeiture consistent with California Public Contract Code section 20172.

**2-1.40 Withdrawal of Bid:** A bid may be withdrawn prior to, but not after, the hour fixed in the public notice for the opening of bids, provided that a written request to withdraw the bid, executed by the bidder or the bidder's authorized representative, is filed with the Engineer before this deadline. The withdrawal of a bid shall not prejudice the right of a bidder to submit a new bid.

**2-1.43 Public Opening of Bids:** Bids will be opened and read publicly at the time and place indicated in the Notice to Bidders. Bidders or their authorized agents are invited to be present.

**2-1.46 Department's Decision on Bid:** Serial bids from the same bidder will not be accepted. This section shall not be interpreted to mean that the same contractor may not be the contractor in one bid and listed as a subcontractor in another bid, provided that no collusion exists.

**2-1.48 Competency of Bidders:** No bid will be accepted from or contract awarded to a contractor that is not licensed in accordance with the law, that does not hold a license qualifying it to perform work under this contract, to whom a bid form has not been issued by the Engineer, or that has not successfully completed projects of similar character, scope and cost to the proposed project. Bidders will be required to provide a list of previous similar jobs with their bids.

### 3 CONTRACT AWARD AND EXECUTION

**3-1.04 Contract Award:** The City reserves the right to reject any or all bids. Bids are required for the entire work described herein. All bids will be compared with the Engineer's estimate of the quantities of work to be completed. Contract award, if any, will be made to the lowest responsible and responsive bidder within thirty days from the date bids are opened.

**3-1.05 Contract Bonds:** Within ten days after receipt of the Notice of Award, the successful bidder shall provide the following bonds to the City:

- a. Performance Bond: A performance bond to guarantee the faithful performance of the terms and conditions of the Contract by Contractor, which shall be executed in a sum of not less than 100% of the Contract price;
- b. Labor and Materials Bond: A labor and materials bond (payment bond) in accordance with Part 6 of Division 4, sections 8000 *et seq.* of the California Civil Code, to guarantee against any and all claims of subcontractors or other third parties furnishing labor, materials, or supplies for the Contract, which shall be executed in a sum of 100% of the Contract price; and
- c. Material Guaranty Bond: A material guaranty bond (warranty bond) to serve as surety for the guarantee requirements outlined in Section 6-3.01B, which shall be executed in a sum of not less than 50% of the Contract price.

The bond(s) shall be provided in a form acceptable to the City and issued by a corporate surety in good financial standing and authorized and admitted to transact a surety business in the state of California for the purposes and in the amount(s) stated above.

Whenever the financial or legal status of any surety on any such bond(s) is/are unacceptable to the City, it may make a demand to Contractor for further bond(s) or additional surety, not exceeding the sums originally required. Thereafter, no payment shall be made upon the Contract to Contractor or any assignees of Contractor until such bond(s) or additional surety has/have been provided to the City.

**3-1.06 Contractor License:** Contractor must be properly licensed as a contractor from Contract award through Contract acceptance (Pub Cont. Code § 10164).

**3-1.07 Indemnification and Insurance:** Indemnification: Contractor shall defend, hold harmless and indemnify City, its officers, agents and employees, and each and every one of them, from and against any and all actions, damages, costs, liabilities, claims, demands, losses, judgments, penalties, costs and expenses of every type and description, including, but not limited to, any fees and/or costs reasonably incurred by City's staff attorneys or outside attorneys and any fees and expenses incurred in enforcing this provision (hereafter collectively referred to as "Liabilities"), including but not limited to Liabilities arising from personal injury or death; damage to personal, real or intellectual property or the environment; contractual or other economic damages, or regulatory penalties, arising out of or in any way connected with the performance of or the failure to perform the Contract by Contractor, any subcontractor or agent, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, whether or not such Liabilities are caused in part by a party indemnified hereunder, or such Liabilities are litigated, settled or reduced to judgment; provided, that the foregoing indemnity does not apply to liability for any damage or expense for death or bodily injury to persons or damage to property to the extent arising from (i) the sole negligence, or willful misconduct of, or defects in design furnished by City, its agents, servants, or independent contractors who are directly responsible to City (excluding Contractor), or (ii) the active negligence of City.

The existence of any of the insurance policies or coverages described in this Contract shall not affect or limit any of City's rights hereunder, nor shall the limits of such insurance limit Contractor's liability to the City hereunder. The provisions of this section shall survive any expiration or termination of the Contract.

**Insurance:** Contractor shall maintain in full force and effect all of the insurance coverage described in and in accordance with the insurance requirements set forth below. Maintenance of such insurance coverage during the entire performance of the Contract is a material element of the Contract. Failure by Contractor to (i) maintain or renew coverage, (ii) provide notice of any changes, modifications, or reductions in coverage, or (iii) provide evidence of renewal, if necessary, may be deemed a material breach of the Contract by Contractor, whereas the City shall be entitled to all rights and remedies at law or in equity. Notwithstanding the foregoing, any failure by Contractor to maintain required insurance coverage shall not excuse or alleviate Contractor from any of its other duties or obligations under the Contract. In the event Contractor retains or utilizes any subcontractors or sub-consultants in performance of the work, Contractor shall assure that any such subcontractor has first obtained, and shall maintain, all of the insurance coverage requirements herein set forth below.

### **Insurance Requirements:**

**A. Insurance Policies:** Contractor shall maintain and keep in full force and effect, the following policies of insurance with minimum coverage as indicated below and issued by insurers with an AM Best rating of no less than A-VI or a rating otherwise acceptable to the City.

| Insurance                                         | Minimum Coverage Limits                             | Additional Coverage Requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Commercial general liability                   | \$5 million per occurrence<br>\$5 million aggregate | Coverage must be at least as broad as ISO CG 00 01 and must include products liability and completed operations coverage which shall continue for a period of three years after acceptance of the work by the City. If insurance applies separately to a project/location, aggregate may be equal to per occurrence amount. Coverage may be met by a combination of primary and umbrella or excess insurance, but umbrella and excess shall provide coverage at least as broad as specified for underlying coverage. Completed Operations Coverage can be provided in the form of an endorsement to Contractor's insurance (at least as broad as ISO Form CG 20 37 04 13. See endorsements below for other Additional Insured Requirements. Coverage shall not exclude subsidence. |
| 2. Business auto coverage                         | \$3 million                                         | Coverage at least as broad as ISO Form Number CA 00 01 covering any auto (Code 1). Insurance shall cover owned, non-owned and hired autos.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 3. Workers' compensation and Employer's Liability | \$1 million                                         | As required by the State of California, with Statutory Limits and Employer's Liability Insurance with limit of no less than \$1 million per accident for bodily injury or disease. The Workers' Compensation policy shall be endorsed with a waiver of subrogation in favor of the City for all work performed by Contractor, its employees, agents and subcontractors.                                                                                                                                                                                                                                                                                                                                                                                                            |

- |    |                                                                                                   |                                                                      |                                                                                                                                                                                                                                                                                                                                                                                 |
|----|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4. | Contractor's pollution legal liability and/or asbestos legal liability and/or errors and omission | \$1 million per occurrence or claim<br>\$2 million aggregate         | If the work involves lead-based paint or asbestos identification/remediation, the pollution liability policy must not contain lead-based paint or asbestos exclusions. If the work involves mold identification, the pollution liability policy must not contain a mold exclusion and a definition of "Pollution" in said policy shall include microbial matter including mold. |
| 5. | Course of construction/builders' risk                                                             | Amount of completed value of project without co-insurance provisions | Required for construction projects over \$3 million. The City shall be named as loss payee.                                                                                                                                                                                                                                                                                     |

**B. Endorsements:**

1. All policies shall provide or be endorsed to provide that coverage shall not be canceled by either party, except after prior written notice has been provided to the City in accordance with the policy provisions.
2. Liability policies shall provide or be endorsed to provide the following:
  - a. For any claims related to this Contract, Contractor's insurance coverage shall be primary and any insurance or self-insurance maintained by City shall be in excess of Contractor's insurance and shall not contribute with it. Endorsements at least as broad as 20 01 04 13 or evidence of policy language will be required in non- ISO CGL policies.
  - b. **The City of Santa Rosa, its officers, agents and employees are to be covered as additional insureds on the CGL policy.** Additional Insured Endorsements at least as broad as 20 10 04 13 or 20 38 04 13 are required.

**C. Verification of Coverage and Certificates of Insurance:** Contractor shall furnish City with original certificates and endorsements effecting coverage required above. Certificates and endorsements shall make reference to policy numbers. All certificates and endorsements are to be received and approved by the City before work commences and must be in effect for the duration of the Contract. The City reserves the right to require complete copies of all required policies and endorsements during the duration of the Contract and for a period of three years following City's acceptance of the work.

**D. Other Insurance Provisions:**

1. No policy required by this Contract shall prohibit Contractor from waiving any right of recovery prior to loss. Contractor hereby waives such right with regard to the indemnitees.
2. All insurance coverage amounts provided by Contractor and available or applicable to this Contract are intended to apply to the full extent of the policies. Nothing contained in this Contract limits the application of such insurance coverage. Coverage for an additional insured shall NOT be limited to the insured's vicarious liability. Defense costs must be paid in addition to coverage amounts.
3. Self-insured retentions above \$10,000 must be approved by the City. At the City's option, Contractor may be required to provide financial guarantees.
4. City reserves the right to modify these insurance requirements, including limits, based on the nature of the risk, prior experience, insurer, coverage, or other special circumstances.

**3-1.18 Contract Execution:** The fully executed Contract, original bonds and insurance certificates and endorsements required under the Contract shall be delivered to the City within ten calendar days of Contractor's receipt of the Notice of Award.

The Engineer will supply Contractor with up to ten sets of the Invitation for Bids and Project Plans. At least one complete set of the Invitation for Bids and Project Plans shall be kept at the construction site in good condition and made available to the Engineer at all times. Additional copies of the Invitation for Bids and Project Plans will be provided by the Engineer at Contractor's cost.

**3-1.19 Bidders' Securities:** Within ten days after the opening of bids, the City will return the bid guarantees to all bidders except the three lowest responsible bidders. The bid guarantees of the three lowest responsible bidders will be retained until the Contract has been fully executed. In the event all bids are rejected, all bid guarantees will be returned to the respective bidders.

**3-1.20 Failure to Execute Contract:** Contractor's failure to deliver to the City the fully executed Contract within ten calendar days of Contractor's receipt of the Notice of Award shall be cause for the cancellation of the award and the forfeiture of the bid guaranty to the City. If the successful bidder refuses or fails to execute the Contract, the City may award the Contract to the second lowest responsible bidder. If the second lowest responsible bidder refuses or fails to execute the Contract, the City may award the Contract to the third lowest responsible bidder. The refusal or failure by the second or third lowest responsible bidder to deliver to the City the fully executed Contract within ten calendar days of receipt of the Notice of Award to the respective bidder shall likewise be cause for the cancellation of the award and the forfeiture of the bid guaranty of the respective bidder. In its discretion, the City may then re-advertise the project or construct it by day labor.

**3-1.22 Subcontractors:** The successful bidder shall furnish a list of all subcontractors as required under Sections 2-1.10. The list shall include the name, business address, DIR registration number and the state contractor's license number of each subcontractor on the list and the names of the responsible managing employees whose names appear on the subcontractors' licenses.



## 4 SCOPE OF WORK

**4-1.05 Changes and Extra Work:** All changes to the Contract shall be made by written change order only.

All extra work shall be recorded by Contractor on a daily report signed by both the City and Contractor. The “daily reports” shall thereafter be considered the true record of extra work performed. A copy of the daily reports will be furnished to Contractor. Contractor is directed to Section 9-1.04 of this Invitation for Bids.

**4-1.05C Compensation for Altered Quantities:** Payment and compensation for altered quantities shall not conform to the provisions of Section 9-1.06 of the Standard Specifications, except as modified herein.

### **4-1.07 Value Engineering**

#### **4-1.07B Value Engineering Change Proposal (VECP):**

Contractor may submit a VECP to reduce any of the following:

1. Total cost of construction
2. Construction activity duration
3. Traffic congestion

Before preparing a VECP, meet with the Engineer to discuss:

1. Proposal concept
2. Permit issues
3. Impact on other projects
4. Project impacts, including traffic, schedule, and later stages
5. Peer reviews
6. Overall proposal merits
7. Review times required by the Department and other agencies

The VECP must not impair the project's essential functions or characteristics, including:

1. Service life
2. Operation economy
3. Maintenance ease
4. Desired appearance
5. Design and safety

The VECP must include:

1. Description of the Contract specifications and drawing details for performing the work and the proposed changes
2. Itemization of Contract specifications and plan details that would be changed
3. Detailed cost estimate for performing the work under the existing Contract and under the proposed change; Determine the estimates under section 9-1.04 of the Standard Specifications
4. Deadline for the Engineer to decide on the changes
5. Bid items affected and resulting quantity changes

The Department is not required to consider a VECP. If a VECP is similar to a change in the Project Plans or City Specifications being considered by the Department at the time the proposal is submitted or if the proposal is based on or similar to plans or City Specifications adopted by the

Department before Contract award, the Department does not accept the VECP and may make these changes without VECP payments.

If the Department does not approve a Change Order before the deadline stated in the VECP or other date Contractor subsequently stated in writing, the VECP is rejected. The Department does not adjust time or payment for a rejected VECP.

The Department decides whether to accept a VECP and the estimated net construction-cost savings from adopting the VECP or parts of it.

The Department may require Contractor to accept a share of the investigation cost as a condition of reviewing a VECP. After written acceptance, the Department considers the VECP and deducts the agreed cost.

If the Department accepts the VECP or parts of it, the Department issues a Change Order that:

1. Incorporates changes in the Contract necessary to implement the VECP or the parts adopted
2. Includes the Department's acceptance conditions
3. States the estimated net construction-cost savings resulting from the VECP
4. Obligates the Department to pay Contractor 50 percent of the estimated net savings.

In determining the estimated net construction-cost savings, the Department excludes Contractor's VECP preparation cost and the Department's VECP investigation cost, including parts paid by Contractor. If a VECP providing for a reduction in working days is accepted by the Department, 50 percent of the reduction is deducted from the Contract time.

If a VECP providing for a reduction in traffic congestion or avoiding traffic congestion is accepted by the Department, the Department pays 60 percent of the estimated net savings in construction costs attributable to the VECP. Submit detailed traffic handling comparisons between the existing Contract and the proposed change, including estimates of the traffic volumes and congestion.

The Department may apply an accepted VECP for general use on other contracts.

If an accepted VECP is adopted for general use, the Department pays only the contractor who first submitted the VECP and only for the contracts awarded to that contractor before the submission of the accepted VECP.

If the Department does not adopt a general-use VECP, an identical or similar submitted proposal is eligible for acceptance.

## 5 CONTROL OF WORK

**5-1.02 Contract Documents:** In the event of a conflict in any of the Contract Documents, the order of precedence from highest to lowest shall be as follows:

1. Special Provisions
2. Project Plans, consisting of 63 sheets entitled Skyfarm 'A' and Hansford Court Lift Station Reconstruction, 2019-0024
3. City Standards
4. City Specifications
5. Standard Specifications
6. Standard Plans

provided, that in the event of a conflict between any Federal Requirement in Section 10 of these Special Provisions and any other provision in the Contract Documents, the more stringent provision shall control and prevail.

**5-1.05 Order of Work:** The work as shown on the Project Plans and as specified in the Invitation for Bids shall be constructed in a sequence that is satisfactory to and approved by the Engineer.

Contractor shall prepare a work schedule per Section 8-1.02 of the Standard Specifications.

With the exception of trenching, all existing street, street light base, curb and gutter, storm drain, water line, and sewer line work shall be completed before any existing street paving is removed.

Full compensation for the conformance to the requirements of this section is included in the Contract price and no additional allowance will be made to Contractor for this work.

**5-1.17 Character of Workers:** Attention is directed to Section 5-1.17 of the Standard Specifications which states:

"If a worker appears to the Engineer to be incompetent or acts disorderly or improperly, discharge the worker immediately upon request. Do not employ that worker again on the work."

No additional compensation shall be granted to Contractor in the event City exercises any part of its rights under this section and any and all costs related to such exercise shall be borne by Contractor.

**5-1.20 Cooperation with Other Entities:** Attention is directed to Section 5-1.20 of the Standard Specifications.

Other construction including but not limited to utility, power, and pipe line relocation, may be in progress by other forces within and adjacent to the project area at the same time work is being performed under this Contract by Contractor. Contractor shall coordinate and cooperate with the forces performing other work, to the end that such forces may conduct their operations with as little inconvenience and delay as possible.

Each contractor or other entity performing work at or near the job or material site is responsible to the other for damage to work, persons, or property and for costs due to unnecessary delays.

**5-1.20B(4)(a) Offsite Staging Areas and Construction Yards:** Attention is directed to Santa Rosa City Code section 20-52.040, Temporary Use Permit.

A Temporary Use Permit shall be obtained for any offsite construction yard on private property to be used for any of the following:

1. Stockpiling of equipment and/or materials;
2. Staging of construction;

3. Placement of work trailers or mobile offices;
4. Storage of trench spoils; or
5. Other construction related activities not specifically enumerated above.

**5-1.26 Construction Surveys:** Contractor shall carefully preserve all benchmarks, grade stakes, and all other survey markers. In the case of willful or careless destruction, Contractor shall bear the cost of replacing the markers.

**5-1.27A Examination and Audit:** Pursuant to California Government Code section 8546.7, any contract with the City involving expenditures in excess of \$10,000 shall be subject to the examination and audit of the California State Auditor for a period of three years after final payment is made to Contractor by City under this Contract. Any such examination and audit will be confined to those matters connected with the performance of this Contract.

**5-1.30A Inspection:** Contractor shall bear all costs associated with the re-inspection of any defective, rejected or unauthorized work as determined by the Engineer in Engineer's sole discretion. Such costs of re-inspection, including any costs incurred by the City for additional staff time or fees for third-party consultant inspectors, will be deducted from one or more progress payments hereunder.

**5-1.36D(a) Property and Facility Preservation:** Attention is directed to Section 5-1.36 of the Standard Specifications.

At Contractor's sole expense, all fences, gates, landscaping, drainage ditches, sidewalks, irrigation systems, storm drains and any other facilities that are damaged, removed or destroyed because of Contractor's operations, shall be replaced in accordance with City Standards at a minimum and restored to the same or better condition. Concrete surface treatment and score marks shall match adjacent existing concrete improvements.

**5-1.36E Obstructions:** Attention is directed to Section 5-1.36 of the Standard Specifications and to the possible existence of underground gas mains, high voltage lines, telephone ducts, storm drains and water and sewers systems, the locations of which are not shown on the Project Plans. The determination of the location of these facilities and the cost of repair or replacement in the event of damage to such facilities are the sole responsibility of Contractor.

Should Contractor alter any public utility or private improvements to facilitate its operations or for its sole benefit, which alteration would not be otherwise required, Contractor shall make whatever arrangements are necessary with the owner or controlling authorities and shall bear all expenses in connection therewith. Any damages to any public utility or private improvement caused by Contractor shall be repaired by Contractor at its sole expense and to the full satisfaction of the Engineer or the controlling authority.

Any subsurface information and data furnished under any part of this Contract are not intended as a representation or warranty but are furnished for information only. It is expressly understood that the City will not be responsible for the accuracy thereof or for any deduction, interpretation or conclusion drawn therefrom by Contractor. The information is made available so that Contractor may have ready access to the same information available to the City and is not part of this Contract.

PRIOR TO STARTING ANY EXCAVATION, CONTRACTOR SHALL (AT LEAST TWO WORKING DAYS IN ADVANCE) CALL UNDERGROUND SERVICE ALERT (USA) toll free at (800) 227-2600 and provide USA with all necessary data relative to the proposed excavation. USA will accept calls and process information to participating agencies who have underground facilities in the area between the hours of 7:30 a.m. and 5:00 p.m. daily, except Saturdays, Sundays, and holidays. Between the hours of 5:00 p.m. and 7:30 a.m., calls will be recorded and then processed after 7:30 a.m. For emergency situations, after hours, and on Saturdays, Sundays and holidays, Contractor shall contact the owner of the affected facility.

Contractor shall coordinate all work with the appropriate City field personnel. When City work forces are required at the job site to perform Contract items of work, Contractor shall give a minimum of two working days advanced notification to the appropriate field office:

|                  |                |
|------------------|----------------|
| Water Division:  | (707) 543-4200 |
| Sewer Division:  | (707) 543-4200 |
| Street Division: | (707) 543-3880 |
| Survey Division: | (707) 543-3834 |

**5-1.43 Potential Claims and Dispute Resolution:** "Claim" means a separate demand by Contractor sent by registered mail or certified mail with return receipt requested, for one or more of the following: (A) A time extension, including, without limitation, for relief from damages or penalties for delay assessed by the City under the Contract; (B) Payment by the City of money or damages arising from work done by, or on behalf of, Contractor pursuant to the Contract and payment for which is not otherwise expressly provided or to which the claimant is not otherwise entitled; or (C) Payment of an amount that is disputed by the City.

Upon receipt of a Claim, the City shall conduct a reasonable review of the Claim and, within a period not to exceed 45 days, shall provide Contractor a written statement identifying what portion of the Claim is disputed and what portion is undisputed, provided, the parties may extend the 45 day time period by mutual agreement.

If the City needs approval from the City Council to provide the claimant a written statement identifying the disputed portion and the undisputed portion of the Claim, and the Council does not meet within the 45 days or within the mutually agreed to extension of time following receipt of a Claim, the City shall have up to three days following the next duly publicly noticed meeting of the City Council after the 45-day period, or extension expires to provide Contractor a written statement identifying the disputed portion and the undisputed portion.

Any payment due on an undisputed portion of the Claim shall be processed and made within 60 days after the City issues its written statement. If the City fails to issue a written statement, the Claim shall be deemed rejected in its entirety.

If Contractor disputes the City's written response, or if the City fails to respond to a Claim within the time prescribed, Contractor may demand in writing an informal conference to meet and confer for settlement of the issues in dispute. Upon receipt of a demand in writing sent by registered mail or certified mail, return receipt requested, the City shall conduct a meet and confer conference within 30 days for settlement of the dispute. Within 10 business days following the conclusion of the meet and confer conference, if the Claim or any portion of the Claim remains in dispute, the City shall provide Contractor a written statement identifying the portion of the Claim that remains in dispute and the portion that is undisputed. Any payment due on an undisputed portion of the Claim shall be processed and made within 60 days after the City issues its written statement. Any disputed portion of the Claim, as identified by Contractor in writing, shall be submitted to nonbinding mediation, with the City and Contractor sharing the associated costs equally. The City and Contractor shall mutually agree to a mediator within 10 business days after the disputed portion of the Claim has been identified in writing. If the parties cannot agree upon a mediator, each party shall select a mediator and those mediators shall select a qualified neutral third party to mediate with regard to the disputed portion of the Claim. Each party shall bear the fees and costs charged by its respective mediator in connection with the selection of the neutral mediator.

## 6 CONTROL OF MATERIALS

**6-2.01G Source of Supply and Quality of Materials:** All materials required to complete the work under the Contract shall be furnished by Contractor and shall be free of hazardous substances.

**6-2.01H General:** Statistical means will not be used by the City for determination of Standard Specification compliance. Whenever both operating range test results and Contract compliance requirements are specified in these special provisions, the operating range requirements shall apply to the individual test results.

**6-2.01I Material Submittals:** Upon award of the Contract by City, Contractor shall submit to the Engineer a list of all materials proposed to be used on this project and any supporting documentation and/or samples required and source of supply.

For material listed on the "Engineer's List of Approved Items" which is located in the Sewer and Water sections only of the City Standards, the Engineer shall be provided with the name of the manufacturer and model/part number for all material proposed for this project, unless that item has been replaced as shown on the Project Plans or in the Invitation for Bids.

For all other materials used on this project, regardless of the type of work, Contractor shall provide to the Engineer the name of the manufacturer and model/part number along with supporting documentation and/or samples that will allow the Engineer to determine the material's acceptability.

The Engineer reserves the right to reject any proposed material, whether on the City's "Engineer's List of Approved Items" or not. If the City obtains information indicating that a listed item is not performing satisfactorily or is found to be defective, that item will be rejected and Contractor shall submit a replacement for review at no additional cost to the City.

**6-3.01B Material Guarantee:** Before any contract is awarded, the bidder may be required to furnish samples of materials and detailed descriptions of equipment to be used in the construction of the project. The materials samples may be subjected to the tests provided for in the Standard Specifications or in this Invitation for Bids to determine their quality and fitness for the project. The successful bidder shall unconditionally guarantee project materials and workmanship for a period of one year from the date of recording of the Notice of Completion. The guarantee shall cover 100% of all costs of repairs within the one-year period, including all costs of labor, materials, equipment, and incidentals. Except as may be otherwise provided in Section 3-1.05, the successful bidder shall provide a surety bond executed by a corporate surety authorized and admitted to transact a surety business in the state of California in the minimum amount of one-half of the Contract price to cover this guarantee.

**6-2.03D Quality Assurance:** California Test 216 (Relative Compaction) testing will be modified as follows: A mechanical compactor (Ploog Engineering Co. Model M 100 or equivalent) with 10-pound hammer and split compaction molds shall be used in lieu of the specified manual compaction equipment.

California Test 231 (Nuclear Gage Determination of In-Place Density) will be modified as follows: In-place density and relative compaction may be determined on the basis of individual test sites in lieu of the area concept, at the discretion of the Engineer.

### **6-4 Water Utility**

**6-4.01A Construction Water:** All water required for the performance of the work shall be provided by Contractor. Prior to obtaining water from the City's water system, Contractor shall obtain a Water Use Permit from the City of Santa Rosa Water Department and rent a hydrant or bridge meter. Contractor is responsible for the cost of all water and the cost of all deposits, permits and fees.

Contractor is prohibited from operating gate valves or fire hydrants on the City system.

The acquisition of water from the City's water system through un-metered hydrants or other facilities is a violation of City ordinance and State law. The use of water from sources other than the City's water system must be approved by the Engineer in advance of the use.

Citations and fines will be levied for violation of these and other utility regulations and deductions will be made from payments consistent with Section 7-1.02A (1) of the Standard Specifications.

**6-4.01B Water Utility Notification:** Contractors or parties requiring work of any kind by the City of Santa Rosa Water Department forces shall request such services a minimum of 48 hours in advance of the time such services are desired. Work requests which will involve the City of Santa Rosa Water Department forces for more than eight hours or an extensive number of City parts shall be requested a minimum of seven calendar days in advance.

If it is necessary to terminate or disrupt utility service to any customer, Contractor shall make the request for such work by City forces an additional 72 hours (three additional working days for a total of five working day's advance notice) in advance of the time such services are desired to allow affected customers a minimum of 72 hours' notice. Contractors who fail to keep field appointments will be billed for scheduled City of Santa Rosa Water Department crew standby time which was used and the Contractor shall bear the costs incurred by the City of Santa Rosa's Water Department for re-notification of customers.

City of Santa Rosa Water Department crews work a 9/80 schedule. This schedule may prohibit shutdowns for tie-ins on alternating Fridays. After hours work or weekend work may be performed if prior authorization from the Engineer is obtained.

Other than the hours specified in this Invitation for Bids, requests by Contractor for after hours or weekend work is to be avoided whenever possible. Any overtime costs incurred by City for such work shall be borne by Contractor.

Interruption of utilities service to commercial customers shall be coordinated with the customer to minimize disruption to the enterprise to the greatest extent practicable. After notification by the Contractor of the need, the City of Santa Rosa Water Department will contact all commercial customers and inform Contractor accordingly.

**6-4.01C Water Facility Damage:** All damage caused to the City's water system shall be immediately reported to the Engineer.

Damage caused to the City's water system by Contractor's operations shall be repaired by the Contractor at Contractor's sole expense in a manner satisfactory to the City of Santa Rosa Water Department. Such repairs shall not be charged to the City or any City project. All repair work shall be witnessed and approved by the City of Santa Rosa Water Department prior to backfilling the excavation. The City will require re-excavation if backfilling occurs prior to inspection, which costs shall be borne by Contractor.

Contractor is responsible for, at its sole cost and expense, the repair and remediation of damage to property and facilities caused by any of the following circumstances:

1. Contractor fails to make a written request for a markout or begins excavation without providing the City of Santa Rosa Water Department a reasonable opportunity to mark facilities;
2. Contractor destroys markouts;
3. Contractor fails to perform hand digging or probing for utilities near markouts; or

4. Contractor fails to use reasonable caution, regardless of whether markouts are present or clear. Reasonable caution includes any efforts to avoid damaging existing facilities, such as when excavating in the vicinity of water mains.

City may, in its discretion, opt to make the repairs for which Contractor is responsible with its own forces. In such cases, the repairs will be made at Contractor's expense in accordance with the emergency repair rate schedule of the City of Santa Rosa Water Department. The City may make repairs whenever restoration of service requires extraordinary speed or special equipment. Contractor will be billed accordingly and City shall have the right and option to withhold payment hereunder, or a portion thereof, for any such costs billed but not promptly paid by Contractor.

**6-4.02 Salvage:** All valves, hydrants, and other appurtenances of the water system that are the property of City and removed by Contractor shall be delivered to the City's Municipal Services Center (55 Stony Point Road) unless Contractor has obtained specific written approval from the City of Santa Rosa Water Department to otherwise dispose of the materials.

**6-4.03 Trade Names and Alternatives:** Except where indicated that no substitutions are allowed, material and equipment specifications that identify a particular patent, trade name or manufacturer, may be satisfied through substitute materials and equipment accepted by the City. Contractor may offer substitute materials and equipment of equal or better quality to the City. Any such offer shall be made in writing to the Engineer at least four weeks in advance of the time Contractor wishes to order the materials or equipment. Contractor shall include sufficient data which, together with any other information the Engineer may require, will enable the Engineer to determine the acceptability of the materials and equipment. When the substitute materials or equipment necessitate changes to any part of the work, the information shall include drawings and details showing all such changes and Contractor shall perform these changes as a part of any acceptance of substitute materials or equipment. The use of substituted materials and equipment will be permitted only after written acceptance of the materials and equipment by the Engineer. Such acceptance shall not relieve the Contractor from full responsibility for the sufficiency, quality and performance of the substitute materials and equipment.



## 7 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

**7-1.02A (1) Forfeitures for Health and Safety Violations:** Contractor shall comply with all applicable provisions of the Santa Rosa City Code and any failure to do so shall constitute a breach of the Contract. In the event of any violation of the Santa Rosa City Code that may impact public health and safety, including, but not limited to Chapter 17-12, "Storm Water" and Chapter 13-04, "Street Encroachments," City shall have the right to impose a charge against Contractor in an amount equal to \$500.00 per violation per day. Prior to the imposition of any charge hereunder, City shall first provide a written notice to Contractor of the violation and setting forth a reasonable period of time for Contractor to cure the violation(s). In the event Contractor fails to cure any such violation within the time provided, City shall have the right, in addition to all other rights and remedies available to City, to deduct and withhold as a permanent forfeiture by Contractor the appropriate amounts from any payment otherwise due Contractor under this Contract.

**7-1.02K (2) Wages:** Pursuant to Labor Code sections 1770 *et seq.*, each laborer or mechanic of Contractor or any subcontractor engaged in work on the project under this Contract shall be paid not less than the hourly wage rate of per diem wages set forth in the prevailing wage rate schedule published by the Director of Industrial Relations, regardless of any contractual relationship which may be alleged to exist between Contractor or any subcontractor and such laborers and mechanics. A copy of the schedule of prevailing wage rates can be obtained online at [www.dir.ca.gov](http://www.dir.ca.gov) or from the Department of Transportation and Public Works at 69 Stony Circle, Santa Rosa.

Any laborer or mechanic employed to perform work on the public works project under this Contract, which work is not covered by any of the foregoing classifications, shall be paid not less than the prevailing wage rate of per diem wages specified herein for the classification which most nearly corresponds to the work to be performed by the worker.

The foregoing specified prevailing wage rates are minimum rates only, and Contractor may pay any wage rate in excess of the applicable rate.

Pursuant to Labor Code Section 1775, Contractor as a penalty to the owner shall forfeit not more than \$200.00 for each calendar day, or a portion thereof, for each worker paid less than the prevailing wage rate established by the Department of Industrial Relations for such work or craft in which such worker is employed. The difference between such prevailing wage rates and the amount paid to each worker for each calendar day or portion thereof for which the worker was paid less than the prevailing wage rate shall be paid to each worker by Contractor.

Contractor shall only provide prevailing wage reports upon written request from City.

**7-1.02K (4) Apprentices:** Contractor agrees to comply with Chapter 1, Part 7, Division 2, sections 1777.5 *et seq.* of the California Labor Code. These sections require contractors and subcontractors to employ apprentices in apprenticeable occupations in a ratio of not less than one hour of apprentice work for each five hours of journeyman work (unless an exception is granted in accordance with Section 1777.5), and the contractors and subcontractors shall not discriminate among otherwise qualified employees as apprentices solely on the ground of sex, race, religion, creed, national origin, ancestry, or color. Only apprentices as defined in Labor Code section 3077, who are in training under apprenticeship standards and who have written apprentice agreements will be employed on public works in apprenticeable occupations. The responsibility for compliance with these provisions is fixed with the prime contractor for all apprenticeable occupations.

**7-1.02K(6)(a)(1) Notice to Vendors:** Attention is directed to the current OSHA Standards. All equipment, tools and materials which are furnished and/or installed as part of this Contract shall meet or exceed the aforementioned standards in order to be considered acceptable.

**7-1.02K(6)(b) Excavation Safety:** When the digging or excavation occurs during project construction, Contractor shall:

1. Promptly notify City in writing of the following conditions before any such conditions are disturbed:
  - a. Material that Contractor believes may be hazardous waste as defined in Health and Safety Code section 25117 that is required to be removed to a Class I, Class II or Class III disposal site in accordance with provisions of existing law;
  - b. Subsurface or latent physical conditions at the site differing from those indicated in the Invitation for Bids; and
  - c. Physical conditions at the site of any unusual nature, materially different from those ordinarily encountered and generally recognized as inherent in the type of work under the Contract.
2. The City will investigate the conditions and will issue a change order under the terms of the Contract if it finds that the conditions warrant it.
3. If a dispute arises between City and Contractor as to whether a change order is warranted, Contractor shall not be excused from any scheduled completion date provided for in the Contract but shall proceed with all work to be performed under the Contract.

**7-1.02K(6)(b)(1) Trench Excavation Safety Plans:** When the estimated cost for the excavation of any trench or trenches five feet or more in depth will exceed \$25,000.00, Contractor shall submit to the Engineer in advance of excavation a detailed plan showing the design of shoring, bracing, sloping or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches. If such plan varies from the shoring system standards established by the construction safety orders, or if the trench is anticipated to be greater than 20 feet, the plan shall be prepared by a registered civil or structural engineer.

A permit to do the above described work shall be obtained from the State of California, Division of Industrial Safety. Proof of such permit shall be submitted to the Engineer prior to starting the trench work.

Full compensation for complying with the provisions of this section shall be considered as included in the Contract price and no additional allowance will be made for the work.

**7-1.02K(6)(d) Confined Space Safety:** Any confined space entry for this project, including but not limited to manhole or water storage tank entry, will require a confined space entry permit pursuant to Cal/OSHA regulations as set forth in title 8 California Code of Regulations (CCR) sections 5157 or 5158. Confined space entry shall have the meaning ascribed in title 8 CCR sections 5157 and 5158. For any confined space entry for construction operations regulated by title 8 CCR section 1502, Contractor shall comply with title 8 CCR section 5158, "Other Confined Space Operations." For any other confined space operations, Contractor shall comply with title 8 CCR section 5157, "Permit-Required Confined Spaces."

Attention is directed to the technical specifications in the Special Provisions for information regarding entry to any City maintained confined space. Pursuant to title 8 CCR section 5157, Contractor is required to obtain any available information regarding hazards and operations for any City maintained confined spaces. The City maintained Confined Space Entry Manual is available for viewing at the City of Santa Rosa Water Department or Transportation and Public Works Department office at 69 Stony Circle, Santa Rosa.

Contractor shall immediately inform the Engineer of any previously unidentified hazards confronted or created during confined space entry.

**7-1.02L (3) Patents and Royalties:** All fees, royalties, or claims for any patented invention, article, process or method that may be used upon or in any manner connected with the work under this Contract shall be paid by Contractor. Contractor and its sureties shall protect and hold harmless City and its officers, agents, and employees from any and all demands made for such fees royalties or claims brought or made by any third party, and before the final payment is made on the account of the Contract, Contractor shall, if requested by City, furnish acceptable proof of a proper release from all such claims and liabilities.

Should Contractor, its officers, agents, or employees, or any one of them be enjoined from furnishing or using any invention, article, material, or plans supplied or required to be supplied or used under the Contract, Contractor shall promptly substitute other articles, materials, or appliances in lieu thereof of equal efficiency, quality, finish, suitability, and market value, and satisfactory in all respects to the Engineer. In the event that the Engineer elects, in lieu of such substitution, to have supplied and to retain and use any such invention, article, materials, or plans as may be required to be supplied by the Contract, Contractor shall pay such royalties and secure such valid licenses as may be requisite and necessary for City, its officers, agents, and employees, or any one of them to use such invention, article, materials, or appliance without being disturbed or in any way interfered with by any proceeding in law of equity on account thereof. Should Contractor neglect or refuse to make the substitution promptly or to pay such royalties and secure such licenses as may be necessary, then in that event the Engineer shall have the right to make such substitutions or City may pay such royalties and secure such licenses and charge Contractor even though final payment under the Contract may have been made.

**7-1.02M (3) Mined Materials:** California Public Contract Code section 20676 prohibits surface mining operators which are subject to the Surface Mining and Reclamation Act of 1975 (SMARA) from selling California mined construction material to the City unless the operator is identified in a list referred as the **3098 List**. The List, which is maintained by the Department of Conservation's Office of Mine Reclamation (OMR), changes throughout the year and can be viewed at the OMR website: [http://www.consrv.ca.gov/OMR/ab\\_3098\\_list/index.htm](http://www.consrv.ca.gov/OMR/ab_3098_list/index.htm). To confirm whether or not a specific operator is on the List at any given time, Contractor shall call the OMR at (916)323-9198.

**7-1.03A Maintaining Traffic:** Attention is directed to Sections 7-1.04 of the Standard Specifications and to the following modifications thereof.

If construction is within City owned right-of-way, provisions shall be made for the safe passage of public traffic through the work site at all times consistent with the requirements of Santa Rosa City Code Chapter 13-04.

Except for projects to be performed under a minor contract, Contractor shall install and maintain project identification signs at each end of the project or as directed by the Engineer two weeks prior to any construction activity. City shall furnish the appropriate sign panels upon request from Contractor. To mount the sign panels, Contractor shall furnish and install 4" X 4" posts or mount by other appropriate methods as approved by the Engineer. These sign panels shall be returned to the City Corporation Yard at 55 Stony Point Road after completion of the project.

Two weeks prior to any construction activity, advance notice signs for road closures shall be furnished and installed by Contractor at each end of the project and shall remain in place throughout the duration of the subject closure. Details of panel construction and lettering shall be approved by the Engineer.

Contractor shall furnish, install, and maintain at its expense all barricades, signs, lights, and other devices necessary to adequately warn of any obstructions to the traveled and pedestrian way and provide flaggers as necessary for the safety of public traffic and pedestrians and to provide access to property adjacent to the work site and Contractor shall comply with the Americans with Disabilities Act of 1990 (42 U.S.C. 12101, *et seq.*) (ADA) and any regulations and guidelines issued pursuant to the ADA.

Contractor shall comply with the current edition of the California Manual of Uniform Traffic Control Devices (CA MUTCD) for all items related to traffic within the work site.

Rain and other occurrences that may cause the suspension or delay of the work shall in no way relieve Contractor of its responsibility to provide traffic control and public access through the work site as specified herein. At all times, Contractor shall keep at the work site such materials, forces and equipment as may be necessary to keep roads, streets, and driveways within the work site open to traffic and in good repair and shall expedite the passage of such traffic, using such forces and equipment as may be necessary.

Should Contractor fail, in the opinion of the Engineer, to provide all the materials, forces and equipment necessary to maintain traffic through the work site as set forth herein, City may take steps necessary to remedy any such failure, including but not limited to causing such work to be performed and/or suspending any further work under the Contract. Any such remedial cost and expense incurred by the City, plus an administrative charge of 15%, shall be immediately due and payable by Contractor and may be deducted from any amounts owed to Contractor hereunder. In the event there are insufficient sums owed to Contractor hereunder to cover the foregoing costs and charges, City shall have the right to pursue any other remedy to recover the same, including but not limited to, proceeding against any surety or bond in favor of City. City's rights under Section 7-1.02 are intended to be in addition to and not in lieu of any charges imposed by City against Contractor under Section 7-1.02A (1) above for violations of the Santa Rosa City Code.

Contractor shall be responsible for informing emergency response agencies operating within the area of the work of obstructions to either public or private roads caused by reason of Contractor's operations hereunder.

Contractor shall make provisions for the safe passage of pedestrians around the project work site at all times.

## 8 PROSECUTION AND PROGRESS

**8-1.01A Assignments:** Once awarded, this Contract shall not be transferred, assigned, or sub-contracted, except as herein expressly provided without the prior written consent of the City in the City's sole and absolute discretion. See Section 5-1.12 of the Standard Specifications.

**8-1.04B Standard Start:** Contractor shall begin work within ten calendar days after the date authorized in the Notice to Proceed and shall diligently prosecute the Contract to completion before the expiration of:

### 195 WORKING DAYS

**8-1.05 Time of Completion:** Working days will be counted beginning with the day the Contractor begins work or with the tenth day after the date authorized in the Notice to Proceed, whichever occurs first.

Unless otherwise directed by Engineer, Contractor shall not conduct any activities that generate noise earlier than 7:00 a.m. or later than 6:00 p.m.

**8-1.10 Liquidated Damages:** Contractor hereby agrees that Contractor shall pay to the City liquidated damages for each and every calendar day delay over and above the number of working days prescribed above for finishing the work in the amount shown in Section 8-1.10 of the Standard Specifications.

**8-1.13 Contractor's Control Termination:** Attention is directed to Section 8-1.13 of the Standard Specifications. City may terminate Contractor's control of the work for failure to include the Federal Requirements in Contractor's subcontracts.

**8-1.14. Contract Termination:** Attention is directed to Section 8-1.14 of the Standard Specifications.

## 9 MEASUREMENT AND PAYMENT

**9-1.04 Force Account Work:** All work done on a force account basis shall be recorded daily on report sheets prepared by Contractor and signed by both the Engineer and Contractor. Such reports shall thereafter be considered the true record of force account work performed during the project. Such reports shall be furnished to the Engineer and a copy retained by Contractor.

All extensions of labor, equipment, and material costs shall be completed by Contractor and submitted to the Engineer within 30 days of the completion of the extra work. Completed and extended extra work reports received later than the times herein prescribed may be deemed invalid and rejected without payment at the discretion of the Engineer.

**9-1.07 Payment Adjustments for Price Index Fluctuations:** Any references to Opt Out of Payment Adjustments for Price Index Fluctuations in the Standard Specifications are deleted in their entirety.

**9-1.16 Progress Payments:** Once each month for progress pay purposes, the City will prepare a written estimate of the total amount of completed work and accepted materials purchased by Contractor but not installed. The City shall retain five percent of such estimated value of the completed work and the unused materials and pay Contractor the balance after deducting all previous payments and all sums to be retained under the provisions of the Contract. No such estimate or payment shall be required to be made when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the Contract or when, in the Engineer's judgment, the total value of the completed work since the last estimate is less than \$500.00. No such estimate or payment shall be construed to be an acceptance of any defective work or improper materials.

After Contract acceptance, the Engineer will prepare a written proposed final estimate of the proposed final quantities of work completed under the Contract and the value of such work and will submit such estimate to Contractor. The City shall retain five percent of such estimated value of the work done and shall pay to Contractor the balance after deducting all amounts to be retained under the provisions of the Contract.

The City may, at its option and at any time, retain out of any amounts due Contractor sums sufficient to cover any unpaid claims of City or others, provided that sworn statements of all non-City claims shall have been filed with the Director of Finance.

**9-1.16E(6) Substitution of Securities for Withheld Amounts:** Pursuant to Public Contract Code section 22300, securities may be substituted for any moneys withheld by City to ensure performance under this Contract, provided that substitution of securities provisions shall not be required in contracts in which there will be financing provided by the Farmer's Home Administration of the United States Department of Agriculture pursuant to the Consolidated Farm and Rural Development Act (7 USC sections 1921 *et seq.*), and where federal regulations or policies or both do not allow the substitution of securities. At the request and expense of Contractor, securities equivalent to the amount withheld shall be deposited with the City, or with a state or federally chartered bank as the escrow agent, which shall then pay such moneys to Contractor. The Director of Finance is authorized to execute substitution of securities agreements on behalf of the City. The City will return the securities to Contractor upon satisfactory completion of the Contract as determined by City in its sole discretion and the resolution of all outstanding claims against the securities. Contractor shall be the beneficial owner of any securities substituted for moneys withheld and shall receive any interest thereon.

Securities eligible for investment under this section shall include those listed in Government Code section 16430, bank or savings and loan certificates of deposit, interest bearing demand deposit accounts, standby letters of credit or any other security mutually agreed to by Contractor and the City, provided that the substituted security is equal to or not less than five percent of the Contract amount.

Security substitutions must be submitted by Contractor and approved by City prior to the time of the first progress payment to be made under the Contract. No other method of substituting securities for retention will be accepted. The security substitution shall be done only upon execution of an agreement satisfactory to City which includes the following provisions:

- a. The amount of securities to be deposited;
- b. The terms and conditions of conversion to cash in case of the default of Contractor;  
and
- c. The procedure for return of securities upon completion of the Contract.

**9-1.17D Final Payment and Claims:** The processing of payment of the final estimate shall not be commenced less than 35 days after the date of recording of the Notice of Completion with the County Recorder's Office. Contractor is advised that it takes approximately ten days for a check to be issued following a request for payment.

Contractor shall submit its written statement of all claims for additional compensation under the Contract to the Engineer within 15 days after submission to Contractor of the proposed final estimate.

If Contractor does not file a claim within the 15-day period, or upon Contractor's approval, the Engineer will issue a final written estimate and the City shall pay to Contractor the entire sum due after deducting all previous payments, if any, and all amounts to be retained under the provisions of the Contract.

If Contractor files a claim within the 15-day period, the Engineer will furnish a semi-final estimate and pay the amount due under the semi-final estimate within 30 days. The semi-final estimate is conclusive as to the amount payable except as may be affected by claims and any amount retained. The Engineer shall then consider and investigate such claim and shall make such revision in the final quantities as the Engineer may find to be due and shall then make and issue a final written estimate. The City will pay the amount due, after deducting all previous payments, if any, and amounts to be retained under the provisions of the Contract.

Any and all prior partial estimates and payments shall be subject to correction in the final estimate and payment.

The final estimate shall be conclusive and binding against both parties to the Contract on all questions relating to the performance of the Contract and the amount of work done thereunder and compensation therefor, except in the case of gross error.

**9-1.17D (3) Final Determination of Claims:** Claims filed by Contractor shall be in sufficient detail to enable the Engineer to determine the basis and amount of the Claims. Contractor shall also furnish reasonable documentation to the City to support Claims. If additional information is required by the Engineer, Contractor shall provide such information to the Engineer no later than the 15<sup>th</sup> day after receipt of the written request from the Engineer. If the 15<sup>th</sup> day falls on a weekend, holiday, or day City offices are closed, then the information shall be provided to the Engineer no later than close of the next business day. Failure to submit the requested information to the Engineer within the time specified will be sufficient cause for denying the Claim.

Contractor shall keep full and complete records of the costs and additional time incurred for any work for which a claim for additional compensation is made. The Engineer or any designated Claim

investigator or auditor shall have access to those records and any other records as may be reasonably required by the Engineer to determine the facts or contentions in each Claim. Failure to grant access to such records shall be sufficient cause for denying the Claims.

**9-1.22 Arbitration:** Any references to Arbitration in the Standard Specifications are deleted in their entirety.

Claims submitted by Contractor shall be accompanied by a notarized certificate containing the following language:

Under the penalty of law for perjury or falsification and with specific reference to the California False Claims Act, Government Code sections 12650 *et seq.*, and the United States False Claims Act, title 31, United States Code sections 3729 *et seq.*, the undersigned,

\_\_\_\_\_,  
(Name)

\_\_\_\_\_ of  
(Title)

\_\_\_\_\_  
(Contractor)

hereby certifies that the claim for additional compensation made herein is supported by a true statement of the actual costs incurred and time expended on this project and is fully documented by records maintained by Contractor.

Dated \_\_\_\_\_

/s/ \_\_\_\_\_

Subscribed and sworn before me this \_\_\_\_\_ day of

\_\_\_\_\_

\_\_\_\_\_  
Notary Public

My Commission Expires \_\_\_\_\_

Failure to submit the notarized certificate will be sufficient cause for denying the claim.

Any claim for overhead expenses, in addition to being certified as stated above, shall be supported by an audit report of an independent Certified Public Accountant. Any such overhead claim shall also be subject to audit by the City at its discretion.

Any costs or expenses incurred by the City in reviewing or auditing any claims that are not supported by Contractor's cost accounting or other records shall be deemed to be damages incurred by the City within the meaning of the California False Claims Act and the United States False Claims Act.



## 10 FEDERAL REQUIREMENTS

### A. Definitions

1. Government means the United States of America and any executive department or agency thereof.
2. FEMA means the Federal Emergency Management Agency.
3. Third Party Subcontract means a subcontract at any tier entered into by Contractor or subcontractor, financed in whole or in part with Federal assistance originally derived from the Federal Emergency Management Agency.

### B. Federal Changes

1. Contractor shall at all times comply with all applicable regulations, policies, procedures, and FEMA Directives as they may be amended or promulgated from time to time during the term of this Contract, included but not limited to the requirements of 2 C.F.R. §§ 200.317 through 200.326 and more fully set forth in Appendix II to Part 200 – Contract Provisions for Non-Federal Entity Contracts Under Federal Awards, which is included herein by this reference. Contractor's failure to so comply shall constitute a material breach of this Contract.
2. Contractor agrees to include the above clause in each third-party subcontract financed in whole or in part with Federal assistance provided by FEMA. It is further agreed that the clause shall not be modified, except to identify the subcontractor who will be subject to its provisions.

### C. Compliance with the Contract Work Hours and Safety Standards Act.

Pursuant to section 3701 of title 40 of the United States Code, this Section C shall apply to Contractor in the event the amount payable under this Contract exceeds \$100,000 and may involve the employment of mechanics or laborers.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.
2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1) of this section Contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1) of this section.
3. Withholding for unpaid wages and liquidated damages. City shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by Contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and

Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2) of this section.

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

#### **D. Clean Air Act and Federal Water Pollution Control Act**

This Section D shall apply in the event the amount payable under this Contract exceeds \$150,000.

##### Clean Air Act

1. Contractor agrees to comply with all applicable standards, orders and regulations issued pursuant to the Clean Air Act, as amended, 42 U.S.C. §§ 7401 *et seq.*
2. Contractor agrees to report each violation to City and understands and agrees that City will, in turn, report each violation as required to assure notification to the State of California, Federal Emergency Management Agency, and the appropriate Environmental Protection Agency Regional Office.
3. Contractor agrees to include these requirements in each subcontract exceeding \$150,000 financed in whole or in part with Federal assistance provided by FEMA.

##### Federal Water Pollution Control Act

1. Contractor agrees to comply with all applicable standards, orders and regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 U.S.C. §§ 1251 *et seq.*
2. Contractor agrees to report each violation to City and understands and agrees that City will, in turn, report each violation as required to assure notification to the State of California, Federal Emergency Management Agency, and the appropriate Environmental Protection Agency Regional Office.
3. Contractor agrees to include these requirements in each subcontract exceeding \$150,000 financed in whole or in part with Federal assistance provided by FEMA.

#### **E. Suspension and Debarment**

1. This Contract is a covered transaction for purposes of title 2 Code of Federal Regulations parts 180 and 3000. As such, Contractor is required to verify that none of Contractor, its principals (defined at 2 C.F.R. § 180.995), or its affiliates (defined at 2 C.F.R. § 180.905) are excluded (defined at 2 C.F.R. § 180.940) or disqualified (defined at 2 C.F.R. § 180.935).
2. Contractor represents and warrants that it is not debarred, suspended, or otherwise excluded from or ineligible for participation in Federal assistance programs under Executive Order 12549 "Debarment and Suspension." Contractor agrees that neither Contractor nor any of its third-party subcontractors shall enter into any third-party subcontracts for any of the work under this Contract with a third-party subcontractor that is debarred, suspended, or otherwise excluded for or ineligible for participation in Federal assistance programs under executive Order 12549.
3. Contractor must comply with title 2 Code of Federal Regulations, part 180, subpart C and title 2 Code of Federal Regulations, part 3000, subpart C and must include a requirement to comply with these regulations in any lower tier covered transaction it enters into.

4. This certification is a material representation of fact relied upon by City. If it is later determined that Contractor did not comply with title 2 Code of Federal Regulations, part 180, subpart C or title 2 Code of Federal Regulations, part 3000, subpart C, in addition to remedies available to the State of California and the City of Santa Rosa, the Federal Government may pursue available remedies, including but not limited to suspension and/or debarment.

**F. Procurement of Recovered Materials**

1. In the performance of this Contract, Contractor shall make maximum use of products containing recovered materials that are EPA- designated items unless the product cannot be acquired—
  - a. Competitively within a timeframe providing for compliance with the Contract performance schedule;
  - b. Meeting Contract performance requirements; or
  - c. At a reasonable price.
2. Information about this requirement, along with the list of EPA- designate items, is available at EPA's Comprehensive Procurement Guidelines web site, <https://www.epa.gov/smm/comprehensive-procurement-guideline-cpq-program>.

**G. Byrd Anti-Lobbying Amendment, 31 U.S.C. § 1352 (as amended)**

Contractors who apply or bid for an award of \$100,000 or more shall file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by section 1352 of title 31 of the United States Code. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient.

**H. MBE/WBE Requirements**

1. Contractor shall take all necessary affirmative steps to assure that minority businesses, women's business enterprises, and labor surplus area firms are used when possible through the "Good Faith Effort" process in 2 C.F.R. § 200.321. Contractor shall document and report its Good Faith Effort processes. Contractor shall also ensure that all of its subcontractors take the affirmative steps required under 2 C.F.R. § 200.321. Affirmative steps shall include:
  - a. Placing qualified small and minority businesses and women's business enterprises on solicitation lists;
  - b. Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources;
  - c. Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses, and women's business enterprises;
  - d. Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority businesses, and women's business enterprises;
  - e. Using the services and assistance, as appropriate, of such organizations as the Small Business Administration and the Minority Business Development Agency of the Department of Commerce; and
  - f. Requiring all subcontractors to take the affirmative steps listed in paragraphs (a) through (e) above.

## **I. Miscellaneous Provisions**

1. **DHS Seal.** Contractor shall not use the Department of Homeland Security ("DHS") seal(s), logos, crests, or reproductions of flags or likenesses of DHS agency officials without specific FEMA pre- approval.
2. **FEMA Assistance.** Contractor acknowledges that FEMA financial assistance will be used to fund this Contract only. Contractor shall comply will all applicable federal laws, regulations, executive orders, FEMA policies, procedures, and directives.
3. **Federal Government Not Party.** The Federal Government is not a party to this Contract and is not subject to any obligations or liabilities to City, Contractor, or any other party pertaining to any matter resulting from this Contract.
4. **False Claims.** Contractor acknowledges that Title 31 United States Code Chapter 38 (Administrative Remedies for False Claims and Statements) applies to Contractor's actions pertaining to this Contract.

## **J. Equal Employment Opportunity**

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

1. Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. Contractor will, in all solicitations or advertisements for employees placed by or on behalf of Contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
3. Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of Contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
5. Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of the said rules, regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part and Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions as may be imposed and remedies invoked as provided in

Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

7. Contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, Contractor may request the United States to enter into such litigation to protect the interests of the United States.

**K. Records.**

1. Contractor shall retain any and all records necessary to document the charges under this Contract and make such records available for inspection for a period of not less than four (4) years.
2. Contractor shall keep and maintain full and complete documentation and accounting records concerning all extra or special services performed by it that are compensable by other than an hourly or flat rate.
3. Contractor shall maintain the records and any and all other records pertinent to this Contract for a period of four (4) years after completion of all services hereunder.
4. Contractor agrees to provide City, the State of California, the Federal Emergency Management Agency ("FEMA") Administrator, the Comptroller General of the United States, and any or all of their authorized representatives, access to any books, documents, papers, and records of Contractor which are pertinent to this Contract for the purposes of making audits, examinations, excerpts, and transcriptions.
5. Contractor agrees to permit all or any of the foregoing parties to reproduce by any means whatsoever or to copy excerpts and transcriptions as reasonably needed.
6. Contractor agrees to provide the FEMA Administrator or his authorized representatives access to work sites pertaining to the services being performed under this Contract.

# TECHNICAL SPECIFICATIONS



## SKYFARM 'A' AND HANSFORD COURT LIFT STATION

### RECONSTRUCTION

#### 100% SUBMITTAL

March 2020



Exp 6/30/2021

Date: March 20, 2020



Exp 3/31/2021

Date: March 20, 2020

SECTION 01010  
SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Work to be done under these Contracts and in accordance with these Specifications consists of furnishing all equipment, superintendence, labor, skill, material and all other Items necessary for the construction of the wastewater lift stations at Skyfarm 'A' and Hansford Court.

The Contractor shall sequence the work such that reconstruction of both lift stations is performed in parallel.

The Contractor shall perform all work required for such construction in accordance with the Contract Documents and subject to the terms and conditions of the Contract, complete and ready for use.

- B. The principal features of the Work to be performed under these Contracts includes:

Furnishing and installing facilities as described in the Contract Documents hereafter.

- C. The foregoing description(s) shall not be construed as a complete description of all work required.

1.02 CONTRACT DOCUMENTS

- A. The Work to be done is shown on the set of Drawings entitled "Skyfarm 'A' and Hansford Court Lift Station Reconstruction and dated March 2020. The numbers and titles of all Drawings appear on the index sheet of the Drawings, Drawing G001. All drawings so enumerated shall be considered an integral part of the Contract Documents as defined herein.
- B. Certain Document Sections refer to Divisions of the Contract Specifications. Sections are each individually numbered portions of the Specifications (numerically) such as 08110, 13182, 15206, etc. The term Division is used as a convenience term meaning all Sections within a numerical grouping. Division 16 would thus include Sections 16000 through 16902.
- C. Where references in the Contract Documents are made to Contractors for specific disciplines of work (i.e. Electrical Contractor, etc.), these references shall be interpreted to be the single prime Contractor when the project is bid or awarded as a single prime contract.

1.03 GENERAL ARRANGEMENT

- A. Drawings indicate the extent and general arrangement of the work. If any departures from the Drawings are deemed necessary by the Contractor to accommodate the materials and equipment he proposes to furnish, details of such departures and reasons therefore shall be submitted as soon as practicable to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer. Approved changes shall be made without additional cost to the Owner for this work or related work under other Contracts of the Project.
- B. The specific equipment proposed for use by the Contractor on the project may require changes, in structures, auxiliary equipment, piping, electrical, mechanical, controls or other work to provide a complete satisfactory operating installation. The Contractor shall submit to the Engineer, for approval, all necessary Drawings and details showing such changes to verify conformance with the overall project structural and architectural requirements and overall project operating performance. The Bid Price shall include all costs in connection with the preparation of new drawings and details and all changes to construction work to accommodate the proposed equipment, including increases in the costs of other Contracts.

#### 1.04 CONSTRUCTION PERMITS, EASEMENTS AND ENCROACHMENTS

- A. The Owner shall obtain or cause to be obtained all permanent and temporary construction easements as shown on the Drawings. The Contractor shall verify that these agreements have been obtained and shall comply with the conditions set forth in each agreement.
- B. The Contractor shall obtain, keep current and pay all fees for any necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated. Record copies of all permits shall be furnished to the Engineer.
- C. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to his operations on this Project.

#### 1.05 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the Engineer is required to provide additional engineering services as a result of substitution of materials or equipment which are not "or equal" by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.
- B. Structural design shown on the Contract Drawings is based upon typical weights for major items of equipment as indicated on the Contract Drawings and specified. If the equipment furnished exceeds the weights of said equipment, the Contractor shall assume the responsibility for all costs of redesign and for any construction changes required to



accommodate the equipment furnished, including the Engineer's expenses in connection therewith.

- C. In the event that the Engineer is required to provide additional engineering services as a result of Contractor's errors, omissions, or failure to conform to the requirements of the Contract Documents, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

#### 1.06 ADDITIONAL OWNER'S EXPENSES

- A. In the event the Work of this Contract is not completed within the time set forth in the Contract or within the time to which such completion may have been extended in accordance with the Contract Documents, the additional engineering or inspection charges incurred by the Owner may be charged to the Contractor and deducted from the monies due him. Extra work or supplemental Contract work added to the original Contract, as well as extenuating circumstances beyond the control of the Contractor, will be given due consideration by the Owner before assessing engineering and inspection charges against the Contractor.
- B. Unless otherwise specifically permitted, the normal time of work under this Contract is limited to 8 hours per day, Monday through Friday. Work beyond these hours will result in additional expense to the Owner. Any expenses and/or damages, including the cost of the Engineer's on-site personnel, arising from the Contractor's operations beyond the hours and days specified above shall be borne by the Contractor.
- C. Charges assessed to the Contractor for additional engineering and inspection costs will be determined based on actual hours charged to the job by the Engineer. Daily rates will depend on the number and classifications of employees involved, but in no case shall such charges exceed \$1,800 per day for field personnel and \$2,400 per day for engineering personnel, based on an eight-hour workday.
- D. Charges for additional Owner's expenses shall be in addition to any liquidated damages assessed in accordance with the Contract.

#### 1.07 TIME OF WORK

- A. The normal time of work for this Contract is limited to 40 hours per week and shall generally be between the hours of 7:00 a.m. and 6:00 p.m., Monday through Friday. The Contractor may elect to work beyond these hours or on weekends provided that all costs incurred by the Owner for additional engineering shall be borne by the Contractor.
  - 1. The Owner shall deduct the cost of additional engineering costs from monies due the Contractor.
- B. If it shall become imperative to perform work at night, the Owner and Engineer shall be informed a reasonable time in advance of the beginning of such work. Temporary lighting

and all other necessary facilities for performing and inspecting the work shall be provided and maintained by the Contractor.

- C. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. Contractor shall carefully protect his work against damage or injury from the weather, and when work is permitted during freezing weather, he shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

#### 1.08 SUBSURFACE DATA

- A. Subsurface data are offered in good faith solely for placing the Bidder in receipt of all information available to the Owner and Engineer and in no event is to be considered as part of the Contract Documents.
- B. The Bidder must interpret such subsurface data according to his own judgment and acknowledge that he is not relying upon the same as accurately describing the subsurface conditions, which may be found to exist.
  - 1. The test boring logs present factual information of the subsurface conditions at the specific test boring location only. The Bidder should not consider, or conclude, that the subsurface conditions will be consistent between test boring locations.
- C. The Bidder further acknowledges that he assumes all risks contingent upon the nature of the sub-surface conditions to be actually encountered by him in performing the work covered by the Contract, even though such actual conditions may result in the Bidder performing more or less work than he originally anticipated.
- D. The Bidder is further advised that the Owner has made sub-surface investigations and a report has been prepared, in connection with this project for the Engineer, a copy of which can be provided on request.
- E. In making this data available, the Owner makes no guarantee, either expressed or implied, as to their accuracy or to the accuracy of any interpretation thereof.

#### 1.09 SURVEYS AND LAYOUT

- A. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as directed by the Engineer. Elevation of existing ground and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and therefore are presented only as an approximation. Any error or apparent discrepancy in the data shown or omissions of data required for accurately accomplishing the stake out survey shall be referred immediately to the Engineer for interpretation or correction.
- B. All survey work for construction control purposes shall be made by the Contractor at his expense. The Contractor shall provide a Licensed Surveyor as Chief of Party, competently qualified men, all necessary instruments, stakes, and other material to perform the work.

- C. Contractor shall establish all baselines for the location of the principal component parts of the work together with a suitable number of bench marks and batter boards adjacent to the work. Based upon the information provided by the Contract Drawings, the Contractor shall develop and make all detail surveys necessary for construction, including slope stakes, batter boards, stakes for all working points, lines and elevations.
- D. Contractor shall have the responsibility to carefully preserve the bench marks, reference points and stakes, and in the case of destruction thereof by the Contractor or resulting from his negligence, the Contractor shall be charged with the expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.
- E. Existing or new control points, property markers and monuments that will be or are destroyed during the normal causes of construction shall be reestablished by the Contractor and all reference ties recorded therefore shall be furnished to the Engineer. All computations necessary to establish the exact position of the work shall be made and preserved by the Contractor.
- F. The Engineer may check all or any portion of the work and the Contractor shall afford all necessary assistance to the Engineer in carrying out such checks. Any necessary corrections to the work shall be immediately made by the Contractor. Such checking by the Engineer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of his work.
- G. At completion of the work, the Contractor shall furnish Record Drawings indicating the final layout of all structures, roads, all structures, existing benchmarks, etc. The Record Drawings shall indicate all critical elevations of piping, structures, finish grades, etc.
- H. Contractor shall have all weirs surveyed by a licensed land surveyor and adjusted to match specified elevations as shown on the Contract Drawings. Weirs shall be surveyed at no more than ten (10) feet spacing, but no less than 2 points shall be surveyed on each section of weir plate. Final elevations shall be set to within a tolerance of +/- 0.05 inches of specified elevation. If a greater tolerance is allowed, it will be noted on the Contract Drawings. A final report showing all specified and surveyed elevations shall be certified by the surveyor and delivered to the Engineer.

#### 1.10 NOT USED

#### 1.11 FIRE PROTECTION

- A. Contractor shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc., and shall provide adequate facilities for extinguishing fires which do occur. Burning, if permitted in Division 2, shall be limited to areas approved by the Engineer and Owner and properly controlled by the Contractor.
- B. When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the Contractor shall immediately alert the local Fire Marshal, the Engineer, and the Owner of such tank or device. The Contractor shall exercise all safety precautions and shall comply with all

instructions issued by the Fire Marshal and shall cooperate with the Owner of the tank or device to prevent the occurrence of fire or explosion.

#### 1.12 CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of either the EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable rules and regulations.

#### 1.13 FIRST AID FACILITIES AND ACCIDENTS

##### A. First Aid Facilities

- 1. The Contractor shall provide at the site such equipment and facilities as are necessary to supply first aid to any of his personnel who may be injured in connection with the work.

##### B. Accidents

- 1. The Contractor shall promptly report, in writing, to the Engineer and Owner all accidents whatsoever out of, or in connection with, the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage, giving full details and statements of witnesses.
- 2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Owner and the Engineer.
- 3. If any claim is made by anyone against the Contractor or a Subcontractor on account of any accidents, the Contractor shall promptly report the facts, in writing, to the Engineer and Owner, giving full details of the claim.

#### 1.14 ULTIMATE DISPOSITION OF CLAIMS BY ONE CONTRACTOR ARISING FROM ALLEGED DAMAGE BY ANOTHER CONTRACTOR

- A. During the progress of the work, other Contractors may be engaged in performing other work or may be awarded other Contracts for additional work on this project. In that event, the Contractor shall coordinate the work to be done hereunder with the work of such other Contractors and the Contractor shall fully cooperate with such other Contractors and carefully fit its own work to that provided under other Contracts as may be directed by the Engineer. The Contractor shall not commit or permit any act which will interfere with the performance of work by any other Contractor.
- B. If the Engineer shall determine that the Contractor is failing to coordinate his work with the work of the other Contractors as the Engineer directed, then the Owner shall have the right to withhold any payments otherwise due hereunder until the Contractor completely complies with the Engineer's directions.

- C. If the Contractor notifies the Engineer in writing that another Contractor is failing to coordinate his work with the work of this Contract as directed, the Engineer will promptly investigate the charge. If the Engineer finds it to be true, he will promptly issue such directions to the other Contractor with respect thereto as the situation may require. The Owner, the Engineer, nor any of their agents shall not, however, be liable for any damages suffered by the Contractor by reason of the other Contractor's failure to promptly comply with the directions so issued by the Engineer, or by reason of another Contractor's default in performance, it being understood that the Owner does not guarantee the responsibility or continued efficiency of any Contractor.
- D. The Contractor shall indemnify and hold the Owner and the Engineer harmless from any and all claims of judgments for damages and from costs and expenses to which the Owner may be subjected or which it may suffer or incur by reason of the Contractor's failure to comply with the Engineer's directions promptly.
- E. Should the Contractor sustain any damage through any act or omission of any other Contractor having a Contract with the Owner for the performance of work upon the site or of work which may be necessary to be performed for the proper execution of the work to be performed hereunder, or through any act or omission of a Subcontractor of such Contract, the Contractor shall have no claim against the Owner or the Engineer for such damage, but shall have a right to recover such damage from the other Contractor under the provision similar to the following provisions which have been or will be inserted in the Contracts with such other Contractors.
- F. Should any other Contractor having or who shall hereafter have a Contract with the Owner for the performance of work upon the site sustain any damage through any act or omission of the Contractor hereunder or through any act or omission of any Subcontractor of the Contractor, the Contractor agrees to reimburse such other Contractor for all such damages and to defend at his own expense any suit based upon such claim and if any judgment or claims against the Owner shall be allowed, the Contractor shall pay or satisfy such judgment or claim and pay all costs and expenses in connection therewith and shall indemnify and hold the Owner harmless from all such claims.
- G. The Owner's right to indemnification hereunder shall in no way be diminished, waived or discharged, by its recourse to assessment of liquidated damages as provided in the Contract, or by the exercise of any other remedy provided for by Contract Documents or by law.

#### 1.15 BLASTING AND EXPLOSIVES

- A. THE USE OF BLASTING OR EXPLOSIVES SHALL NOT BE ALLOWED UNDER THIS PROJECT.

#### 1.16 LIMITS OF WORK AREA

- A. The Contractor shall confine his construction operations within the Contract limits shown on the Drawings and/or property lines and/or fence lines. Storage of equipment and materials, or erection and use of sheds outside of the Contract limits, if such areas are the property of the Owner, shall be used only with the Owner's approval. Such storage or temporary

structures, even within the Contract's limits, shall be confined to the Owner's property and shall not be placed on properties designated as easements or rights-of-way unless specifically permitted elsewhere in the Contract Documents.

#### 1.17 WEATHER CONDITIONS

- A. No work shall be done when the weather is unsuitable. The Contractor shall take necessary precautions (in the event of impending storms) to protect all work, materials, or equipment from damage or deterioration due to floods, driving rain, or wind, and snow storms. The Owner reserves the right, through the opinion of the Engineer, to order that additional protection measures over and beyond those proposed by the Contractor, be taken to safeguard all components of the Project. The Contractor shall not claim any compensation for such precautionary measures so ordered, nor claim any compensation from the Owner for damage to the work from weather elements.
- B. The mixing and placing of concrete or pavement courses, the laying of masonry, and installation of sewers and water mains shall be stopped during rainstorms, if ordered by the Engineer; and all freshly placed work shall be protected by canvas or other suitable covering in such manner as to prevent running water from coming in contact with it. Sufficient coverings shall be provided and kept ready at hand for this purpose. The limitations and requirements for mixing and placing concrete, or laying of masonry, in cold weather shall be as described elsewhere in these Specifications.

#### 1.18 PERIODIC CLEANUP: BASIC SITE RESTORATION

- A. During construction, the Contractor shall regularly remove from the site of the work all accumulated debris and surplus materials of any kind which result from his operations. Unused equipment and tools shall be stored at the Contractor's yard or base of operations for the Project.
- B. When the work involves installation of sewers, drains, water mains, manholes, underground structures, or other disturbance of existing features in or across streets, rights-of-way, easements, or private property, the Contractor shall (as the work progresses) promptly backfill, compact, grade, and otherwise restore the disturbed area to the basic condition which will permit resumption of pedestrian or vehicular traffic and any other critical activity or functions consistent with the original use of the land. The requirements for temporary paving of streets, walks, and driveways are specified elsewhere. Unsightly mounds of earth, large stones, boulders, and debris shall be removed so that the site presents a neat appearance.
- C. The Contractor shall perform the cleanup work on a regular basis and as frequently as ordered by the Engineer. Basic site restoration in a particular area shall be accomplished immediately following the installation or completion of the required facilities in that area. Furthermore, such work shall also be accomplished, when ordered by the Engineer, if partially completed facilities must remain incomplete for some time period due to unforeseen circumstances.
- D. Upon failure of the Contractor to perform periodic cleanup and basic restoration of the site to the Engineer's satisfaction, the Owner may, upon five (5) days prior written notice to the

Contractor, without prejudice to any other rights or remedies of the Owner, cause such work for which the Contractor is responsible to be accomplished to the extent deemed necessary by the Engineer, and all costs resulting therefrom shall be charged to the Contractor and deducted from the amounts of money that may be due him.

#### 1.19 USE OF FACILITIES BEFORE COMPLETION

- A. The Owner reserves the right to enter and use any portion of the constructed facilities before final completion of the whole work to be done under this Contract. However, only those portions of the facilities which have been completed to the Engineer's satisfaction, as evidenced by his issuing a Certificate of Substantial Completion covering that part of the work, shall be placed in service.
- B. It shall be the Owner's responsibility to prevent premature connections to or use of any portion of the installed facilities by private or public parties, persons or groups of persons, before the Engineer issues his Certificate of Substantial Completion covering that portion of the work to be placed in service.
- C. Consistent with the approved progress schedule, the Contractor shall cooperate with the Owner, his agents, and the Engineer to accelerate completion of those facilities, or portions thereof, which have been designated for early use by the Owner.

#### 1.20 CONSTRUCTION VIDEO

- A. The Contractor shall video the entire project site including all concrete and asphalt pavements, curb and gutter, fencing to remain, structures to be demolished, and existing structures that are to be modified. The original video image shall be turned over to the Engineer prior to beginning construction activities. The video shall be provided as an Audio Video Interleave File (.avi) and shall be provided on DVD+R/DVD-ROM compatible media only. The video shall clearly identify existing site and structural conditions prior to construction.

### PART 2 -- PRODUCTS

(NOT USED)

### PART 3 -- EXECUTION

(NOT USED)

## SECTION 01025

### MEASUREMENT AND PAYMENT

#### 1.0 MEASUREMENT AND PAYMENT

##### 3.1. General

Measurements of the completed work shall be in accordance with, and by instruments and devices calibrated to United States Standard Measures and the units of measurement for payment, and the limits thereof, shall be made as shown on the Plans, Specifications, General Requirements, and Supplementary Conditions.

##### 3.2. Units of Measurement

Measurements shall be in accordance with U.S. Standard Measures. A pound is an avoirdupois pound. A ton is 2,000 pounds avoirdupois. The unit of liquid measure is the U.S. gallon.

##### 3.3. Certified Weights

When payment is to be made on the basis of weight, the weighing shall be done on certified platform scales, or when approved by the Construction Manager, on a completely automated weighing and recording system. The Contractor shall furnish the Construction Manager with duplicate licensed weighmaster's certificates showing the actual net weights. The Owner will accept the certificates as evidence of the weights delivered.

##### 3.4. Methods of Measurement

Materials and items of work which are to be paid for on the basis of measurement shall be measured in accordance with the method stipulated in the particular sections involved. In determining quantities, all measurements shall be made in a horizontal plane unless otherwise specified.

Material not used from a transporting vehicle shall be determined by the Construction Manager and deducted from the certified tag.

When material is to be measured and paid for on a volume basis and it would be impractical to determine the volume, or when requested by the Contractor in writing and approved by the Construction Manager in writing, the material will be weighed and converted to volume measurement for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Construction Manager and shall be agreed to by the Contractor before such method of measurement of pay quantities will be adopted.

Full compensation for all expense involved in conforming to the above requirements for measuring and weighing materials shall be considered as



included in the unit price paid for the materials being measured or weighed and no additional allowances will be made therefore.

Quantities of material wasted or disposed of in a manner not called for under the Contract; or rejected loads of material, including material rejected after it has been placed by reason of failure of the Contractor to conform to the provisions of the Contract; or material not unloaded from the transporting vehicle; or material placed outside the lines indicated on the plans or given by the Construction Manager; or material remaining on hand after completion of the Contract, will not be paid for and such quantities will be deducted from the final total quantities. No compensation will be allowed for hauling rejected material.

## 2.0 BID ITEMS

The Bid Amounts for each Bid Item will be used for comparative bid analysis. The Bid amounts will also form the basis of monthly progress payments. The Contractor will be required to submit a detailed report that documents which sewer main sections (manhole to manhole), parcel laterals, parcel cleanouts, and structures are included in each monthly pay request.

Each Lump Sum bid amount will undergo further breakdown as described later in this section. Unit prices for any unit price bid items will be the basis for monthly progress payment determinations and for any changes related to that Work item. Bid Item 2 will also demonstrate the Contractor's compliance with the California Labor Code relating to the price for sheeting, shoring, and bracing of excavations. Bid items are not intended to be exclusive descriptions of work categories and the Contractor shall determine and include in its pricing all materials, labor, and equipment necessary to complete each Bid Item (work phase) as shown and specified.

### **BID ITEM 1: Mobilization and Demobilization – Lump Sum**

Bid Item 1 includes all labor, materials, and equipment necessary. Item will be paid for on a **lump sum** basis with a 50% payment of the lump sum upon the Contractors mobilization on site and 50% payment of the lump sum upon the Contractors demobilization from the project site. Items of mobilization include payment of bonds and insurance, water pollution control, traffic control and equipment/materials onsite. Items of demobilization include, removing all equipment, performing site cleanup, submission of warranties, record drawings and acceptance of the entire project by the City. This bid item is limited to a maximum amount of five (5) percent of the Bid Price for Skyfarm A and Hansford Ct.

### **BID ITEM 2: All Other Work Including Shoring and Bracing – Lump Sum**

Bid Item 2 includes all costs for all other work required under the contract for Skyfarm A and Hansford Ct. except for work specifically being provided under Bid Items 3 through 6, as well as the planning, design, engineering, furnishing, construction and the removal and disposal of all temporary sheeting, shoring, and bracing of excavations as required but not limited to the provisions of any permits, in accordance with the requirements of OSHA, the Construction Safety Orders of the State of California, and pursuant to the

provisions of Sections 6700 through 6708 of the California Labor Code.

Payment for this Bid Item shall be by lump sum which price named on the Bid Schedule under this Bid Item shall constitute full compensation for completion of all such Work as required per the Contract Documents. Payment will be made for the work completed in proportion to the total value of the work for this Bid Item.

**BID ITEM 3: Skyfarm A Lift Station, Building and Appurtenances – Lump Sum**

Bid Item 3 includes payment for all costs associated with the construction, installation, testing and start-up of the Skyfarm A Lift Station, building and appurtenances. The bid price shall include but not be limited to: temporary bypass pumping system and maintenance, demolition, excavation, backfill, concrete and masonry work, pumps, guide rails, piping and valves, pipe support, hatches, electrical service, instrumentation, and all equipment contained in the building, site civil improvements (paving, grading, etc.) and appurtenances as provided in the drawings and specifications, and all work associated with the Skyfarm A Lift Station that is not included as part of other Bid Items. All work in this Bid Item shall be considered as included in the unit price at no additional compensation.

**BID ITEM 4: Hansford Ct. Lift Station and Appurtenances – Lump Sum**

Bid Item 4 includes payment for all costs associated with the construction, installation, testing and start-up of the Hansford Ct. Lift Station and appurtenances. The bid price shall include but not be limited to: temporary bypass pumping system and maintenance, demolition, excavation, backfill, concrete and masonry work, pumps, piping and valves, pipe support, hatches, electrical service, instrumentation, and all equipment at the lift station site, site civil improvements (paving, grading, etc.) and appurtenances as provided in the drawings and specifications, and all work associated with the Hansford Ct. Lift Station that is not included as part of other Bid Items. All work in this Bid Item shall be considered as included in the unit price at no additional compensation.

**BID ITEM 5: Skyfarm A Generator – Lump Sum**

Bid Item 5 includes all costs for the generators associated with the pump station site for Skyfarm A. The bid price shall include but not be limited to: procurement of the standby generators, enclosures and appurtenances as provided in the drawings and specifications, and all work associated with installation, commissioning and start-up of standby generators for Skyfarm A that are not included as part of other Bid Items. All work in this Bid Item shall be considered as included in the lump sum price at no additional compensation. Payment will be made for the work completed in proportion to the total value of the work for this Bid Item.

**BID ITEM 6: Hansford Ct. Generator – Lump Sum**

Bid Item 6 includes all costs for the generator associated with the pump station site for Hansford Ct. The bid price shall include but not be limited to: procurement of the standby generators, enclosures and appurtenances as provided in the drawings and specifications, and all work associated with installation, commissioning and start-up of standby generators for Hansford Ct. that are not included as part of other Bid Items. All work in this Bid Item shall be considered as included in the lump sum price at no additional compensation. Payment will be made for the work completed in proportion to the total value of the work for this Bid Item.

### 3.0 CONTRACTOR'S COST BREAKDOWN

For work to be performed for a lump sum amount, the Contractor shall submit a cost breakdown to the Construction Manager prior to the first payment and within thirty (30) days after Notice to Proceed. The cost breakdown, as agreed upon by the Contractor and the Construction Manager, shall be used for preparing future estimates for partial payments to the Contractor, and shall list the major items of work with a price fairly apportioned to each item. Mobilization, overhead, bond, insurance, other general costs and profit shall be prorated to each item so that the total of the prices for all items equal the lump sum price. At the discretion of the Construction Manager, mobilization, bond and insurance costs may be provided for separately if accompanied by invoices to verify actual expenses.

The cost breakdown shall be generally in the same format as the Contract specifications divisions and subdivisions, with major items of work listed individually. The cost breakdown shall be by structure, civil, landscaping, or other logical division of work. The cost breakdown for architectural, structural, mechanical, and electrical work shall include separate items for identifiable portions of the structures. The cost breakdown shall include separate allowances for any testing and startup work required. Measurable approximate quantities of work performed by the Contractor or its subcontractors shall be provided. For quantities that are the sum total of several individual quantities, backup summaries shall be provided which list the individual descriptions and quantities. These summaries then will be used to determine the quantities of work in place in subsequent progress payment requests.

The above is a statement of the intent of the Contract Documents to provide a moderate level of detail, acceptable to the Construction Manager, to allow a fair and reasonable estimate to be made of the value of work installed. The detail of the cost breakdown must be sufficient to provide timely processing of the monthly progress payment request.

The cost breakdown will be subject to the approval of the Construction Manager, and upon request, the Contractor shall substantiate the price for any or all items and provide additional level of detail, including quantities of work. The cost breakdown shall be sufficiently detailed to permit its use by the Construction Manager as one of the bases for evaluating requests for payments. The Construction Manager shall be the sole judge of the adequacy of the cost breakdown.

The cost breakdown shall be solely used to determine progress payments. The cost breakdown shall not be considered in determining payment or credit for additional or deleted work.

- END OF SECTION -

## SECTION 01035

### MODIFICATION PROCEDURES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Work includes all labor, materials, equipment and appliances required for the complete execution of additions, modifications and alterations to existing buildings and structures as shown on the Drawings and specified under the various Sections of the Contract Specifications and as required by conditions at the site.
- B. The Contractor shall have examined all work to be performed to the existing buildings and familiarize himself with the nature and extent to which the existing buildings will be damaged, items removed or rearranged due to the work under his Contract and that of other Contracts.
  - 1. Cutting and patching shall conform to the requirements of the General Conditions, Supplemental Conditions, and as specified herein.
  - 2. Patching work shall be performed with similar materials and in the same manner as adjoining work. Joining between old and new work shall be perfect and practically invisible. All due caution shall be taken to obtain a bond between old and new work.
- C. Major portions of the work are indicated on the Drawings and the accompanying Specifications thereto. All work must be complete in all respects and executed with high quality workmanship.
- D. Work not specifically indicated by details or general notes on the Drawings may include the following:
  - 1. Re-pointing brickwork; removing and replacing broken, cracked, disintegrating and missing brickwork, utilizing mortar and face brick as specified under Division 4, Masonry.
  - 2. Removing cracked and/or disintegrating sealant materials around window frames and panes of glass thereto; replacing missing and broken panes of glass; re-caulking and sealing window frames and glazing with sealants specified under Division 7 - Thermal and Moisture Protection and Division 8 - Doors and Windows.
  - 3. Removing loose rust, sealing or peeling paint from metal surfaces by scraping, sanding or wire brushing; priming and repainting metal surface (inside and outside) as specified under Division 9 - Finishes.
  - 4. Patching and repairing existing membrane or built-up roofing, metal flashing; correcting pitch of roof areas to eliminate ponding; cleaning out and/or replacing

unusable roof drains, etc. Roofing materials shall be as specified under Division 7 - Thermal and Moisture Protection.

5. Cutting masonry and installing new expansion and control joints.
6. Removing existing and constructing new parapet walls and copings; clean and patch copings where practicable and replacing copings where broken.
7. Patching, cleaning, sealing and resurfacing concrete floors, walls, lintels, sills and trim and replacing lintels where broken.
8. Cutting and modifying existing openings as necessary to receive new work and providing new lintels, doors, frames, etc.
9. Patching existing doors and frames and refinishing as required.
10. Patching, refinishing and/or replacing ceilings.
11. Patching and/or replacing broken, spalled, cracked and disintegrating concrete encasing steel columns and piers.
12. Cleaning and repainting steel handrailing, brackets, sleeves, etc. Replacing existing railing with new aluminum railing, brackets, sleeves, etc.

#### 1.02 SITE AND BUILDINGS

##### A. Site Visit

1. Prior to submission of Bids, the Contractor shall have visited the site and thoroughly acquainted himself with the exact nature of the work indicated on the Drawings and the Specifications requirements. Failure to comply with the aforementioned requirements shall not constitute a basis for claims for additional compensation.

##### B. Measurements

1. Prior to ordering any materials or doing any work, the Contractor shall verify all measurements, dimensions and other conditions of each building scheduled for work as may be necessary or required in connection with his work. The Contractor shall be responsible for the correctness of same.

#### 1.03 MATERIALS

- A. All materials to perform and complete the work shall be new. Salvaged materials, such as brick, stone copings, granite sills, may be used under certain conditions subject to the approval of the Owner and Engineer.
- B. All salvaged materials shall be sound and undamaged. Materials to be reused shall be stored and protected as directed by the Engineer. Care shall be taken to prevent damage to materials or equipment to be reused.

#### 1.04 SHORING, UNDERPINNING AND BRACING

- A. When necessary and required, the Contractor shall provide underpinning and temporary shoring and bracings, all in accordance with code requirements, and as approved by the Engineer.
- B. Shoring and bracing shall be of such form and so installed as to safely support the work and interfere as little as possible with the progress of the work. Suitable means shall be provided to adjust any settlement in the shoring supports. Temporary shoring shall consist of sound timbers or rolled shapes of required dimensions which shall be removed after necessity for same ceases to exist. All work removed or damaged through installation of temporary shoring or through improper shoring shall be replaced or repaired after the shoring is removed, at no additional cost to the Owner.

#### 1.05 WORK PREPARATION AND TEMPORARY ACCESS

- A. The Contractor, before commencing work, shall prepare and submit for approval a progress schedule in accordance with the requirements of Section 01300 - Submittals, in order to coordinate the work of all trades and to insure completion on or before the completion date. The Owner and the Engineer reserve the right to revise or modify such schedules as required to expedite each phase of work and to coordinate such work with the partial use of the building for purposes as directed.
- B. No facility such as toilets, corridors, etc., shall be barricaded or access restricted without providing other temporary or interim means of access. It is further required that no work specified hereinafter shall disturb or interfere with the operation of the existing mechanical installation until proposed new work has been completed or satisfactorily installed. Exception may be made to this requirement only by written approval from the Owner and Engineer.
- C. Detailed sequence of availability of areas within the present buildings where work is to be performed under each Contract shall be in accordance with Section 01520, Maintenance of Utility Operations During Construction, but may be modified by the Contractor, upon authorization by the Owner and Engineer as the work progresses.
- D. Existing built-in equipment to remain in the final work, but requiring temporary removal for the installation of new construction, alterations, repairs and/or renovations, shall be disconnected by the Electrical Subcontractor and removed by the Contractor to temporary storage areas designated by the Owner. Resetting of existing equipment under this heading shall be performed by the Contractor and connecting to electric service lines shall be performed by the Electrical Subcontractor.
- E. The Contractor shall furnish and install all temporary fire exits, fire extinguishers, hose and safety devices as may be required by authorities having jurisdiction.
- F. Work within existing buildings to be performed, once started, shall be completed as quickly as practicable and each trade shall determine before work is started that all required materials are at hand or readily obtainable to avoid delays.

- G. Shutdowns of existing services within existing buildings which may be occupied during construction will be permitted only upon approval by the Owner subject to at least three week notice in writing to the Owner in each case. Shutdowns will be limited to times which will result in the least interference with normal operations. Refer to Section 01520 - Maintenance of Utility Operations During Construction for additional requirements.

#### 1.06 DUST-PROOF PARTITIONS

- A. The Contractor shall furnish and erect all necessary temporary dust-proof partitions where required to protect unaltered portions of existing buildings and structures or as directed by the Owner or Engineer.
- B. Partitions shall be constructed of wood studs with plywood on both sides. Partitions shall extend from floor to ceiling with a closure plate at floor and ceiling. The Contractor shall furnish and install one door in each enclosure complete with hardware attached and keyed as directed. Such enclosures will be required in areas of major demolition work and for protection of existing equipment.

#### 1.07 WEATHER PROTECTION

- A. Where exterior walls or roofs are being altered, or disturbed for any adjacent alteration, the Contractor shall provide temporary weather protection in those areas to keep interior of buildings absolutely dry and unaffected by the weather. The Contractor will be held responsible for any damage caused by improper protection against weather.
- B. Where existing exterior walls or roofs are disturbed due to alterations, disturbances shall be kept to a minimum and walls or roofs shall be repaired and patched in such a manner that the buildings will be absolutely watertight and meet the conditions of the existing roofing flashing and waterproofing bonds and guarantees.

#### 1.08 CUTTING, PATCHING, REPAIRING, AND REFINISHING

- A. The Contractor shall be responsible for cutting all openings in walls, floors and ceilings (indicated to remain) to accommodate alteration work under his Contract in accordance with the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified. Rough patching and all finish patching shall be by the Contractor.
  - 1. Where new openings are to occur in existing exterior and interior concrete and masonry bearing walls and structural concrete floor, the Contractor will be required to notify the Owner and Engineer in writing and shall obtain approval prior to cutting operations. The Engineer will determine whether such openings affect the structural stability or load bearing capacities of walls and floors.
  - 2. All holes and openings to be cut in existing walls, floors and ceilings of any nature shall be geometrically correct and no larger than necessary to accommodate the new work.
  - 3. No cutting of finished or structural work may be done without the approval of the Engineer.

- B. Major demolition and removal work such as demolition of buildings and structures, complete or nearly complete removal of floors, walls and ceilings indicated on the Drawings, shall be performed by the Contractor. The Contractor shall also be responsible for all finish patching operations of holes and openings in existing floors, walls, ceilings and roofs to accommodate the alteration work under the Plumbing, HVAC and Electrical Sections as well as that required for the Contractor's work hereinafter specified.
- C. Each Contractor and/or his Subcontractors shall provide sleeves, forms and inserts for installation by the General Contractor as specified in Section 01010, Summary of Work.

#### 1.09 EXISTING EQUIPMENT AND FURNISHINGS

- A. Existing built-in equipment to remain in the final work and requiring temporary removal shall be as hereinbefore specified under paragraph 1.05, D.
- B. Existing appliances and portable equipment such as desks, chairs, tables, etc., shall remain the property of the Owner and will be removed from rooms and spaces to be altered by the Contractor prior to construction and alteration operations, and stored where directed by the Owner.
- C. All unsalvageable equipment shall become the property of the Contractor in accordance with the requirements of Section 01540, Demolition and Removal of Existing Structures and Equipment, and shall be removed from each building and away from the site. Equipment to be retained, or relocated, shall be as shown on the Drawings or as specified.

#### 1.10 SCHEDULE OF INTERIOR FINISHES FOR EXISTING BUILDINGS

- A. Unless otherwise specified, all materials required for the work in the existing buildings shall be new, and where required shall match existing adjacent finishes.
- B. As indicated on the Drawings, specified or otherwise required to complete the work, the Contractor shall cut new openings and block up existing openings in floors, walls, partitions and ceilings; remove existing floors; remove, relocate existing and/or install new windows, doors, frames, transoms, access doors, partition sash and trim.
- C. The Contractor shall remove window sash, frame, sill, stool and trim at exterior door openings to be blocked up; remove door, frame and trim and, unless otherwise hereinafter specified or indicated on the Drawings to be blocked up with other materials, window and door openings shall be blocked up with brick and/or masonry block.
  - 1. At door, sash and other openings in interior partitions and walls to be closed, block up such openings with same materials and construction as adjacent, unless otherwise indicated on the Drawings. Plaster and finishes applied at blocked up openings shall finish even and straight, flush with and of the same texture or other surface characteristics of existing adjacent finishes.
- D. Existing finishes or subfloor surfaces which are scheduled to receive new floor finishes shall be repaired, patched with concrete, asphalt latex type emulsion and underlayment as required to suit existing surfaces or the new floor surfacing material to be applied.



- E. Concrete and floors disturbed by alterations shall be patched to finish even, straight and flush with adjacent surfaces.
- F. Where new ceramic tile flooring or base is to be installed over present concrete floors or base, and where a cove exists at the floor, the Contractor shall cut away part of the cove by grinding or other approved means to the extent required for installation of the new flooring or base.
- G. Existing partitions to be removed shall be removed for their entire height.
- H. Where existing bases and other trim are removed and grounds are exposed and will not be covered by new finishing materials such as resilient base, new trim, or wall covering, grounds shall be removed and wall surfaces patched with plaster to finished even, straight and flush with adjacent existing plaster surfaces. Where existing plaster ceilings are scheduled to be removed, the ceilings shall be replaced with new metal furring, lathing and plaster finish or acoustical ceilings or other ceiling system as indicated on the Drawings.
- I. Where partitions or walls are removed and existing ceiling on each side of the partition or wall is to remain, the gap shall be patched; a vertical break shall be provided if the ceilings are at different levels. Where the ceiling on one side is to remain and a new ceiling is scheduled for the area on the other side, the new ceiling shall be constructed so that the new and existing finished ceiling areas will be at the same level.
- J. Existing floors, walls and ceilings shall be cut as required for removal of existing services and for installation of new plumbing, heating, ventilating and air conditioning, and electrical work and related piping, duct work, conduits, fixtures and equipment.
- K. In addition to work specifically called for in the finish schedule on the Drawings, all finishes disturbed in the performance of any alterations or new work by any Contractor shall be patched or repaired to match existing surfaces or finishes. Holes, slots, chases, etc., in floors, walls and ceilings left by the removal of existing, or installation of new piping, plumbing fixtures, radiators, duct work, registers, grills, conduit, receptacles, switches, lighting fixtures and other items of the other Contracts shall also be patched or repaired by the Contractor.
- L. Existing spaces not listed on the finish schedule on the Drawings may require no work other than complete painting and patching by the Contractor of surfaces damaged in performance of any work included under this Contract.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 01070

### ABBREVIATIONS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The following is a partial list of typical abbreviations which may be used in the Specifications, and the organizations to which they refer:

|          |   |                                                                            |
|----------|---|----------------------------------------------------------------------------|
| AASHTO   | - | American Association of State Highway and Transportation Officials         |
| ACI      | - | American Concrete Institute                                                |
| ACIFS    | - | American Cast Iron Flange Standards                                        |
| AFBMA    | - | Anti-Friction Bearing Manufacturer's Association                           |
| AGA      | - | American Gas Association                                                   |
| AGMA     | - | American Gear Manufacturers Association                                    |
| AIA      | - | American Institute of Architects                                           |
| AISC     | - | American Institute of Steel Construction                                   |
| AISI     | - | American Iron and Steel Institute                                          |
| ANSI     | - | American National Standard Institute                                       |
| API      | - | American Petroleum Institute                                               |
| ASCE     | - | American Society of Civil Engineers                                        |
| ASHRAE   | - | American Society of Heating, Refrigeration, and Air Conditioning Engineers |
| ASME     | - | American Society of Mechanical Engineers                                   |
| ASTM     | - | American Society for Testing and Materials                                 |
| AWS      | - | American Welding Society                                                   |
| AWWA     | - | American Water Works Association                                           |
| CEMA     | - | Conveyor Equipment Manufacturer's Association                              |
| CRSI     | - | Concrete Reinforcing Steel Institute                                       |
| DIPRA    | - | Ductile Iron Pipe Research Association                                     |
| Fed Spec | - | Federal Specifications                                                     |
| IEEE     | - | Institute of Electrical and Electronic Engineers                           |
| IPCEA    | - | Insulated Power Cable Engineers Association                                |
| ISO      | - | Insurance Services Offices                                                 |
| NBS      | - | National Bureau of Standards                                               |
| NCDOT    | - | North Carolina Department of Transportation                                |
| NEC      | - | National Electric Code                                                     |
| NEMA     | - | National Electrical Manufacturers Association                              |
| OSHA     | - | Occupational Safety and Health Act                                         |
| PCI      | - | Precast Concrete Institute                                                 |
| UL       | - | Underwriters Laboratories, Inc.                                            |
| USGS     | - | United States Geological Survey                                            |

#### PART 2 -- PRODUCTS

(NOT USED)

#### PART 3 -- EXECUTION

(NOT USED)

01070  
Abbreviations

SECTION 01090  
REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Wherever reference is made to any published standards, codes, or standard specifications, it shall mean the latest standard code, specification, or tentative specification of the technical society, organization, or body referred to, which is in effect at the date of invitation for Bids.
- B. All materials, products, and procedures used or incorporated in the work shall be in strict conformance with applicable codes, regulations, specifications, and standards.
- C. A partial listing of codes, regulations, specifications, and standards includes the following:

Air Conditioning and Refrigeration Institute (ARI)

Air Diffusion Council (ADC)

Air Moving and Conditioning Association (AMCA)

The Aluminum Association (AA)

American Architectural Manufacturers Association (AAMA)

American Concrete Institute (ACI)

American Gear Manufacturers Association (AGMA)

American Hot Dip Galvanizers Association (AHDGA)

American Institute of Steel Construction, Inc. (AISC)

American Iron and Steel Institute (AISI)

American National Standards Institute (ANSI)

American Society of Civil Engineers (ASCE)

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

American Society of Mechanical Engineers (ASME)

American Society for Testing and Materials (ASTM)

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American Standards Association (ASA)  
American Water Works Association (AWWA)  
American Welding Society (AWS)  
American Wood-Preserver's Association (AWPA)  
Anti-Friction Bearing Manufacturers Association (AFBMA)  
Building Officials and Code Administrators (BOCA)  
California Building Code (CBC)  
Conveyor Equipment Manufacturers Association (CEMA)  
Consumer Product Safety Commission (CPSC)  
Factory Mutual (FM)  
Federal Specifications  
Instrument Society of America (ISA)  
Institute of Electrical and Electronics Engineers (IEEE)  
National and Local Fire Codes  
Lightning Protection Institute (LPI)  
National Electrical Code (NEC)  
National Electrical Manufacturer's Association (NEMA)  
National Electrical Safety Code (NESC)  
National Electrical Testing Association (NETA)  
National Fire Protection Association (NFIPA)  
Regulations and Standards of the Occupational Safety and Health Act (OSHA)  
Southern Building Code Congress International, Inc. (SBCCI)  
Sheet Metal & Air Conditioning Contractors National Association (SMACCNNA)  
Standard Building Code

Standard Mechanical Code

Standard Plumbing Code

Uniform Building Code (UBC)

Underwriters Laboratories Inc. (UL)

- D. Contractor shall, when required, furnish evidence satisfactory to the Engineer that materials and methods are in accordance with such standards where so specified.
- E. In the event any questions arise as to the application of these standards or codes, copies shall be supplied on-site by the Contractor.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01200  
PROJECT MEETINGS

PART 1 -- GENERAL

1.01 PRE-BID MEETING

- A. A pre-bid meeting will be held at the time and place to be designated in the Instructions to Bidders.
- B. The Engineer will be available to discuss the project and answer pertinent questions. No oral interpretation will be made as to the meaning of the Documents. Interpretation, if deemed necessary by the Engineer, will be in the form of an Addendum to the Contract Documents.

1.02 PRECONSTRUCTION MEETING

- A. A preconstruction meeting will be held after Award of Contract, but prior to starting work at the site.
- B. Attendance:
  - 1. Owner
  - 2. Engineer
  - 3. Contractor
  - 4. Major subcontractors
  - 5. Safety representative
  - 6. Representatives of governmental or other regulatory agencies.
- C. Minimum Agenda:
  - 1. Tentative construction schedule
  - 2. Critical work sequencing
  - 3. Designation of responsible personnel
  - 4. Processing of Field Decisions and Change Orders
  - 5. Adequacy of distribution of Contract Documents

6. Submittal of Shop Drawings and samples
7. Procedures for maintaining record documents
8. Use of site and Owner's requirements
9. Major equipment deliveries and priorities
10. Safety and first aid procedures
11. Security procedures
12. Housekeeping procedures
13. Processing of Partial Payment Requests
14. General regard for community relations

#### 1.03 PROGRESS MEETING

- A. Progress meetings will be held monthly at the City's Municipal Services Center during the performance of the work of this Contract. Additional meetings may be called as progress of work dictates.
- B. Engineer will preside at meetings and record minutes of proceedings and decisions. Engineer will distribute copies of minutes to participants.
- C. Attendance:
  1. Engineer
  2. Contractor
  3. Subcontractors, only with Engineer's approval or request, as pertinent to the agenda
- D. Minimum Agenda:
  1. Review and approve minutes of previous meetings.
  2. Review progress of Work since last meeting.
  3. Review proposed 30-60 day construction schedule.
  4. Note and identify problems which impede planned progress.
  5. Develop corrective measures and procedures to regain planned schedule.
  6. Revise construction schedule as indicated and plan progress during next work period.

7. Maintaining of quality and work standards.
8. Complete other current business.
9. Schedule next progress meeting.

#### PART 2 -- PRODUCTS

(NOT USED)

#### PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -



## SECTION 01300

### SUBMITTALS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

###### A. Progress Schedule

1. Within two (2) weeks after issuance of the Notice to Proceed, the Contractor shall prepare and submit five (5) copies of his proposed progress schedule to the Engineer for review and approval.
2. If so required, the schedule shall be revised until it is approved by the Engineer.
3. Schedule shall be updated monthly, depicting progress to the last day of the month and five (5) copies submitted to the Engineer not later than the fifth day of the month, and prior to the application for progress payment. Failure to provide monthly schedule updates will be grounds for the Engineer or Owner to withhold progress payment approval.
4. Schedule shall be prepared in the form of a horizontal bar chart showing in detail the proposed sequence of the work and identifying construction activities for each structure and for each portion of work.
5. Schedule shall be time scaled, identifying the first day of each week. The Schedule shall be provided with estimated dates for Early Start, Early Finish, Late Start and Late Finish. The work shall be scheduled to complete the Project within the Contract time. The Late Finish date shall equal the Contract Completion Date.
6. Schedule shall show duration (number of days) and float for each activity. Float shall be defined as the measure of leeway in starting or completing a scheduled activity without adversely affecting the project completion date established by the Contract Documents.
7. Updated schedule shall show all changes since the previous submittal.
8. All revisions to the schedule must have the prior approval of the Engineer.

###### B. Equipment and Material Orders Schedule

1. Contractor shall prepare and submit five (5) copies of his schedule of principal items of equipment and materials to be purchased to the Engineer for review and approval.
2. If so required, the schedule shall be revised until it is approved by the Engineer.

3. Schedule shall be updated monthly and five (5) copies submitted to the Engineer not later than the fifth day of every month with the application for progress payment.
4. The updated schedule shall be based on the Progress Schedule developed under the requirements of Paragraph 1.01(A) of this Section.
5. Schedule shall be in tabular form with appropriate spaces to insert the following information for principal items of equipment and materials:
  - a. Dates on which Shop Drawings are requested and received from the manufacturer.
  - b. Dates on which certification is received from the manufacturer and transmitted to the Engineer.
  - c. Dates on which Shop Drawings are submitted to the Engineer and returned by the Engineer for revision.
  - d. Dates on which Shop Drawings are revised by manufacturer and resubmitted to the Engineer.
  - e. Date on which Shop Drawings are returned by Engineer annotated either "Furnish as Submitted" or "Furnish as Corrected".
  - f. Date on which accepted Shop Drawings are transmitted to manufacturer.
  - g. Date of manufacturer's scheduled delivery.
  - h. Date on which delivery is actually made.

C. Working Drawings

1. Within thirty (30) days after the Notice to Proceed, each prime Contractor shall prepare and submit five (5) copies of his preliminary schedule of Working Drawing submittals to the Engineer for review and approval. If so required, the schedule shall be revised until it is approved by the Engineer.
2. Working Drawings include, but are not limited to, Shop Drawings, layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Contractor shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Working Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. Contractor shall secure such information, details, Drawings, etc., from all possible sources including the Drawings, Working Drawings prepared by subcontractors, Engineers, suppliers, etc.
3. Working Drawings shall accurately and clearly present the following:

- a. All working and installation dimensions.
  - b. Arrangement and sectional views.
  - c. Units of equipment in the proposed positions for installation, details of required attachments and connections, and dimensioned locations between units and in relation to the structures.
  - d. Necessary details and information for making connections between the various trades including, but not limited to, power supplies and interconnecting wiring between units, accessories, appurtenances, etc.
4. In the event that the Engineer is required to provide additional engineering services as a result of a substitution of materials or equipment by the Contractor, the additional services will be provided in accordance with Section 01010 - Summary of Work, and will be covered in supplementary or revised Drawings which will be issued to the Contractor. All changes indicated that are necessary to accommodate the equipment and appurtenances shall be incorporated into the Working Drawings submitted to the Engineer.
5. Working Drawings specifically prepared for this Project shall be on mylar or other approved reproducible material sheets of the same size as the Drawings. Working Drawings shall conform to recognized drafting standards and be neat, legible and drawn to a large enough scale to show in detail the required information.
6. The Drawings are used for engineering and general arrangement purposes only and are not to be used for Working Drawings.
7. Shop Drawings
- a. Contractor shall submit for review by the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished by the Contract Documents.
  - b. Structural and all other layout Drawings prepared specifically for the Project shall have a plan scale of not less than 1/4-inch = 1 foot.
  - c. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of prepared Shop Drawings, such submittals shall specifically indicate the item for which approval is requested. Identification of items shall be made in ink, and submittals showing only general information are not acceptable.
8. Layout and Installation Drawings
- a. Contractor shall prepare and submit for review by the Engineer layout and installation drawings for all pipes, valves, fittings, sewers, drains, heating and ventilation ducts, all electrical, heating, ventilating and other conduits, plumbing lines, electrical cable trays, lighting fixture layouts, and circuiting,

instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, etc., under this Contract. The final dimensions, elevation, location, etc., of pipe, valves, fittings, sewers, ducts, conduits, electrical cable trays, equipment, etc., may depend upon the dimensions of equipment and valves to be furnished by the Contractor.

- b. Layout and installation drawings are required for both interior and exterior piping, valves, fittings, sewers, drains, heating and ventilation ducts, conduits, plumbing lines, electrical cable trays, etc.
- c. Layout and installation Drawings shall show connections to structures, equipment, sleeves, valves, fittings, etc.
- d. Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.
- e. The Drawings for pipes, ducts, conduits, etc., shall show all 3-inch and larger electrical conduits and pressure piping, electrical cable trays, heating and ventilation ducts or pipes, structure, manholes or any other feature within four (4) feet (measured as the clear dimension) from the pipe duct, conduit, etc., for which the profile is drawn.

#### 9. Contractor Responsibilities

- a. All submittals from subcontractors, manufacturers or suppliers shall be sent directly to the Contractor for checking. Contractor shall thoroughly check all Drawings for accuracy and conformance to the intent of the Contract Documents. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors, manufacturers, or suppliers by the Contractor for correction before submitting them to the Engineer.
- b. All submittals shall be bound, dated, properly labeled and consecutively numbered. Information on the label shall indicate Specification Section, Drawing number, subcontractor's, manufacturer's or supplier's name and the name or type of item the submittal covers. Each part of a submittal shall be marked and tabulated.
- c. Working Drawings shall be submitted as a single complete package including all associated drawings relating to a complete assembly of the various parts necessary for a complete unit or system.
- d. Shop Drawings shall be submitted as a single complete package for any operating system and shall include all items of equipment and any mechanical units involved or necessary for the functioning of such system. Where applicable, the submittal shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

- e. ALL SUBMITTALS SHALL BE THOROUGHLY CHECKED BY THE CONTRACTOR FOR ACCURACY AND CONFORMANCE TO THE INTENT OF THE CONTRACT DOCUMENTS BEFORE BEING SUBMITTED TO THE ENGINEER AND SHALL BEAR THE CONTRACTOR'S STAMP OF APPROVAL CERTIFYING THAT THEY HAVE BEEN SO CHECKED. SUBMITTALS WITHOUT THE CONTRACTOR'S STAMP OF APPROVAL WILL NOT BE REVIEWED BY THE ENGINEER AND WILL BE RETURNED TO THE CONTRACTOR.
  - f. If the submittals contain any departures from the Contract Documents, specific mention thereof shall be made in the Contractor's letter of transmittal. Otherwise, the review of such submittals shall not constitute approval of the departure.
  - g. No materials or equipment shall be ordered, fabricated, shipped or any work performed until the Engineer returns to the Contractor the submittals, herein required, annotated "Furnish as Submitted", "Furnish as Corrected", or "Furnish as Corrected – Confirm." If a submittal is returned "Furnish as Corrected – Confirm" the portions of work covered by the submittal that require confirmation by the Engineer shall not be ordered, fabricated, shipped, or any work performed until those portions are approved in a subsequent submittal either "Furnish as Submitted" or "Furnish as Corrected".
  - h. Where errors, deviations, and/or omissions are discovered at a later date in any of the submittals, the Engineer's prior review of the submittals does not relieve the Contractor of the responsibility for correcting all errors, deviations, and/or omissions.
10. Procedure for Review
- a. Submittals shall be transmitted in sufficient time to allow the Engineer at least thirty (30) working days for review and processing.
  - b. Contractor shall transmit seven (7) copies of all technical data or drawing to be reviewed.
  - c. Submittal shall be accompanied by a letter of transmittal containing date, project title, Contractor's name, number and titles of submittals, a list of relevant specification sections, notification of departures from any Contract requirement, and any other pertinent data to facilitate review.
  - d. Submittals will be annotated by the Engineer in one of the following ways:
    - "Furnish as Submitted" (FAS) - no exceptions are taken
    - "Furnish as Corrected" (FAC) - minor corrections are noted and shall be made.

"Furnish as Corrected – Confirm" (FACC) - some corrections are noted and a partial resubmittal or additional information are required as specifically requested.

"Revise and Resubmit" (R&R) - major corrections are noted and a full resubmittal is required.

"For Information Only – Not Reviewed" (FIO) – submittal was received and was distributed for record purposes without review.

- e. If a submittal is satisfactory to the Engineer in full or in part, the Engineer will annotate the submittal "Furnish as Submitted", "Furnish as Corrected", or "Furnish as Corrected – Confirm", retain four (4) copies and return remaining copies to the Contractor. If reproducible transparencies are submitted, the Engineer will retain the copies and return the reproducible transparencies to the Contractor. In the case of "Furnish as Corrected – Confirm" a partial resubmittal or additional information are required as specifically requested.
- f. If a full resubmittal is required, the Engineer will annotate the submittal "Revise and Resubmit" and transmit three (3) copies to the Contractor for appropriate action. If reproducible transparencies are submitted, the Engineer will retain the copies and return the reproducible transparencies to the Contractor.
- g. Contractor shall continue to resubmit submittals in part if they are returned "Furnish as Corrected – Confirm" or in full if they are returned "Revise and Resubmit" as required by the Engineer until submittals are acceptable to the Engineer. It is understood by the Contractor that Owner may charge the Contractor the Engineer's charges for review in the event a submittal is not approved (either "Furnish as Submitted" or "Furnish as Corrected") by the third submittal for a system or piece of equipment. These charges shall be for all costs associated with engineering review, meetings with the Contractor or manufacturer, etc., commencing with the fourth submittal of a system or type of equipment submitted for a particular Specification Section.
- h. Acceptance of a Working Drawing by the Engineer will constitute acceptance of the subject matter for which the Drawing was submitted and not for any other structure, material, equipment or appurtenances indicated or shown.

#### 11. Engineer's Review

- a. Engineer's review of the Contractor's submittals shall in no way relieve the Contractor of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.
- b. Engineer's review will be confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the

purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

12. Record Working Drawings

- a. Contractor shall maintain current record drawings onsite for the Engineer's review. Record drawings shall be updated monthly at a minimum.
- b. Prior to final payment, the Contractor shall furnish the Engineer one complete set of all accepted Working Drawings, including Shop Drawings, for equipment, piping, electrical work, heating system, ventilating system, air conditioning system, instrumentation system, plumbing system, structural, interconnection wiring diagrams, etc.
- c. Working Drawings furnished shall be corrected to include any departures from previously accepted Drawings.

D. Operation and Maintenance Manuals

1. Two (2) preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not less than 60 days prior to the start-up of the respective equipment.
2. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner. Following review of the preliminary copies of the Operation and Maintenance Manuals, one (1) copy will be returned to the Contractor with required revisions noted, or the acceptance of the Engineer noted.
3. Manuals shall contain complete information in connection with assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts.
4. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contact information.
5. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.
6. Following the Engineer's review of the preliminary manuals, the Contractor shall submit five (5) paper copies and two (2) electronic copies of the final Operation and Maintenance Manuals to the Engineer. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents. Failure of the final manuals to reflect the required revisions noted by the Engineer during a

review of the Preliminary documents will result in the manuals being returned to the Contractor. Acceptable final Operation and Maintenance Manuals shall be provided not less than two week prior to equipment start-up.

E. Certified Shop Test Reports

1. Each piece of equipment for which pressure, head, capacity, rating, efficiency, performance, function or special requirements are specified or implied shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and applicable test codes and standards. Contractor shall keep the Engineer advised of the scheduling of shop tests so that the Engineer may arrange for the witnessing or inspection at the proper time and place.
2. The Contractor shall secure from the manufacturers seven (7) copies of the actual test data, the interpreted results and a complete description of the testing facilities and testing setup, all accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company and notarized. These reports shall be forwarded to the Engineer for review.
3. In the event any equipment fails to meet the test requirements, the manufacturer shall make all necessary changes, adjustments or replacements and the tests shall be repeated, at no additional cost to the Owner or Engineer, until the equipment test requirements are acceptable to the Engineer.
4. No equipment shall be shipped to the Project until the Engineer notifies the Contractor, in writing, that the shop test reports are acceptable.

F. Samples

1. Contractor shall furnish for review all samples as required by the Contract Documents or requested by the Engineer.
2. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show the nature of the material, trade name of manufacturer and location of the work where the material represented by the sample will be used.
3. Samples shall be checked by the Contractor for conformance to the Contract Documents before being submitted to the Engineer and shall bear the Contractor's stamp of approval certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the Contractor.
4. Engineer's review will be for compliance with the Contract Documents and his comments will be transmitted to the Contractor with reasonable promptness.
5. Accepted samples will establish the standards by which the completed work will be judged.



#### G. Construction Photographs

1. The General Contractor shall take photographs at the locations and at such stages of the construction as directed by the Engineer. These photographs shall be in the form of digital images in uncompressed TIFF or JPEG format produced with a minimum 3.0 mega pixels and image resolution of not less than 1024 by 768 pixels.
2. Provide the equivalent of up to 1,000 digital images per month for the duration of the Contract time. When directed by the Engineer, frequency of photographs may be increased to weekly sessions provided that the equivalent number of digital images is not exceeded. Engineer may waive requirements for digital images during inactive construction periods in favor of increased photographs during active construction sequences.
3. The General Contractor shall take images using the maximum range of depth of field, and that are in focus, to clearly show the work. Photos with blurry or out-of-focus areas will not be accepted.
4. Submittal Requirements
  - a. Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software. to the Engineer within seven (7) days of the date taken.
  - b. Date and Time: Include date and time filename for each image.
  - d. At completion of the work, all electronic files shall be turned over to the Owner.

#### PART 2 -- PRODUCTS

(NOT USED)

#### PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 01350

### SEISMIC ANCHORAGE AND BRACING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to design and provide seismic restraint and bracing for all nonstructural architectural, mechanical, electrical, and plumbing components and their supports and attachments permanently attached to the primary structure in which the components are to be installed in accordance with the Contract Documents and the seismic restraint requirements of Chapter 13 in ASCE 7.
- B. Furnish mechanical, electrical, and plumbing equipment manufacturer certifications showing seismic compliance in accordance with Chapter 13 of ASCE 7 for equipment designated as an essential component or to remain operational following a seismic event.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 – Metal Materials
- B. Section 05050 – Metal Fastening
- C. Section 05120 – Structural Steel
- D. Section 15000 – Basic Mechanical Requirements
- E. Section 15020 – Pipe Supports
- F. Section 16000 – Basic Electrical Requirements
- G. Division 17 – Control and Information Systems
- H. Further requirements for seismic anchorage and bracing may be included in other Sections of the Specifications. See section for the specific item in question.

##### 1.03 DEFINITIONS

- A. Nonstructural components: All architectural, mechanical, electrical or plumbing elements or systems and their supports or attachments provided under this contract which are permanently attached to the floors, roof, walls, columns and beams of newly constructed buildings, building additions, existing buildings or non-building structures.
  - 1. Architectural nonstructural components include, but are not limited to, interior nonstructural walls and partitions, exterior wall panels and glazing elements,

glass curtain walls, skylights, cabinets, suspended ceilings, fascias, and cladding.

2. Mechanical nonstructural components include, but are not limited to, HVAC units, fans, water and wastewater treatment process equipment, instrumentation cabinets, piping and ductwork.
  3. Electrical nonstructural components include, but are not limited to, conduit systems, cable tray systems, boxes, transformers, panelboards, switchboards, switchgear, busway, individual motor controllers, motor control centers, variable frequency drives, automatic transfer switches, and lighting systems.
  4. Plumbing nonstructural components include, but are not limited to, sprinkler systems and associated piping, and sump pumps.
- B. Seismic Restraint: Attachments and supports, including braces, frames, legs, hangers, saddles, and struts which anchor and brace nonstructural components to minimize their displacement during an earthquake and transmit loads between non-structural components and their attachments to the structure or building.
- C. Attachment: Elements including anchor bolts, welded connections, and mechanical fasteners which secure non-structural components or supports to the structure.
- D. Hazardous: Toxic, flammable, explosive or corrosive materials in excess of building code mandated threshold quantities for non-hazardous condition.
- E. Essential Components: Nonstructural components considered necessary to public safety for which the importance factor  $I_p$  applies, including:
1. Life safety systems which must function following an earthquake, including but not limited to, sprinklers for fire protection, emergency lighting, egress corridors and stairways, and smoke purge systems.
  2. Components which contain, convey or support hazardous materials.
  3. Components which are within or attached to an Occupancy or Risk Category IV structure as defined in ASCE 7 Chapter 1.
- F. Nonbuilding Structures: All self-supporting structures which are supported by an independent foundation or by other structures which include, but are not limited to, storage tanks, silos, exhaust stacks, storage racks, and towers.
- G. Delegated Design: Design of a structure or structural element(s) which has been deferred by the contract documents to be performed during the project construction stage, by a registered design professional retained by the contractor and with the design submitted as a shop drawing to the Engineer.

#### 1.04 EXEMPTIONS

- A. The following nonstructural components are exempt from requiring seismic anchorage and bracing: (See paragraph 1.07.C herein for Seismic Design Category)
1. All mechanical, electrical and plumbing nonstructural components in Seismic Design Category D, E or F provided all the following apply:
    - a.  $I_p = 1.0$ .
    - b. Components are positively attached to the structure without consideration of frictional resistance and have flexible connections between the components and associated ductwork, piping and conduit.
    - c. Either of the following:
      - i. Component center of mass is 4 ft or less above a floor level and weighs 400 lbs or less.
      - ii. Component weighs 20 lbs or less or 5 plf or less for distribution systems.
  2. Other exemptions as allowed by the Specifications, Codes and Standards referenced herein.

#### 1.05 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. The building code shall be the version in effect at the time of Bid within the jurisdiction where the Work is located. All other referenced specifications, codes, and standards refer to the version as referenced by the building code. If no version is referenced by the building code, then the most current issue available at the time of Bid shall be used.
1. California Building Code
  2. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures
  3. NFPA 13 Standard for Installation of Sprinkler Systems
  4. FEMA 412 Installing Seismic Restraints for Mechanical Equipment
  5. FEMA 413 Installing Seismic Restraints for Electrical Equipment
  6. FEMA 414 Installing Seismic Restraints for Duct and Pipe
  7. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Seismic Restraint Manual: Guidelines for Mechanical Systems

8. ACI 318 Building Code Requirements for Structural Concrete and Commentary
9. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete
10. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

#### 1.06 SUBMITTALS

##### A. Submit the following in accordance with Section 01300, Submittals.

1. Seismic anchorage and bracing shop drawings for all architectural, mechanical, electrical, and plumbing nonstructural components, elements and systems not meeting any of the exemptions in paragraph 1.4 above and do not have a design for seismic anchorage and bracing provided within the contract documents. Submittals shall include the following:
  - a. Component manufacturer's cut sheets and fabrication details for equipment bases and foundations, including dimensions, structural member sizes, support point locations and equipment operational loads. Equipment anchorage details shall clearly indicate anchor size, pattern, embedment and edge distance requirements to satisfy operational and seismic forces. Details shall also indicate grout, bearing pads, isolators, etc required for complete installation.
  - b. Design calculations, signed and sealed by a Professional Engineer registered in the State of California confirming the proposed seismic restraints and attachment will provide sufficient strength and stiffness to resist the design earthquake and limit damage to nonstructural components and the entire support is sufficient to resist the combined gravity and seismic loads. Separate calculation submittals for vertical and lateral load support systems shall not be allowed.
  - c. Detailed Shop Drawings, signed and sealed by a Professional Engineer registered in the State of California, showing specific details of the support design including material, installation, attachments, connection hardware, etc, and the restraint layout and location of all hangers and supports (resisting both gravity and seismic loads), including restraint orientation and direction of force(s) to be resisted. Within each submittal, the Contractor shall include a **cumulative** set of hanger and support location drawings (one cumulative 'living drawing for each building structure) containing all proposed mechanical, electrical and plumbing support locations submitted to date showing the locations of all support attachments to the primary structure. Load magnitudes shall be indicated at attachments to the structure where the sum of the reaction loads on a single member exceeds 1000 pounds vertically or exceeds 500 pounds horizontally. Unless requested by the Engineer, load magnitudes need not be submitted for load values less than these stated values. Separate

shop drawing submittals for vertical and lateral load support systems shall not be allowed.

- d. For components required to be certified as seismically qualified in accordance with paragraph 1.06.A.2 below, submit installation guidelines provided by the equipment manufacturer for proper seismic mounting of the equipment.
2. For each mechanical, electrical and plumbing nonstructural components and systems furnished, including associated equipment appurtenances and attachments, designated as essential components in Seismic Design Categories C through F, provide Manufacturer's Certification signed and sealed by a registered Professional Engineer in the State of California to show the component is seismically qualified in accordance with the Specifications, Codes, and Standards requirements referenced herein. The following requirements shall be met:
- a. Seismic qualification shall be substantiated either by approved shake table testing or experience data, with the evidence of such qualification testing or experience data submitted to the Engineer along with the manufacturer's statement certifying the equipment shall remain operable following the design seismic event.
  - b. Components with hazardous contents shall also be certified by the manufacturer to maintain containment following the design seismic event based on analysis, approved shake table testing, or experience data. Evidence demonstrating compliance shall be submitted to the Engineer.
  - c. Seismic qualification testing shall be based on ASCE 7 and on a nationally recognized testing standard procedure such as ICC-ES AC 156.

#### 1.07 DESIGN REQUIREMENTS

- A. Seismic restraints systems for nonstructural components shall be subject to the most current local Building Code in conjunction with the seismic provisions of the California Building Code (CBC) Section 1613 and referenced ASCE 7 Chapter 13.
- B. Seismic restraints systems for nonbuilding structures shall be subject to the most current local Building Code in conjunction with the seismic provisions of the California Building Code (CBC) Section 1613 and referenced ASCE 7 Chapter 15.
- C. Nonstructural components shall be assigned to the same Seismic Design Category as the structure they occupy or to which they are attached. Design of seismic support system and anchorage shall follow the site-specific seismic criteria noted on the drawings. Criteria shall include site-specific spectral response coefficients, site class, seismic design category, and risk category.
- D. Component Importance Factor  $I_p$  shall be 1.5 for all essential nonstructural components

noted in item 1.03.E above. All other nonstructural components shall utilize  $I_p = 1.0$  unless noted otherwise.

- E. Components shall be restrained and braced for earthquake forces both in the vertical and each orthogonal direction. Seismic restraint systems shall limit deflections of components per ASCE 7 and the displacements shall not impede component functionally and containment.
- F. Anchorage shall be designed in accordance with ASCE 7. Mechanical fasteners used to secure nonstructural architectural, mechanical, electrical and plumbing components shall meet the requirements of Specification Section 05050. All mechanical fasteners used to anchor essential components and other elements so designated in Specification Section 05050 shall be considered Structural Anchors.
- G. Avoid crossing structural expansion joints with seismic supports or bracing. Nonstructural components shall not be attached to multiple structure elements which may respond differently in an earthquake without provisions to accommodate independent movement. Flexible expansion loops or offsets, flexible joints, bellows type pipe expansion joints, couplings, etc shall be provided at structure expansion joints to allow for independent structure movement and thermal movement of piping, ductwork and conduit. Minimum movement capability in the vertical and each orthogonal direction shall equal the width of the joint.
- H. Provide flexible connections, piping, conduit, etc at foundation levels where below grade utilities enter into the structure.
- I. Design of support system for components with multiple attachments shall take into account the stiffness and ductility of the supporting members. Equipment designed as free-standing shall only be attached at its base. Use of non-free standing equipment requiring both vertical and lateral attachment is contingent upon loads applied to the structure and requires approval by the Engineer.
- J. The seismic restraint design shall be based on actual equipment data (dimensions, weight, center of gravity, etc) obtained from the specifications or the approved equipment manufacturer. The equipment manufacturer shall verify the attachment points on the equipment can safely withstand the combination of seismic, self-weight and other loads imposed.
- K. Attachments of nonstructural component supports and seismic restraints causing the building structure slabs, beams, walls, columns, etc. to be overstressed shall not be permitted.
- L. Where the weight of a nonstructural component is greater than or equal to 25 percent of the effective seismic weight (as defined by ASCE 7) of the structure it is attached to, the component shall be classified as a nonbuilding structure and its support designed in accordance with ASCE 7 Chapter 15.
- M. No reaction loads (either vertical or lateral) from nonstructural component supports and seismic restraints shall be allowed on any element where design has been delegated

unless the additional loads on the element have been coordinated with the delegated designer and the submittal is accompanied by a sealed letter from the delegated designer indicating the element has been designed to support the reaction loads.

- N. Reaction loads from nonstructural component supports and seismic restraints shall be transferred directly to the primary structural members, with no components supported from secondary members unless otherwise approved.
- O. No holes shall be drilled into any structural steel for attachment of component supports without prior approval of the Engineer.

## PART 2 -- PRODUCTS

### 2.01 MATERIALS

- A. Seismic restraints and braces shall be constructed of appropriate materials and connecting hardware to provide a continuous load path between the component and supporting structure of sufficient strength and stiffness to resist the calculated design seismic forces and displacements.
- B. Component restraint, bracing and connection materials shall be compatible with and in general match the component and component gravity support materials. Contact between dissimilar metals shall be prevented. See Section 15020 – Pipe Supports for additional details.
- C. Post-installed concrete anchors used for seismic restraint and bracing anchorage shall be considered structural anchors per Section 05050 and shall be prequalified for use in seismic applications.
- D. Powder actuated fasteners in steel or concrete shall not be used for sustained tension loads in Seismic Design Categories D, E or F unless approved for seismic loading or specifically exempted by ASCE 7. Powder actuated fasteners in masonry shall not be used unless approved for seismic loading regardless of Seismic Design Category.
- E. Friction clips shall not be used in Seismic Design Categories D, E or F for supporting sustained tension loads in combination with resisting seismic forces. C-type and large flange clamps may be used for hanger attachments provided restraining straps meeting NFPA 13 requirements are utilized and loosening of threaded connections is prevented by lock nuts, burred threads, etc.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION OF SEISMIC RESTRAINTS AND ANCHORAGES

- A. No components, seismic anchorages or restraints shall be installed prior to review and acceptance by the Engineer and permitting agency.
- B. Seismic certified equipment shall be installed per the manufacturer's recommendations. Fasteners shall meet manufacturer's requirements.



- C. Following installation, all seismic restraints, bracing and seismically qualified equipment shall be inspected. See the drawings and Chapter 17 of the California Building Code for Special Inspection requirements.

- END OF SECTION -

SECTION 01400  
QUALITY CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Testing Laboratory Services

1. Laboratory testing and checking required by the Specifications, including the cost of transporting all samples and test specimens, shall be provided and paid for by the Owner unless otherwise indicated in the Specifications.
2. Materials to be tested include, but are not necessarily limited to the following: cement, concrete aggregate, concrete, bituminous paving materials, structural and reinforcing steel, waterproofing, select backfill, crushed stone or gravel and sand.
3. Tests required by the Owner shall not relieve the Contractor from the responsibility of supplying test results and certificates from manufacturers or suppliers to demonstrate conformance with the Specifications.
4. Procedure
  - a. The Contractor shall plan and conduct his operations to permit taking of field samples and test specimens, as required, and to allow adequate time for laboratory tests.
  - b. The collection, field preparation and storage of field samples and test specimens shall be as directed by the Engineer with the cooperation of the Contractor.
5. Significance of Tests
  - a. Test results shall be binding on both the Contractor and the Owner, and shall be considered irrefutable evidence of compliance or noncompliance with the Specification requirements, unless supplementary testing shall prove, to the satisfaction of the Owner, that the initial samples were not representative of actual conditions.
6. Supplementary and Other Testing
  - a. Nothing shall restrict the Contractor from conducting tests he may require. Should the Contractor at any time request the Owner to consider such test results, the test reports shall be certified by an independent testing laboratory acceptable to the Owner. Testing of this nature shall be conducted at the Contractor's expense.

## 1.02 FIELD TESTING OF EQUIPMENT

- A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions.
- B. Preliminary Field Tests, Yellow Tag
  1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall check the equipment for alignment, direction of rotation and that it is free from defects.
  2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.
  3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.
  4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.
- C. Final Field Tests, Blue Tag
  1. Upon completion of the installation, and at a time approved by the Engineer, equipment will be tested by operating it as a unit with all related piping, ducting, electrical controls and mechanical operations.
  2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.
  3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Equipment shall be tested for the characteristics as specified for the item.
  4. Each pump shall be tested at maximum rated speed for at least four points on the pump curve for capacity, head and electric power input. The rated motor nameplate current and power shall not be exceeded at any point within the specified range. Vibrometer readings shall be taken when directed by the Engineer and the results recorded. Additional tests shall be performed as prescribed in other sections of the Specifications.

5. Pumps with drive motors rated at less than five horsepower shall only be tested for excess current or power when overheating or other malfunction becomes evident in general testing.
6. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.
7. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.
8. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.
9. All costs in connection with such tests including all materials, equipment, instruments, labor, etc., shall be borne by the Contractor.

#### 1.03 IMPERFECT WORK, EQUIPMENT, OR MATERIALS

- A. Any defective or imperfect work, equipment, or materials furnished by the Contractor which is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it may have been overlooked by the Engineer and estimated for payment. Any equipment or materials condemned or rejected by the Engineer shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.
- B. The Engineer may order tests of imperfect or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor; and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the work, equipment, or material was not impaired, consistent with the final general appearance of same, the work, equipment, or materials may be deemed acceptable. If the results of such tests reveal that the required functional capability of the questionable work, equipment, or materials has been impaired, then such work, equipment, or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect work, equipment, or material in lieu of performing the tests.

#### 1.04 INSPECTION AND TESTS

- A. The Contractor shall allow the Engineer ample time and opportunity for testing materials and equipment to be used in the work. He shall advise the Engineer promptly upon placing orders for material and equipment so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the Engineer and his representatives, facilities including labor, and allow proper time for inspecting and testing materials, equipment, and workmanship. The Contractor must anticipate possible delays that may be caused in the execution of his work due to the

necessity of materials and equipment being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required by the Engineer for testing, and shall make his own arrangements for providing water, electric power, or fuel for the various inspections and tests of structures and equipment.

- B. The Contractor shall furnish the services of representatives of the manufacturers of certain equipment, as prescribed in other Sections of the Specifications. The Contractor shall also place his orders for such equipment on the basis that, after the equipment has been tested prior to final acceptance of the work, the manufacturer will furnish the Owner with certified statements that the equipment has been installed properly and is ready to be placed in functional operation. Tests and analyses required of equipment shall be paid for by the Contractor, unless specified otherwise in the Section which covers a particular piece of equipment.
- C. Where other tests or analyses are specifically required in other Sections of these Specifications, the cost thereof shall be borne by the party (Owner or Contractor) so designated in such Sections. The Owner will bear the cost of all tests, inspections, or investigations undertaken by the order of the Engineer for the purpose of determining conformance with the Contract Documents if such tests, inspection, or investigations are not specifically required by the Contract Documents, and if conformance is ascertained thereby. Whenever nonconformance is determined by the Engineer as a result of such tests, inspections, or investigations, the Contractor shall bear the full cost thereof or shall reimburse the Owner for said cost. In this connection, the cost of any additional tests and investigations, which are ordered by the Engineer to ascertain subsequent conformance with the Contract Documents, shall be borne by the Contractor.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 01470

### WATERTIGHTNESS TESTING OF CONCRETE STRUCTURES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. It is the intent of these Specifications that all concrete work and sealing work around built-in items and penetrations be performed as required to insure that groundwater, surface water, and water or liquids in tanks, channels and containers will not intrude into any equipment rooms, pipe galleries, habitable areas or other generally dry areas.
- B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.
- C. Each unit shall be tested separately and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable, non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source.
- D. All water holding structures shall be tested for leakage by the Contractor. The Contractor shall provide at his own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01400 – Quality Control
- B. Section 03300 – Cast-in-Place Concrete

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ACI 350.1-10 - Specification for Tightness Testing of Environmental Engineering Concrete Structures

##### 1.04 SUBMITTALS

- A. Testing procedures shall be submitted for approval prior to the test.
- B. Testing Report: Prior to placing the structure in service, submit for review and approval a detailed bound report summarizing the watertightness test data, describing the testing procedure and showing the calculations on which the test data is based.

## PART 2 – PRODUCTS (NOT USED)

## PART 3 – EXECUTION

### 3.01 TEST PREPARATION

- A. The design capability of the structure to withstand testing shall be verified for the pressures to be applied. Another type of test shall not be substituted for hydrostatic tightness testing without approval of the Engineer.
- B. The structure shall not be tested before all elements of the structure which resist any portion of the retained liquid pressure are in place and the concrete has attained its specified compressive strength.
- C. Unless otherwise specified, coatings shall not be applied until after the hydrostatic tightness testing is complete. Liners that are mechanically locked to the surface during the placement of the concrete shall be installed before the hydrostatic tightness testing. Interior liners shall be visually examined for deficiencies (pinholes, tears and partially fused splices) and must pass integrity testing. Deficiencies shall be prepared.
- D. Clean the exposed concrete surfaces of the structure, including the floor, of all foreign material and debris. Prior to testing, standing water in or outside of the structure that would interfere with the inspection of the exposed concrete surfaces of the structure shall be removed.
- E. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired before filling the containment structure with water.
- F. All openings, fittings, and pipe penetrations in the structure shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired prior to testing. All structural penetrations and inlet/outlets shall be securely sealed to prevent the loss of water from the structure during the test. All structural penetrations shall be monitored before and during the test to determine the watertightness of these appurtenances. If the structure is to be filled using the inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving through this pipe once the structure is filled to the test level. Leakage at these inlet/outlets shall be repaired prior to testing. No allowance shall be made in test measurements for uncorrected known points of leakage
- G. The flow from any underdrain system, if a system is provided, shall be monitored during this same period, and any increase in flow shall be recorded and considered for information as a part of the hydrostatic tightness testing.
- H. The ground water level shall be brought to a level below the top of the base slab and kept at that elevation or at a lower elevation during the test.
- I. No backfill shall be placed against the walls or on the wall footings of the structure to be tested unless otherwise specified.

### 3.02 PROCEDURE

- A. The initial filling of a new structure should not exceed a rate of 4 ft/h. Filling shall be continued until the water surface is at the design maximum liquid level, or either 1 in. below any fixed overflow level in covered containment structure or 4 in. in open structure, whichever is lower.
- B. The exterior surfaces of the structure shall be inspected during the period of filling the structure. If any flow of water is observed from the structure exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired prior to testing.
- C. Watertightness Test - Part 1: Qualitative Criteria
  - 1. The water shall be kept at the test level for at least 3 days prior to Part 2 of the testing.
  - 2. The exterior surfaces of the structure shall be observed in both the early mornings and later afternoons during the 3-day period before Part 2 of the test. If any water is observed on the structure exterior surfaces, including joints, repaired honeycombed areas and cracks, where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the test.
  - 3. Wet areas on top of wall footing shall not be cause to fail Part 1 of the test unless the water can be observed to be flowing.
  - 4. Part 2 of the test may begin prior to completion of repairs for Part 1. However, all defects causing the failure of Part 1 shall be repaired before the structure is accepted.
- D. Watertightness Test - Part 2: Quantitative Criteria
  - 1. The test measurements shall not be scheduled for a period when the forecast is for a difference of more than 35°F between the ambient temperature readings at the times of the initial and final level measurements of the water surface. The test shall also not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed.
  - 2. The vertical distance to the water surface shall be measured to within 1/16 in. from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals. Measurements taken at the same time of day will reduce the probability of temperature difference.
  - 3. Measurements shall be taken at two locations, 180° apart, which will minimize the effect of differential settlement. Measurements shall be taken at the same locations to reduce the probability of measurement differences.



4. The test period shall be at least the theoretical time required to lower the water surface 3/8 in. assuming a loss of water at 0.050% of the water volume per 24-hour period. The test period shall not be longer than five days.
5. The water temperature shall be recorded at a depth of 18 in. below the water surface at the start and end of the test.
6. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open structures and the water level in the container recorded at 24-hour intervals. Determination of evaporation by a shallow pan-type measuring device is not acceptable due to possible heating of the bottom of the shallow pan resulting in accelerated evaporation.

### 3.03 EVALUATION

- A. The containment structure shall continue to be observed in both the early mornings and late afternoons to verify compliance with Part 1 of the test during Part 2.
- B. At the end of the test period, the water surface shall be recorded to within 1/16-in at the location of original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.
- C. The allowable loss of water for tightness tests shall not exceed 0.050% of the test water volume in 24 hours.
- D. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature based on the change recorded in the water level from the open container. If the loss exceeds the allowable loss, the structure shall be considered to have failed the test.
- E. During Part 2 of the test, observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failed test. The structure shall also be considered to have failed the test if moisture can be transferred from the exterior surface to a dry hand. Dampness or wetness on top of a footing shall not be considered as a failure test.

### 3.04 RETESTING

- A. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.
- B. The Contractor shall be permitted to immediately retest when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage. The structure shall only be retested after the most probable areas of leakage are repaired.
- C. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.

- D. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed.

### 3.05 NOTIFICATION BY ENGINEER

- A. If any leaks, in excess of the specified amount, are not remedied by the Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the General Contractor.

- END OF SECTION -

SECTION 01510  
TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall provide temporary light and power, heating, water service and sanitary facilities for his operations, for the construction operations of the other Contractors of this Project at the site. The temporary services shall be provided for use throughout the construction period.
- B. The Contractor shall coordinate and install all temporary services in accordance with the requirements of the utility companies having jurisdiction and as required by applicable codes and regulations.
- C. At the completion of the work, or when the temporary services are no longer required, the facilities shall be restored to their original conditions unless otherwise shown on plans or directed herein.
- D. All costs in connection with the temporary services including, but not limited to, installation, utility company service charges, maintenance, relocation and removal shall be borne by the Contractor at no additional cost to the Owner.
- E. Some temporary facilities that may be required may be indicated on the Drawings; however, the Drawings do not necessarily show any or all of the temporary facilities that the Contractor ultimately uses to complete the work.
- F. Temporary Light and Power
  - 1. The temporary general lighting and small power requirements shall be serviced by 120/240 V, 1 phase, 3 wire temporary systems furnished and installed by the Contractor. This service shall be furnished complete with main disconnect, overcurrent protection, meter outlet, branch circuit breakers, and wiring as required; including branch circuit breakers and wiring as required for furnishing temporary power to the various Contractor's field office service connections, all in accordance with the requirements of the servicing power company and applicable standards and codes. The meter for the temporary 120/240 V service for construction purposes shall be registered in the name of the General Contractor and all energy charges for furnishing this temporary electric power shall be borne by the General Contractor. Any Contractor with a need for power other than the 120/240 V, 1 phase, 3 wire shall provide such power at his own expense.
  - 2. The Contractor shall make all necessary arrangements, and pay for all permits, inspections, and power company charges for all temporary service installations. All temporary systems shall comply with and meet the approval of the local authorities

having jurisdiction. All temporary electrical systems shall consist of wiring, switches, necessary insulated supports, poles, fixtures, sockets, receptacles, lamps, guards, cutouts, and fuses as required to complete such installations. The Contractor shall furnish lamps and fuses for all temporary systems furnished by him and shall replace broken and burned out lamps, blown fuses, damaged wiring and as required to maintain these systems in adequate and safe operating condition. All such temporary light and power system shall be installed without interfering with the work of the other Contractors.

When it is necessary during the progress of construction that a temporary electrical facility installed under this Division interferes with construction operations, the Contractor shall relocate the temporary electrical facilities to maintain temporary power as required at no additional cost to the Owner. The Contractor shall be responsible at all times for any damage or injury to equipment, materials, or personnel caused by improperly protected or installed temporary installations and equipment.

3. The Contractors doing the work at the site shall be permitted to connect into the temporary general lighting system small hand tools, such as drills, hammers, and grinders, provided that:
  - a. Equipment and tools are suitable for 120 V, single phase, 60 Hz operation and operating input does not exceed 1,500 volt-amperes.
  - b. Tools are connected to outlets of the system with only one (1) unit connected to a single outlet.
  - c. In case of overloading of circuits, the Contractor will restrict use of equipment and tools as required for correct loading.
4. The Contractor shall keep the temporary general lighting and power systems energized fifteen minutes before the time that the earliest trade starts in the morning and de-energized fifteen minutes after the time the latest trade stops. This applies to all weekdays, Monday through Friday, inclusive, which are established as regular working days.
5. NOT USED
6. The temporary general lighting system shall be installed progressively in structures as the various areas are enclosed or as lighting becomes necessary because of partial enclosure. Lighting intensities shall be not less than 10 foot candles.
7. The Contractor shall provide a separate temporary night lighting circuit for construction security. This system shall be energized at the end of each normal working day and de-energized at the start of each normal working day by the Contractor. The system is to be left energized over Saturdays, Sundays, and all holidays. Lighting intensities shall be not less than 2 foot candles.

8. Electrical welders provided by each trade used in the erection and fabrication of the buildings, structures and equipment shall be provided with an independent grounding cable connected directly to the structure on which the weld is being made rather than adjacent conduit piping, etc.
9. Upon completion of the work, but prior to acceptance by the Owner, the Contractor shall remove all temporary services, security lighting systems, temporary general lighting systems and all temporary electrical work from the premises.

#### G. Temporary Heating

1. The Contractor shall provide temporary heating, ventilation coverings and enclosures necessary to properly protect all work and materials against damage by dampness and cold, to dry out the work and to facilitate work in all structures.
2. The equipment, fuel, materials, operating personnel and methods used shall be at all times satisfactory and adequate to maintain critical installation temperatures and ventilation for all work in those areas where the same is required.
3. After any structure is enclosed, the minimum temperature to be maintained is 50°F, unless otherwise specified, where work is actually being performed.
4. Before and during the application of interior finishing, painting, etc., the Contractor shall provide sufficient heat to maintain a temperature of not less than 65°F.
5. Any work damaged by dampness or insufficient or abnormal heating shall be replaced by the Contractor at no additional cost to the Owner.

#### H. Temporary Sanitary Service

1. Sanitary conveniences, in sufficient numbers, for the use of all persons employed on the work and properly screened from public observation, shall be provided and maintained at suitable locations by the Contractor, all as prescribed by State Labor Regulations and local ordinances. The contents of same shall be removed and disposed of in a manner consistent with local and state regulations, as the occasion requires. Contractor shall rigorously prohibit the committing of nuisances within, on, or about the work. Sanitary facilities shall be removed from the site when no longer required. All portable toilets shall be placed in secondary containment.

#### I. Temporary Water

1. The Contractor shall provide temporary water service for construction purposes, sanitary facilities, fire protection, field offices and for cleaning.

The Contractor shall pay all charges associated with the connection and all charges for potable water used under this Contract.

2. Contractor shall supply potable water for his employees either by portable containers or drinking fountains.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 01520

### MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

A. The Contractor is responsible for the temporary handling of sewage throughout the construction of the project. This includes the construction, modifications, and the relocations of sewer, wet wells, and facilities.

B. Work under the Contract shall not reduce the quality of the effluent or cause odor or other nuisance except as explicitly permitted hereinafter. In performing the work shown and specified, the Contractor shall plan and schedule his work to meet collection system operating requirements, and the constraints and construction requirements as outlined in this Section. No discharge of raw or inadequately treated wastewater shall be allowed. The Contractor shall pay all civil penalties, costs, assessments, etc., associated with any discharge of raw or inadequately treated wastewater associated with the Contractor's work.

C. The Contractor shall be responsible for coordinating the general construction and electrical, HVAC and plumbing construction schedules and for ensuring that permanent or temporary power is available for all existing, proposed, and temporary facilities that are required to be on line at any given time.

D. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without cost to the Owner and provided that all requirements of these Specifications are fulfilled. The Contractor shall submit any such plan for providing additional temporary facilities to eliminate a constraint to the PM for review. Such plans must be approved by the Engineer and Owner prior to the Contractor proceeding. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be consecutive calendar days.

##### 1.02 GENERAL CONSTRAINTS

A. The Contractor shall schedule the Work so that the lift station is maintained in continuous operation. All pumping processes shall be maintained in continuous operation during the construction period except during approved process interruptions. All short-term system or partial systems shutdowns and diversions shall be approved by the Engineer. Long-term shutdowns and diversions shall conform to the requirements hereinafter specified and shall be minimized by the Contractor as much as possible. If in the judgement of the Engineer a requested shutdown is not required for the Contractor to perform the Work, the Contractor shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the Owner. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown period shall commence at a time approved by the Owner, and the Contractor shall proceed with the

Work continuously, start to finish, until the Work is completed and normal operation is restored. If the Contractor completes all required Work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service.

- B. The Contractor shall schedule short-term and long-term shutdowns in advance and shall present all desired shutdowns in the 30 and 60-day schedules at the progress meetings (see Section 01200). Shutdowns shall be fully coordinated with the Owner at least 48 hours before the scheduled shutdown. Contractor personnel shall operate Owner's facilities involved in the short-term and long-term shutdowns and diversions.
- C. Short term shutdowns in plant flow will be allowed for tie-ins to existing facilities, installation of temporary bulkheads, etc. All such shutdowns shall be scheduled for week-end low-flow periods and shall be limited to less than two (2) hours depending on incoming flow rate and storage volume in the collection and treatment system. Any shutdown of two (2) hours or longer duration shall be defined as a long-term shutdown. The Contractor shall provide appropriate diversion facilities to be approved by the Owner, and at no additional cost to the Owner, when the facility cannot be shut down for a sufficient long time to accomplish the required work. The Contractor may be allowed additional time for short-term interruptions if he can demonstrate to the Owner and Engineer that the collection system will not surcharge or overflow during the requested shutdown period. Duration of short-term interruptions allowed will depend on incoming wastewater flow rate and prevention of any discharge of raw wastewater from the collection system. The schedule and duration of short-term shutdowns shall be at the discretion of the Owner.
- D. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable plant operation shall be furnished by the Contractor at the direction of the Engineer at no extra cost to the Owner.
- E. The Owner shall have the authority to order Work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the facility operations.
- F. If the Contractor impairs performance or operation of the facility as a result of not complying with specified provisions for maintaining operations, then the Contractor shall immediately make all repairs or replacements and do all work necessary to restore the facility to operation to the satisfaction of the Engineer. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis.
- G. The Contractor shall provide the services of emergency repair crews on call 24-hours per day to affect repairs to portions of the facility affected by the Contractor's operations.

#### 1.03 GENERAL OPERATING REQUIREMENTS, CONSTRAINTS, AND CONSTRUCTION REQUIREMENTS

- A. Access to Facility Site, Roadways, and Parking Areas
  - 1. NOT USED
  - 2. NOT USED



3. The Contractor shall provide temporary measures to protect the existing pavement acceptable to the Engineer, and he shall repair any damage to existing paved surfaces that occurs during the construction period. Any areas disturbed along the shoulders of the access road and interior roads and elsewhere inside and outside of the facility shall be repaired, graded, seeded, etc. as necessary to match pre-existing conditions.
4. The General Contractor shall not undertake the restoration/construction of new roadway (paved, gravel, or asphalt overlay) shown on the Contract Drawings, until all other work on the improvements has been completed.
5. It shall be the responsibility of the General Contractor to obtain any permits required from the California Department of Transportation and pay all associated fees.

B. Personnel Access

1. City personnel shall have access to all areas which remain in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and other such work as directed by the Engineer to maintain personnel access to areas in operation. Access and adequate parking areas for City personnel must be maintained throughout construction.

C. Draining Process Pipes and Conduits (General)

1. The contents of all pipes and conduits to be removed, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by the Owner through hoses or piping, or by using pumps if hydraulic conditions so require them. The Contractor shall provide the pumps, piping and hoses at no additional cost to the Owner. No uncontrolled spillage of a pipe or conduit shall be permitted. Any spillage, other than potable water, shall be immediately washed down and flushed into the appropriate drain.

1.04 SPECIFIC OPERATIONAL CONSTRAINTS

- A. The Contractor shall schedule the work for the following based on the constraints given in such a manner as to maintain the wastewater lift station in continuous operation.
  1. Contractor shall maintain pumping at Skyfarm 'A' and Hansford Court for the duration of the Contract. Contractor shall assume operation of the existing temporary pumping systems, relocate the pumping systems to upstream manholes, and provide any maintenance or repairs required during the course of the work. Turnover of the temporary pumping systems from the City to the Contractor shall be coordinated by the Contractor prior to the start of any work on the Contract.

The bypass capacity shall be a minimum of 150 gpm at 240 ft TDH at Skyfarm, and 180 gpm at 120 ft TDH at Hansford Court.

2. Contractor shall maintain backup power onsite at all times. The existing generators onsite can be utilized for backup power while they are operational. When Contractor replaces the existing generators, a portable generator shall be brought on site and made ready to provide temporary power should the need arise.

## PART 2 -- PRODUCTS

### 2.01 EQUIPMENT

Pumps shall be self-priming non-clog sewage pumps with electric motors. Each bypass pump shall be supplied with a pressure gauge, check valve, and isolation valve in the pump discharge piping.

The manhole upstream of each wet well (new manhole at Hansford and existing manhole at Skyfarm) shall be used as the temporary wet well. Pump(s) shall be automatically controlled based upon the fluid level in the temporary wet well. The actual configuration of the bypass pump(s) will be up to the Contractor.

Standby pumping equipment and standby generator shall be at the site continuously during pumping to provide 100 percent standby pumping capacity. The standby generator shall be capable of being hooked up and operational within a period of one hour of a power failure. The generator and receptacles on temporary gear shall be compatible with those currently used by the City.

When bypassing flows, Contractor shall provide manpower to continuously monitor the pumping on a 24 hours basis to respond to alarms, emergencies, and activate standby equipment.

The temporary RTU panel shall be in operation during all bypass operations. Temporary wet well fluid level shall be monitored during bypassing and sent to the SCADA via temporary RTU panel. Pump failure, low-level, and high-level alarms shall be provided that alert both the Contractor and City.

Contractor shall perform a test run on the pumping equipment a minimum of 24 hours before start of actual bypassing flows. A City representative will be present during the test to observe the operation of the bypass equipment.

## PART 3 -- EXECUTION

### 3.01 TEMPORARY HANDLING OF SEWAGE

The Contractor shall provide, construct, operate, maintain, and remove, without damage to existing structures, all temporary sewage handling facilities. The Contractor shall submit

details of proposed equipment for temporary handling of sewage flow as specified. Requirements for operating the bypass system shall be as indicated herein and as shown on the plans. The system shall operate as specified to ensure that neither the upstream nor downstream systems are threatened with sewage overload or spill.

Under no circumstances shall sewage or solids be deposited onto the ground surface, streets, or into ditches, catch basins or storm drains or natural drainage ways. Sewage shall be handled in a manner so as not to create a public nuisance or health hazard.

Bypass system shall be tested in-place and proved to be operating as specified prior to shutting down the existing pumps.

### 3.02 SPILL PREVENTION, CONTROL AND COUNTERMEASURE PLAN

The Contractor shall implement the Spill Prevention, Control and Countermeasure Plan as specified in this section and shown on the Plans. The Contractor may submit equivalent materials and methods for consideration.

- A. The Contractor shall submit for approval, all duty and emergency equipment for bypassing flow, containment, cleanup, and repair of any damage. Specifics for each bypass installation shall include as applicable, but are not limited to:
  - 1. Pipe repair kits
  - 2. Sand bags
  - 3. Rubber matting
  - 4. Bypass pipes, spare pipe sections, pumps, and other relevant equipment
  - 5. Standby pumps
  - 6. Secondary containment in trench or other surrounding land relief
  - 7. The Contractor shall maintain standby and emergency equipment on site.
- B. The Contractor shall provide the names, phone numbers, and hourly working schedules of at least two (2) people who can be contacted 24 hours per day by phone and that may be brought on-site at any time to address on-site emergencies. The Contractor shall provide notification of any substitution in writing at least two days in advance
- C. The Contractor shall protect storm drains during construction as required by the SWPPP permit.
  - 1. The Contractor shall identify those responsible for each activity, present a training plan for approval, and perform the approved training.
  - 2. The Contractor shall protect water quality and respond to spills of sewage, groundwater, or fuels, ensuring there are no conflicts with implementing each of the respective programs. The Contractor shall implement all indicated spill prevention measures (e.g. monitoring of upstream manholes, monitoring in the trench).
- D. The following spill procedures shall be followed by the Contractor.

1. If a spill is detected or a catastrophic pipe failure occurs, the immediate priority of the Contractor shall be to prevent any sewage from reaching storm drains and ultimately surface waters. A storm drain may be used for containment of a large spill if adequate preparations are made as indicated in the plans. The Contractor shall protect vulnerable drains using rubber mats or sand bags continuously during bypass or immediately (have all materials at hand) upon spillage.
2. The Contractor shall anticipate the following bypass system failure modes in the plan and be prepared to act accordingly.
  - a) If the bypass pump fails, begin using standby equipment as soon as possible.
  - b) In the event the bypass pipe is ruptured in a traffic accident or otherwise, the Contractor shall immediately stop the bypass pump, install containment, and notify the City. Inform the City what emergency diversion, if any, is indicated in the plan. Make repairs to the bypass pipe and restart the system. Begin cleanup. Notify the City when the system is back in service.
3. In event of any spill, the Contractor shall immediately and in parallel with above activities, notify City and request City's collections staff to be dispatched. The Contractor should attempt to give the best indication of the approximate size of the spill (<1,000 gallons is small; 1,000 gallons to 10,000 gallons is medium; and >10,000 gallons is large) along with the approximate amount, if any, of sewage discharged to a storm drain or channel so the appropriate response can be dispatched.
4. City staff will respond to monitor the Contractor's clean-up-related activities to ensure the spill is cleaned in accordance with this Plan. It is the Contractor's responsibility to provide the primary means for pipe repair and spill recovery and clean-up including mobilizing any necessary equipment to be onsite within an hour of a spill. Clean up may require a sweeper truck, Vactor truck, water truck, and/or other equipment. All City time and material and special equipment for spill cleaning will be deducted from the Contractor's progress payment.
5. The Contractor shall attempt to pond the water in an area away from storm drains that can be easily and fully recovered for discharge to City's collection system. This ponding activity should not impact any environmentally sensitive areas.
6. The Contractor and Engineer with the assistance of City's collections staff shall coordinate the most efficient and appropriate response, repair, and cleanup of a spill as soon as possible. The Contractor will cooperate with City staff to the fullest extent possible in order to minimize the impacts and volume of the spill in the most efficient manner possible.
7. Disinfection of a spill is not allowed (especially if the water is reaching State waters). All wash water and sewage-contaminated wash water must be contained and recovered in the same manner as the sewage.

8. The Contractor shall have cameras on hand and shall document the spill, its cause, and the response activities as these occur with a video camera and photographs. The Contractor is required to attend a debriefing at the jobsite immediately after the spill is contained and cleaned up.

- END OF SECTION -

## SECTION 01530

### PROTECTION OF EXISTING FACILITIES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Contractor shall be responsible for the preservation and protection of property adjacent to the work site against damage or injury as a result of his operations under this Contract. Any damage or injury occurring on account of any act, omission or neglect on the part of the Contractor shall be restored in a proper and satisfactory manner or replaced by and at the expense of the Contractor to an equal or superior condition than previously existed.
- B. Contractor shall comply promptly with such safety regulations as may be prescribed by the Owner or the local authorities having jurisdiction and shall, when so directed, properly correct any unsafe conditions created by, or unsafe practices on the part of, his employees. In the event of the Contractor's failure to comply, the Owner may take the necessary measures to correct the conditions or practices complained of, and all costs thereof will be deducted from any monies due the Contractor. Failure of the Engineer to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder.
- C. In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defense against such claims. Prior to commencement of work in the vicinity of property adjacent to the work site, the Contractor, at his own expense, shall take such surveys as may be necessary to establish the existing condition of the property. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained.

##### 1.02 PROTECTION OF WORK AND MATERIAL

- A. During the progress of the work and up to the date of final payment, the Contractor shall be solely responsible for the care and protection of all work and materials covered by the Contract.
- B. All work and materials shall be protected against damage, injury or loss from any cause whatsoever, and the Contractor shall make good any such damage or loss at his own expense. Protection measures shall be subject to the approval of the Engineer.

##### 1.03 BARRICADES, WARNING SIGNS AND LIGHTS

- A. The Contractor shall provide, erect and maintain as necessary, strong and suitable barricades, danger signs and warning lights along all roads accessible to the public, as required by the authority having jurisdiction, to insure safety to the public. All barricades

and obstructions along public roads shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise.

- B. Contractor shall provide and maintain such other warning signs and barricades in areas of and around their respective work as may be required for the safety of all those employed in the work, the Owner's operating personnel, or those visiting the site.

#### 1.04 EXISTING UTILITIES AND STRUCTURES

- A. The term existing utilities shall be deemed to refer to both publicly-owned and privately-owned utilities such as electric power and lighting, telephone, water, gas, storm drains, process lines, sanitary sewers and all appurtenant structures.
- B. Where existing utilities and structures are indicated on the Drawings, it shall be understood that all of the existing utilities and structures affecting the work may not be shown and that the locations of those shown are approximate only. It shall be the responsibility of the Contractor to ascertain the actual extent and exact location of existing utilities and structures. In every instance, the Contractor shall notify the proper authority having jurisdiction and obtain all necessary directions and approvals before performing any work in the vicinity of existing utilities.
- C. Prior to beginning any excavation work, the Contractor shall, through field investigations, determine any conflicts or interferences between existing utilities and new utilities to be constructed under this project. This determination shall be based on the actual locations, elevations, slopes, etc., of existing utilities as determined in the field investigations, and locations, elevation, slope, etc. of new utilities as shown on the Drawings. If an interference exists, the Contractor shall bring it to the attention of the Engineer as soon as possible. If the Engineer agrees that an interference exists, he shall modify the design as required. Additional costs to the Contractor for this change shall be processed through a Change Order as detailed elsewhere in these Contract Documents. In the event the Contractor fails to bring a potential conflict or interference to the attention of the Engineer prior to beginning excavation work, any actual conflict or interference which does arise during the Project shall be corrected by the Contractor, as directed by the Engineer, at no additional expense to the Owner.
- D. The work shall be carried out in a manner to prevent disruption of existing services and to avoid damage to the existing utilities. Temporary connections shall be provided, as required, to insure uninterrupted of existing services. Any damage resulting from the work of this Contract shall be promptly repaired by the Contractor at his own expense in a manner approved by the Engineer and further subject to the requirements of any authority having jurisdiction. Where it is required by the authority having jurisdiction that they perform their own repairs or have them done by others, the Contractor shall be responsible for all costs thereof.
- E. Where excavations by the Contractor require any utility lines or appurtenant structures to be temporarily supported and otherwise protected during the construction work, such support and protection shall be provided by the Contractor. All such work shall be performed in a manner satisfactory to the Engineer and the respective authority having jurisdiction over such work. In the event the Contractor fails to provide proper support or protection to any

existing utility, the Engineer may, at his discretion, have the respective authority to provide such support or protection as may be necessary to insure the safety of such utility, and the costs of such measures shall be paid by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -



## SECTION 01540

### DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. This Section covers the demolition, removal, and disposal of existing buildings, structures, pavement, curbs, and sidewalk, removal and disposal of asbestos materials, and any existing equipment including electrical, plumbing, heating and ventilating equipment and piping not required for the operation of the rehabilitated plant as indicated on the Drawings and as specified hereinafter. The Contractor shall furnish all labor, materials and equipment to demolish buildings and structures and to remove fixtures, anchors, supports, piping and accessories designated to be removed on the Drawings.

##### 1.02 TITLE TO EQUIPMENT AND MATERIALS

- A. Contractor shall have no right or title to any of the equipment, materials or other items to be removed from the existing buildings or structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign, or attempt to sell or assign any interest in the said equipment, materials or other items until the said equipment, materials or other items have been removed.
- B. Contractor shall have no claim against the Owner because of the absence of such fixtures and materials.

##### 1.03 CONDITION OF STRUCTURES AND EQUIPMENT

- A. The Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.
- B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner so far as practicable.
- C. The information regarding the existing structures and equipment shown on the Drawings is based on visual inspection and a walk-through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

#### PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

### 3.01 DEMOLITION AND REMOVALS

- A. The removal of all equipment and piping, and all materials from the demolition of buildings and structure shall, when released by the Owner and Engineer, shall be done by the Contractor and shall become the Contractor's property, unless otherwise noted, for disposition in any manner not contrary to the Contract requirements and shall be removed from the site to the Contractor's own place of disposal.
- B. The Electrical Subcontractor specifically, shall de-energize all panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar power equipments prior to removal. Any electric panels or equipment which are to be retained shall be relocated or isolated by the Electrical Subcontractor specifically, prior to the removal of the equipment specified herein.
- C. The Contractor shall proceed with the removal of the equipment, piping and appurtenances in a sequence designed to maintain the plant in continuous operation as described in Section 01520, Maintenance of Utility Operations During Construction, and shall proceed only after approval of the Engineer.
- D. Any equipment piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing facilities shall be replaced to the satisfaction of the Engineer at no cost to the Owner.
- E. Excavation caused by demolitions shall be backfilled with fill free from rubbish and debris.

### 3.02 PROTECTION

- A. Demolition and removal work shall be performed by competent experienced workmen for the various type of demolition and removal work and shall be carried out through to completion with due regard to the safety of Owner employees, workmen on-site and the public. The work shall be performed with as little nuisance as possible.
- B. The work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes, and as hereinafterspecified.
- C. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements so as to prevent any damage to new or existing construction.
- D. The Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

- E. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.
- F. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled or equipment moved.
- G. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dust-proof partitions and other adequate means.
- H. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.
- I. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.
- J. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.

### 3.03 WORKMANSHIP

- A. The demolition and removal work shall be performed as described in the Contract Documents. The work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new work in accordance with applicable Technical Sections of the Specifications and in accordance with the details shown on the Drawings. Prior to starting of work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer.
- B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other supports shall be removed to approximately 1-inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable Sections of these Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate Sections of these Specifications, as shown on the Drawings, and as directed and approved by the Engineer.
- C. Materials or items designated to remain the property of the Owner shall be as hereinafter tabulated. Such items shall be removed with care and stored at a location at the site to be designated by the Owner.

- D. Where equipment is shown or specified to be removed and relocated, the Contractor shall not proceed with removal of this equipment without specific prior approval of the Engineer. Upon approval, and prior to commencing removal operations, the equipment shall be operated in the presence of representatives of the Contractor, Owner and Engineer. Such items shall be removed with care, under the supervision of the trade responsible for reinstallation and protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or item. Any equipment that is removed without proper authorization and is required for plant operation shall be replaced at no cost to the Owner.
- E. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.
- F. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.
- G. The Contractor shall execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the building.
- H. In general, masonry shall be demolished in small sections, and where necessary to prevent collapse of any construction, the Contractor shall install temporary shores, struts, and bracing.
- I. Where alterations occur, or new and old work join, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered work in as good a condition as existed prior to the start of the work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawing or specified, shall comply with that of the various respective trades which normally perform the particular items or work.
- J. The Contractor shall finish adjacent existing surfaces to new work to match the specified finish for new work. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.
- K. The Contractor shall cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.
- L. The Contractor shall confine cutting of existing roof areas designated to remain to the limits required for the proper installation of the new work. The Contractor shall cut and remove insulation, etc., and provide temporary weather tight protection as required until new roofing and flashings are installed.
- M. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the work.

### 3.04 MAINTENANCE

- A. The Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.
- B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and he shall wet down dry materials to lay down and prevent blowing dust.
- C. At reasonable intervals during the progress of the demolition and removal work or as directed by the Engineer, the Contractor shall clean the site and properties, and dispose of waste materials, debris and rubbish.

### 3.05 EQUIPMENT AND MATERIALS RETAINED BY OWNER

- A. The following equipment and materials will be retained by the Owner:

Skyfarm 'A' temporary pump control panel  
Hansford Court temporary pump control panel  
Hansford Court Gorman-Rupp pump skid

- B. The equipment and materials shall be moved by the Contractor to storage areas, on the site, to be designated by the Owner.

- END OF SECTION -

## SECTION 01560

### TEMPORARY ENVIRONMENTAL CONTROLS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

###### A. Dust Control

1. Contractor shall take all necessary measures to control dust from his operations, and to prevent spillage of excavated materials on public roads.
2. Contractor shall remove all spillage of excavated materials, debris or dust from public roads by methods approved by the Engineer.
3. Contractor shall sprinkle water at locations and in such quantities and at such frequencies as may be required by the Engineer to control dust and prevent it from becoming a nuisance to the surrounding area.
4. Dust control and cleaning measures shall be provided at no additional cost to the Owner.

###### B. Rubbish Control

1. Contractor shall have a container on site to collect all daily garbage, which shall be emptied at the end of each week.

###### C. Storm Water And Non-Storm Water Quality Controls

###### 1. Regulatory Requirements

- A. Construction activities are regulated under the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbances Activities (State Water Resources Control Board [SWRCB] Order No. 2009-0009-DWQ, NPDES Permit No. CAS00002 generally referred to as the General Permit [GP]). The appropriate Regional Water Quality Control Board (RWQCB) enforces the General Permit. Coverage under a General Permit requires the submission to the SWRCB of the Permit Registration Documents (PRDs) and receipt from the SWRCB of a Water Discharger Identification Number (WDID) for the Project. Site disturbance, mobilization, or construction activities shall not start until the Contractor is in receipt of the WDID Letter issued by the SWRCB.

A copy of the General Permit is available on the SWRCB website:

[http://www.waterboards.ca.gov/water\\_issues/programs/stormwater/const](http://www.waterboards.ca.gov/water_issues/programs/stormwater/const)

[permits.shtml](#)

- B. The Contractor shall comply with the SWRCB, RWQCB, County, City, and other local agency requirements regarding storm water management, inspection, and monitoring.
- C. The Contractor shall comply with the following prohibitions and limitations, which are contained in the General Permit:
  - 1) Storm water and non-storm water discharge prohibitions:
    - a) Discharge of materials other than storm water, which are not otherwise regulated by a NPDES permit, to a separate storm water sewer system or water of the nation are prohibited.
    - b) Water discharge shall not cause or threaten to cause pollution, contamination (including sediment) or nuisance.
    - c) Water discharge regulated by this General Permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and 40 CFR Part 302.
    - d) Discharge of toxic pollutants prohibited by the Clean Water Act Section 307(a).
  - 2) Receiving Water Limitations:
    - a) Storm water and non-storm water discharges to any surface or groundwater shall not adversely impact human health or the environment.
    - b) Storm water and authorized non-storm water discharges shall not contain pollutants in quantities that threaten to cause pollution or a public nuisance.
    - c) Discharges located within the watershed of a CWA Section 303(d) impaired body shall limit the Total Maximum Daily Load (TMDL) to that approved by the U.S. EPA for “construction activities” or land disturbances.
    - d) Water discharges shall not cause or contribute to a violation of any applicable water quality standards contained in the Statewide Water Quality Control Plan, California Toxics Rule, The National Toxics Rule, California Ocean Plan, Inland Surface Waters and Enclosed Bays and Estuaries Plan, or the applicable Regional Water Board’s Basin Plan.

## 2. General

The Owner will be responsible to the SWRCB for causing the preparation of and compliance with the various management plans called for by the SWRCB. The Contractor shall prepare the SWPPP. The Contractor is responsible for providing the detail planning and compliance activities insofar as they would potentially affect the Contractor's methods and means of performing the Work.

If a violation of the Permit is due to the Contractor's actions or inactions and a fine is assessed, the Contractor shall be responsible for the fine and all applicable remediation requirements.

3. Risk Assessment

- A. The Site has been identified to have a Risk Level 1.
- B. The Owner's Risk Assessment for the Project complies with the requirements of Section VIII of the General Permit.

4. Contractor Responsibilities

- A. The Contractor shall be responsible for meeting the requirements of the General Permit except as specifically noted otherwise within this Section.
- B. If the project is not covered by the General Permit, the Contractor shall be responsible for submitting a water pollution control plan to the City of Santa Rosa that meets the requirements of the City of Santa Rosa's best management practices for erosion and sedimentation control.
- C. The Contractor shall be fully responsible for following BMPs as described in the California Stormwater Quality Association (CASQA) BMP Handbook. [www.casqa.org](http://www.casqa.org)
- D. Within fifteen (15) days of the Award of the Contract the Contractor shall submit the following PRDs that are to be used by the Owner to apply for the Project WDID. This information shall be submitted in electronic form suitable for the submittal to the SWRCB using the Storm Water Multiple Application Report Tracking System (SMARTS) website.
  - 1. SWPPP prepared by a Certified QSD
  - 2. Construction Site Monitoring Plan (CSMP)
  - 3. Rain Event Action Plan (REAP), if applicable
  - 4. Site Map (Provided detail information shall include but not necessarily limited to that recited in Attachment B, Section J of the General Permit.)
  - 5. Active Treatment System (ATS), if applicable
  - 6. Names and 24-hour phone numbers for QSD, QSP(s), and other parties responsible for implementing, monitoring, inspecting and maintaining the SWPPP.



- E. Prior to soil disturbing work the Contractor shall implement the measures of the SWPPP and be in receipt of the Project WDID. This is a prerequisite for coverage under the General Permit.
- F. Contractor's QSD and/or QSP shall update the PRDs including but not limited to the SWPPP, CSMP and Site Map for new or changed conditions or if initial documents were incomplete and submit to Owner.
- G. Contractor shall furnish:
  - 1. Routine inspection reports on Monday of each week [daily and weekly reports, REAPS (if applicable), storm event reports (the before, during and after inspections)].
  - 2. Sampling Reports (pH, Turbidity, non-visible pollutants, etc.) within 48 hours of the storm event.
  - 3. NAL Exceedance Reports within 48 hours of the event.
  - 4. NEL Violation Reports shall be maintained within twelve (12) hours after the NEL Exceedance has been identified. Note this report must be submitted to the SRWCB within 24 hours of the incident.
- H. The Contractor shall develop and submit the annual report to the Owner within ten (10) days of August 1 of each year for submittal to the SWRCB by the Owner. The content shall be complete and fully comply with the requirements of Section XVI of the General Permit. The Contractor's QSD shall prepare and certify the report using the language of Section IV, Item J, Compliance Certification of the General Permit.
- I. Prior to Final Completion the Contractor shall develop and submit an annual report to the Construction Manager for the time frame between the Notice to Proceed or last previous annual report, and the Final Completion Date.
- J. The Contractor shall provide evidence to the Construction Manager with the submission of the SWPPP that the individual(s) responsible for the PRDs development including the SWPPP preparation is a Qualified SWPPP Developer (QSD) who has the certification or registration required by Section VII of the General Permit
- K. The Contractor shall provide evidence to the Construction Manager that the individual(s) responsible for supervising the SWPPP implementation, monitoring and reporting as required by the General Permit is a Qualified SWPPP Developers (QSD) or a Qualified SWPPP Practitioner (QSP) who has the certification or registration required by Section VII of the General Permit.
- L. All QSD and QSP must meet the Certification and/or registration requirement of Section VII of the General Permit. Contractor shall provide evidence and demonstrate that his Qualified SWPPP Developer and Qualified SWPPP Practitioner are qualified to develop PRDs, SWPPP, etc. and supervise the implementation to the Construction Manager.
- M. Contractor shall be responsible for implementing, monitoring, inspecting, and maintaining best management practices (BMPs) and other measures as detailed in the SWPPP, CSMP, REAP, Site Map, other applicable

documents and the requirements of the General Permit. The work shall be supervised by the Contractor's QSD or QSP(s).

- N. Contractor shall be responsible for providing equipment, materials, and workers to implement SWPPP and complying with all the requirements of the General Permit as well as being available for rapid response to BMP failures and emergencies.
- O. The entire plan together with the weekly reports and rain event reports shall be kept and maintained by the Contractor on the construction site during the duration of the Project. Reports shall be certified by the Contractor's QSD or QSP. Reports shall be submitted to the Construction Manager no later than two (2) business days after actual inspection.
- P. The Contractor shall be responsible for taking the proper actions to prevent storm water or non-storm water coming into contact with contaminants and sediments from migrating offsite or entering storm sewer drainage systems. The Contractor shall take immediate action if directed by the Construction Manager or if the Contractor observes contaminants and/or sediments entering the storm drainage system, to prevent further storm water from entering the system.
- Q. The Contractor shall update the SWPPP whenever there is a change in construction or operations which may affect the discharge of any pollutants from the construction site.
- R. The SWPPP shall be amended by the Contractor's QSD or QSP if it is in violation of any conditions of the Construction General Permit or has not achieved the general objective of reducing pollutants in storm water or non-storm water discharges.
- S. All amendments shall be completed at no additional cost to the Owner.
- T. The Contractor shall submit all PRDs and other documents (storm event reports, REAPS, Annual Reports, NAL Exceedance Reports, NEL Violation Reports, etc.) to the Owner. The Contractor's QSD shall certify to the Owner that the submitted documents are in compliance with the Construction General Permit. The certification shall use the language of Section IV, Item J-Compliance Certification, of the CGP. The Contractor shall furnish the following:

1. Three (3) certified hardcopies
  2. An electronic copy suitable for submittal to the SWRCB through the State Water Board's SMARTS website (PDF and MS Word formats when available). The Contractor shall be responsible for uploading the information to the SMARTS website and notifying the Construction Manager that the information has been uploaded.
3. Owner Responsibilities
  - A. The Owner, designated as the Legally Responsible Person (LRP), will prepare and file the Notice of Intent (NOI) and Site Risk Assessment with the SWRCB and will obtain the Project WDID. The Owner requires PRDs from the Contractor in an acceptable electronic format prior to filing the NOI.
  - B. The Owner will review the PRDs submitted and uploaded on the SMARTS website by the Contractor including but not limited to the PRDs, storm event report(s), Annual Report(s), Notices of Violation. Contractor shall provide to the Owner the written (hard copy) and electronic copy (PDF and/or MS Word format).
  - C. The Owner will have LRP signatory responsibility for the SWPPP as defined in Section IV, Item I-Signatory Requirements of the General Permit.
  - D. The Owner will submit to the SWRCB an annual report(s) as developed by the Contractor and the associated fee.
  - E. In accordance with Section II.D of the General Permit, the Owner will submit to the SWRCB a Notice of Termination (NOT) upon completion of construction activities.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 01600

### MATERIALS AND EQUIPMENT

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

###### A. Furnish and Install

1. Where the words "furnish", "provide", "supply", "replace", or "install" are used, whether singularly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.
2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment herein. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

###### B. Concrete Foundations for Equipment

1. Contractor shall provide all concrete foundations shown, specified or required for all equipment furnished under their respective Contract.
2. Anchor bolts and templates for equipment foundations shall be furnished under the Contract for installation by Contractor.
3. All concrete foundations for equipment shall be treated, by the Contractor, with an approved sealer to prevent oil from seeping into the concrete.

##### 1.02 EQUIPMENT AND MATERIALS

- A. All equipment, materials, instruments or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents. Equipment and materials to be incorporated into the work shall be delivered sufficiently in advance of their installation and use to prevent delay in the execution of the work, and they shall be delivered as nearly as feasible in the order required for executing the work.
- B. The Contractor shall protect all equipment and materials from deterioration and damage, including provisions for temporary storage buildings as needed and as specified in Section 01550, Site Access and Storage. Storage of equipment and materials shall be in locations completely protected from flooding, standing water, excessive dust, falling rock, brush fire, etc. Storage areas shall be located sufficiently distant from all construction activities and the movement of construction vehicles to minimize the potential for accidental damage. Any equipment or materials of whatever kind which may have become damaged

or deteriorated from any cause shall be removed and replaced by good and satisfactory items at the Contractor's expense for both labor and materials.

### 1.03 INSTALLATION OF EQUIPMENT

- A. Equipment and materials shall be installed in accordance with the requirements of the General Conditions, Supplemental Conditions and the respective Specification Sections.
- B. Concrete foundations for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Foundation bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Foundations shall be built and bolts installed in accordance with the manufacturer's certified drawings.
- C. Before mounting equipment on a foundation, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all foundation bolt sleeves. The Contractor shall provide a sufficient number of steel plate shims about 2-inches wide and 4-inches long, and of a varying thickness from 1/8 to 1/2-inch. A combination of these shims shall be placed next to each foundation bolt to bring the bottom of the bedplate or frame about 1/8-inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the foundation bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.
- D. Equipment shall be set, aligned and assembled in conformance with manufacturer's drawings or instructions. Run out tolerances by dial indicator method of alignment shall be plus or minus .002-inches, unless otherwise approved by the Engineer.
- E. All blocking and wedging required for the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer.
- F. Each piece of equipment or supporting base, bearing on concrete foundations, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Grout shall be non-shrink grout, as specified under Section 03600, Grout.
- G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.

#### 1.04 CONNECTIONS TO EQUIPMENT

- A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment.
- B. The Contractor shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.
- C. The Contractor shall bring and connect HVAC service to all equipment items requiring same as shown on the Drawings. Electrical connections to equipment requiring electrical service shall be made by the Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.
- D. The Contractor shall bring and connect plumbing service to all equipment items requiring same as shown on the Drawings.

#### 1.05 SUBSTITUTIONS

- A. Requests for substitutions of equipment or materials shall conform to the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified.
  - 1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials, where feasible, to enable the Owner and Engineer to determine if the proposed substitution is equal.
  - 2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.
  - 3. A list of installations where the proposed substitution is equal.
  - 4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.
- B. Where the approval of a substitution requires revision or redesign of any part of the work, including that of other Contracts, all such revision and redesign, and all new drawings and details therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the Owner and Engineer.
- C. In the event that the Engineer is required to provide additional engineering services, then the Engineer's charges for such additional services shall be charged to the Contractor by the Owner in accordance with the requirements of the General Conditions, and the Supplemental Conditions.

- D. In all cases the Owner and Engineer shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without written approval of the Owner and Engineer.
- E. Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor.
- F. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01700  
PROJECT CLOSEOUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Final Cleaning

1. At the completion of the work, the Contractor shall remove all rubbish from and about the site of the work, and all temporary structures, construction signs, tools, scaffolding, materials, supplies and equipment which he or any of his Subcontractors may have used in the performance of the work. Contractor shall broom clean paved surfaces and rake clean other surfaces of grounds.
2. Contractor shall thoroughly clean all materials, equipment and structures; all marred surfaces shall be touched up to match adjacent surfaces; dirty filters and burned out lights replaced as required; all glass surfaces cleaned and floors cleaned and polished so as to leave work in a clean and new appearing condition.
3. Contractor shall maintain cleaning until project, or portion thereof, is occupied by the Owner.

B. Lubrication Survey

1. NOT USED
2. NOT USED.
3. The Contractor shall supply all lubricants, applicators and labor for lubricating the equipment, in accordance with manufacturer's recommendations, for field testing and prior to final acceptance. A supply of required lubricants sufficient for start-up and one year of operation shall also be supplied by the Contractor.
4. NOT USED.

C. Spare Parts and Special Tools

1. As soon as practicable after approval of the list of equipment, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and source or sources of supply.
2. Contractor shall also furnish a list of parts, and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified to be furnished as part of the Contract and a list of additional items recommended by the



manufacturer to assure efficient operation for a period of one-hundred and twenty (120) days for the particular installation.

3. All parts shall be securely boxed and tagged, and clearly marked on the box and individually for identification as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten (10) years.
4. Contractor shall furnish at no additional cost to the Owner with each piece of equipment as a minimum, one (1) complete set, or the number of sets called for in the Technical Specifications, of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment.
5. Contractor shall submit, for approval by the Engineer, a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.

#### D. Equipment Start-Up Services

1. Equipment start-up period, for the training of plant personnel, shall begin after satisfactory completion and acceptance of the field tests and coincidentally with the certified date of substantial completion for the part of the work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the work, the period shall begin upon substantial completion of the project.
2. During the equipment start-up period the Contractor shall furnish, at no additional cost to the Owner the services of factory trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:
  - a. Assist in the start-up and operations of the equipment.
  - b. Assist in the training of plant personnel, designated by the Owner in the proper operation and maintenance of the equipment.
3. The Owner shall:
  - a. Provide the necessary plant personnel to be instructed in the operation and maintenance of the equipment. The Owner's personnel shall operate all equipment.
  - b. Pay for all fuel, power and chemicals consumed beyond quantities specified in the Contract Documents. The Contractor shall pay for fuel, power, and chemicals consumed up to the date of "certified substantial completion" except as otherwise specified herein.
4. Contractor shall be available to promptly repair all work during the start-up period so as to cause minimum disruption to the total plant operation.

5. Upon completion of a minimum of ten (10) consecutive and continuous days of satisfactory operation, or the number of days called for in the Technical Specifications, the Owner will assume operation and operating cost of the equipment. If the equipment malfunctions during this start-up period, the start-up period will be repeated until satisfactory operation is achieved.
6. In the event a system, equipment or component proves defective or is unable to meet specified performance criteria, the Contractor shall replace the defective item and the minimum one (1) year guarantee period, or the guarantee period called for in the Technical Specifications for the item shall start after satisfactory replacement and testing of the item.

E. Final Cleanup; Site Rehabilitation

1. Before finally leaving the site, the Contractor shall wash and clean all exposed surfaces which have become soiled or marked, and shall remove from the site of work all accumulated debris and surplus materials of any kind which result from his operation, including construction equipment, tools, sheds, sanitary enclosures, etc. The Contractor shall leave all equipment, fixtures, and work, which he has installed, in a clean condition. The completed project shall be turned over to the Owner in a neat and orderly condition.
2. The site of the work shall be rehabilitated or developed in accordance with other sections of the Specifications and the Drawings. In the absence of any portion of these requirements, the Contractor shall completely rehabilitate the site to a condition and appearance equal or superior to that which existed just prior to construction, except for those items whose permanent removal or relocation was required in the Contract Documents or ordered by the Owner.

F. Final Inspection

1. Final cleaning and repairing shall be so arranged as to be finished upon completion of the construction work. The Contractor will make his final cleaning and repairing, and any portion of the work finally inspected and accepted by the Engineer shall be kept clean by the Contractor, until the final acceptance of the entire work.
2. When the Contractor has finally cleaned and repaired the whole or any portion of the work, he shall notify the Engineer that he is ready for final inspection of the whole or a portion of the work, and the Engineer will thereupon inspect the work. If the work is not found satisfactory, the Engineer will order further cleaning, repairs, or replacement.
3. When such further cleaning or repairing is completed, the Engineer, upon further notice, will again inspect the work. The "Final Payment" will not be processed until the Contractor has complied with the requirements set forth, and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is properly and satisfactorily constructed in accordance with the requirements of the Contract Documents.

## G. Project Close Out

1. As construction of the project enters the final stages of completion, the Contractor shall, in concert with accomplishing the requirements set forth in the Contract Documents, attend to or have already completed the following items as they apply to his contract:
  - a. Scheduling equipment manufacturers' visits to site.
  - b. Required testing of project components.
  - c. Scheduling start-up and initial operation.
  - d. Scheduling and furnishing skilled personnel during initial operation.
  - e. Correcting or replacing defective work, including completion of items previously overlooked or work which remains incomplete, all as evidenced by the Engineer's "Punch" Lists.
  - f. Attend to any other items listed herein or brought to the Contractor's attention by the Engineer.
2. Just before the Engineer's Certificate of Substantial Completion is issued, the Contractor shall accomplish the cleaning and final adjustment of the various building components as specified in the Specifications and as follows:
  - a. Clean all glass and adjust all windows and doors for proper operation.
  - b. Clean all finish hardware after adjustment for proper operation.
  - c. Touch up marks or defects in painted surfaces and touch up any similar defects in factory finished surfaces.
  - d. Wax all resilient flooring materials.
  - e. Remove bitumen from gravel stops, fascias, and other exposed surfaces.
  - f. Remove all stains, marks, fingerprints, soil, spots, and blemishes from all finished surfaces, tile, stone, brick, and similar surfaces.
3. In addition, and before the Certificate of Substantial Completion is issued, the Contractor shall submit to the Engineer (or to the Owner if indicated) certain records, certifications, etc., which are specified elsewhere in the Contract Documents. A partial list of such items appears below, but it shall be the Contractor's responsibility to submit any other items which are required in the Contract Documents:
  - a. Test results of project components.

- b. Performance Affidavits for equipment.
  - c. Certification of equipment or materials in compliance with Contract Documents.
  - d. Operation and maintenance instructions or manuals for equipment.
  - e. One set of neatly marked-up record drawings showing as-built changes and additions to the work under his Contract.
  - f. Any special guarantees or bonds (Submit to Owner).
  - g. Licensed surveyor's report showing elevations of weirs specified in the Contract Drawings and the final surveyed elevation.
4. The Contractor's attention is directed to the fact that required certifications and information under Item 3 above, must actually be submitted earlier in accordance with other Sections of the Specifications.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 02050

### DEMOLITION

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials and equipment in accordance with the requirements of Section 01520 - Maintenance of Utility Operations During Construction and Section 01540 - Demolition and Removal of Existing Structures and Equipment.
- B. In addition, the Contractor shall demolish and remove all concrete and asphaltic paving, curbs, sidewalk, and miscellaneous yard structures as required and shown on the Contract Drawings during the construction work.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01090 - Reference Standards
- B. Section 01520 - Maintenance of Utility Operations During Construction
- C. Section 01540 - Demolition and Removal of Existing Structures and Equipment

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. References shall be in accordance with reference standards, codes, and specifications as set forth herein and in Section 02100 - Clearing, Grubbing, and Site Preparation.

#### PART 2 -- EXECUTION

##### 2.01 DEMOLITION

- A. Existing concrete and asphaltic paving, curbs, sidewalk and miscellaneous yard structures within the areas designated for new construction work shall be completely demolished and all debris removed from the site.
- B. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris.
- C. Work shall be performed in such manner as not to endanger the safety of the workmen or the public or cause damage to nearby structures.
- D. Provide all barriers and precautionary measures in accordance with Owner's requirements and other authorities having jurisdiction.

- E. Where parts of existing structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove concrete and masonry to the lines designated by drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill with epoxy resin binder flush with the surface.
- F. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

## 2.02 DISPOSAL OF MATERIAL

- A. All debris resulting from the demolition and removal work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed. All other material shall be disposed of off site by the Contractor at his expense.
- B. Burning of any debris resulting from the demolition will not be permitted at the site.

- END OF SECTION -

## SECTION 02100

### CLEARING, GRUBBING, AND SITE PREPARATION

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Includes all labor, material, equipment and appliances required for the complete execution of any additions, modifications, or alterations to existing building(s) and new construction work as shown on the Drawings and specified herein.
- B. Principal items of work include:
  - 1. Notifying all authorities owning utility lines running to or on the property. Protecting and maintaining all utility lines to remain and capping those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.
  - 2. Clearing the site within the Contract Limit Lines, including removal of grass, brush, shrubs, trees, loose debris and other encumbrances except for trees marked to remain.
  - 3. Boxing and protecting all trees, shrubs, lawns and the like within areas to be preserved. Relocating trees and shrubs, so indicated on the Drawings, to designated areas.
  - 4. Repairing all injury to trees, shrubs, and other plants caused by site preparation operations shall be repaired immediately. Work shall be done by qualified personnel in accordance with standard horticultural practice and as approved by the Engineer.
  - 5. Removing topsoil to its full depth from designated areas and stockpiling on site where directed by the Engineer for future use.
  - 6. Disposing from the site all debris resulting from work under this Section.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. California Code of Regulations, Title 27.

##### 1.04 STREET AND ROAD BLOCKAGE

- A. Closing of streets and roads during progress of the work shall be in compliance with the requirements of the Owner and other authorities having jurisdiction. Access shall be provided to all facilities remaining in operation.

#### 1.05 PROTECTION OF PERSONS AND PROPERTY

- A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians and adjacent property and structures from possible injury and damage.
- B. All conduits, wires, cables and appurtenances above or below ground shall be protected from damage.
- C. Provide warning and barrier fence where shown on the Drawings and as specified herein.

### PART 2 -- EXECUTION

#### 2.01 NOT USED

#### 2.02 NOT USED

#### 2.03 NOT USED

#### 2.04 DISPOSAL OF MATERIAL

- A. All debris resulting from the clearing and grubbing work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed by the Engineer for reuse in this Project or removal by others.
- B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.

#### 2.05 WARNING AND BARRIER FENCE

- A. The fence shall be made of a visible, lightweight, flexible, high strength polyethylene material. The fence shall be MIRASAFE as manufactured by Mirafi, Inc., or equal.

- B. Physical Properties

##### Fence:

|               |                      |
|---------------|----------------------|
| Color:        | International Orange |
| Roll Size:    | 4' x 164'            |
| Roll weight:  | 34 lbs.              |
| Mesh opening: | 1-1/2" x 3"          |



Posts:

|                       |                      |
|-----------------------|----------------------|
| ASTM Designation:     | ASTM 702             |
| Length:               | 5 feet long (T-Type) |
| Weight:               | 1.25 #/Foot (min)    |
| Area of Anchor Plate: | 14 Sq. In.           |

- C. Drive posts 12 to 18 inches into ground every 10' to 12'. Wrap fence material around first terminal post allowing overlap of one material opening. Use metal tie wire or plastic tie wrap to fasten material to itself at top, middle and bottom. At final post, cut with utility knife or scissors at a point halfway across an opening. Wrap around and tie at final post in the same way as the first post.
- D. Use tie wire or tie wrap at intermediate posts and splices as well. Thread ties around a vertical member of the fence material and the post, and bind tightly against the post. For the most secure fastening, tie at top, middle and bottom. Overlap splices a minimum of four fence openings, tie as above, fastening both edges of the fence material splice overlap.

- END OF SECTION -

## SECTION 02200

### EARTHWORK

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all labor, equipment and materials required to complete all work associated with excavation, including off-site borrow excavation, dewatering, backfill, drainage layers beneath and around structures, foundation and backfill stone, filter fabric, embankments, stockpiling topsoil and any excess suitable material in designated areas, in place compaction of embankments, backfill and subgrades beneath foundations and roadways, excavation support, disposing from the site all unsuitable materials, providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work shown on the Drawings and specified herein.
- B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.
- C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.
- D. All work under this Contract shall be done in conformance with and subject to the limitations of the latest editions of the Standard Specifications of the California Department of Transportation, State Division of Highways, latest edition.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. Standard Specifications of the California Department of Transportation, State Division of Highways, latest edition.
  - 2. American Society for Testing and Materials (ASTM):
    - ASTM C 127      Test for Specific Gravity and Absorption of Coarse Aggregate.

ASTM C 136      Test for Sieve Analysis of Fine and Coarse Aggregates.

ASTM D 422      Particle Size Analysis of Soils.

ASTM D 423      Test for Liquid Limit of Soils.

ASTM D 424      Test for Plastic Limit and Plasticity Index of Soils.

ASTM C 535 Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

ASTM D 698 Standard Method of Test for the Moisture - Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12-inch (305 mm) Drop.

ASTM D1556    Test for Density of Soil in Place by the Sand-Cone Method. ASTM D1557 Test for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lbs. (4.5 kg) Rammer and 18-inch (457 mm) Drop.

ASTM D2049 Test Method for Relative Density of Cohesionless Soils.

ASTM D2167 Test for Density of Soil in Place by the Rubber-Balloon Method.

ASTM D2216 Test for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.

ASTM D2487      Test for Classification of Soils for Engineering Purposes. ASTM D2922 Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

#### 1.04    SUBSURFACE CONDITIONS

- A.    Information on subsurface conditions is referenced under Division 1, General Requirements.
- B.    Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed excavation. Perform all repairs to same in the event that excavation activities disrupt service.

#### 1.05    SUBMITTALS

- A.    In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:
  - 1.    Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.
3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.
4. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.
5. Samples of synthetic filter fabric and reinforced plastic membrane with manufacturer's certificates or catalog cuts stating the mechanical and physical properties. Samples shall be at least one (1) foot wide and four (4) feet long taken across the roll with the warp direction appropriately marked.
6. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be sealed by a currently registered Professional Engineer in the State of California.
7. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems and near areas where dewatering is required to facilitate construction.
8. Dewatering procedures.

#### 1.06 PRODUCT HANDLING

- A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

#### 1.07 USE OF EXPLOSIVES

- A. THE USE OF EXPLOSIVES SHALL NOT BE ALLOWED UNDER THIS PROJECT

### PART 2 -- PRODUCTS

#### 2.01 SELECT FILL

- A. Soils from the excavations meeting requirements stipulated herein with the exceptions of topsoil and organic material may be used as select fill for backfilling, constructing embankments, reconstructing existing embankments, and as structural subgrade support.
- B. Select fill used for embankment construction shall be a silty or clayey soil material with a Maximum Liquid Limit (LL) of 50 and a Plasticity Index (PI) between 7 and 20.

- C. Select fill used for backfilling shall either be material as described in Paragraph B above or a granular soil material with a Maximum Plasticity Index (PI) of 6.
- D. Regardless of material used as select fill, materials shall be compacted at a moisture content satisfactory to the Engineer, which shall be approximately that required to produce the maximum density except that the moisture content shall not be more than 3% below nor more than 3% above the optimum moisture content for the particular material tested in accordance with the ASTM D698.
- E. Select fill used as subgrade support shall be a coarse aggregate material meeting the gradation requirements of #57 or #78 aggregates in accordance with ASTM C-33, or Aggregate Base Course (ABC) as defined in Section 02207 – Aggregate Materials.
- F. Where excavated material does not meet requirements for select fill, Contractor shall furnish off-site borrow material meeting the specified requirements herein. Determination of whether the borrow material will be paid for as an extra cost will be made based on Article 4 of the General Conditions, as amended by the Supplementary Conditions. When the excavated material from required excavations is suitable for use as backfill, bedding, or embankments, but is replaced with off-site borrow material for the Contractor's convenience, the costs associated with such work and material shall be borne by the Contractor.

## 2.02 TOPSOIL

- A. Topsoil shall be considered the surface layer of soil and sod, suitable for use in seeding and planting. It shall contain no mixture of refuse or any material toxic to plant growth.

## 2.03 NOT USED

## 2.04 NOT USED

# PART 3 -- EXECUTION

## 3.01 STRIPPING OF TOPSOIL

- A. In all areas to be excavated, filled, paved, or graveled the topsoil shall be stripped to its full depth and shall be deposited in storage piles on the site, at locations designated by the Engineer, for subsequent reuse. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials.

## 3.02 EXCAVATION

- A. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, and all other obstacles encountered and shown to be removed within the limits of excavation shown on the Drawings or specified herein. The cost of excavation shall be included in the Lump Sum Bid Price and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein.

- B. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by the Engineer. No excavation shall be wasted except as may be permitted by the Engineer. Refer to the drawings for specific location and placement of suitable excavated materials in the formation of embankments, backfill, and structural and roadway foundations. THE ENGINEER AND/OR MATERIALS TESTING CONSULTANT AND/OR CITY MATERIALS TESTING LABORTORY WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE. The Contractor shall furnish off site disposal areas for the unsuitable material. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer and/or materials testing consultant and/or City Materials Testing Laboratory such measures are necessary to provide proper construction.
- C. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.
- D. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by the Engineer. Concurrent with the excavation of cuts the Contractor shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by the Engineer. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation shall be removed from slopes. The Contractor shall be required to submit plans of open-cut excavation for review by the Engineer before approval is given to proceed.
- E. It is the intent of these Specifications that all structures shall bear on an aggregate base placed to the thickness shown on the Drawings, specified in these Specifications, or not less than 6-inches. Bedding for process piping shall be as specified in Section 15000 - Basic Mechanical Requirements, or as shown on the Drawings.
- F. The bottom of all excavations for structures and pipes shall be examined by the Engineer and/or materials testing consultant and/or City Materials Testing Laboratory for bearing value and the presence of unsuitable material. If, in the opinion of the Engineer and/or materials testing consultant and/or City Materials Testing Laboratory, additional excavation is required due to the low bearing value of the subgrade material, or if the in-place soils are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by the Engineer. Payment for such additional work ordered by

the Engineer shall be made as an extra by a Change Order in accordance with the General Conditions and Division 1. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.

- G. All cuts shall be brought to the grade and cross section shown on the Drawings, or established by the Engineer, prior to final inspection and acceptance by the Engineer.
- H. Slides and overbreaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by the Engineer at no additional cost to the Owner. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.
- I. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a minimum of 6-inches and a maximum of 24-inches of clean fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by the Engineer for this purpose.

### 3.03 EXCAVATION SUPPORT

- A. The Contractor shall furnish, place, and maintain such excavation support which may be required to support sides of excavation or to protect pipes and structures from possible damage and to provide safe working conditions. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing it.
- B. Selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Contractor shall submit drawings and calculations on proposed systems sealed by a Professional Engineer currently registered in the State of California.
- C. The Contractor shall exercise caution in the installation and removal of supports to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.
- D. Contractor shall monitor movement in the excavation support systems as well as movement at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Engineer shall be notified immediately. Contractor shall be exclusively

responsible for repair of any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of his operations.

- E. All excavation supports shall be removed upon completion of the work except as indicated herein. The Engineer may permit supports to be left in place at the request and expense of the Contractor. The Engineer may order certain supports left permanently in place in addition to that required by the Contract. The cost of the materials so ordered left in place, less a reasonable amount for the eliminated expense of the removal work omitted, will be paid as an extra by a Change Order in accordance with the General Conditions and Division 1. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by the Engineer.

#### 3.04 PROTECTION OF SUBGRADE

- A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:
  - 1. Use of heavy rubber-tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.
  - 2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as indicated by the Engineer.
  - 3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other acceptable means.

#### 3.05 PROOFROLLING

- A. The subgrade of all structures and all areas that will support pavements or select fill shall be proofrolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proofrolled with a heavily loaded tandem-wheeled dump truck to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material.

#### 3.06 DEWATERING

- A. The Contractor shall do all dewatering as required for the completion of the work. Procedures for dewatering proposed by the Contractor shall be submitted to the Engineer for review prior to any earthwork operations. All water removed by dewatering operations shall be disposed of in accordance with the State of California and the City of Santa Rosa.



- B. The dewatering system shall be as specified in Section 02140 - Dewatering.

### 3.07 EMBANKMENTS

- A. The Contractor shall perform the construction of embankments in such a manner that cut and fill slopes will be completed to final slopes and grade in a continuous operation. The operation of removing excavation material from any cut and the placement of embankment in any fill shall be a continuous operation to completion unless otherwise permitted by the Engineer.
- B. Surfaces upon which embankments are to be constructed shall be stripped of topsoil, organic material, rubbish and other extraneous materials. After stripping and prior to placing embankment material, the Contractor shall compact the top 12-inches of in place soil as specified under Paragraph 3.09, COMPACTION.
- C. Any soft or unsuitable materials revealed before or during the in place compaction shall be removed as indicated by the Engineer and/or materials testing consultant and/or City Materials Testing Laboratory and replaced with select fill.
- D. Ground surfaces on which embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the embankment with the existing surface. The embankment soils shall be as specified under Part 2 - Products, and shall be deposited and spread in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width of the cross section, and shall be kept approximately level by the use of effective spreading equipment. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. The embankment shall be properly drained at all times. Each layer of the embankment shall be thoroughly compacted to the density specified under Paragraph 3.09, COMPACTION.
- E. The embankment or fill material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.
- F. Where embankments are to be placed and compacted on hillsides, or when new embankment is to be compacted against embankments, or when embankment is built in part widths, the slopes that are steeper than 4:1 shall be loosened or plowed to a minimum depth of 6 inches or, if in the opinion of the Engineer, the nature of the ground is such that greater precautions should be taken to bind the fill to the original ground then benches shall be cut in the existing ground as indicated by Engineer.

- G. When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankments and the other material which meets the requirements for select fill shall be incorporated into the formation of the embankments. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the final grade. Stones, fragmentary rock, or boulders larger than 12-inches in their greatest dimension will not be allowed in any portions of embankments and shall be disposed of by the Contractor as indicated by the Engineer. When rock fragments or stone are used in embankments, the material shall be brought up in layers as specified or directed and every effort shall be exerted to fill the voids with finer material to form a dense, compact mass which meets the densities specified for embankment compaction.

### 3.08 BACKFILLING

- A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings, specified herein, and/or as specified in City of Santa Rosa Construction Standard 215. Select fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 6 inches of pipes. No stone or fragmentary rock larger than 12-inches in their greatest dimension will be allowed for any portion of backfill. Compaction shall be in accordance with the requirements of Paragraph 3.09, COMPACTION.
- B. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.

### 3.09 COMPACTION

- A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

|                                 | Density %<br>Std. Proctor<br>(D698) | Density %<br>Mod. Proctor<br>(D1557) | Max. Lift Thickness<br>as Compacted<br>Inches |
|---------------------------------|-------------------------------------|--------------------------------------|-----------------------------------------------|
| Embankments Beneath Structures* | 98                                  | 95                                   | 8                                             |
| Other Embankments               | 95                                  | 92                                   | 8                                             |
| Backfill Around Structures      | 95                                  | 92                                   | 8                                             |
| Backfill in Pipe Trenches       | 95                                  | 92                                   | 8                                             |

|                                                                 | Density %<br>Std. Proctor<br>(D698) | Density %<br>Mod. Proctor<br>(D1557) | Max. Lift Thickness<br>as Compacted<br>Inches |
|-----------------------------------------------------------------|-------------------------------------|--------------------------------------|-----------------------------------------------|
| Crushed Stone Beneath Structures                                | **                                  | **                                   | 12                                            |
| Select Sand                                                     | --                                  | 98                                   | 8                                             |
| Aggregate Base Course (ABC)<br>Beneath Pavements and Structures | --                                  | 98                                   | 8                                             |
| Crushed Stone Backfill                                          | **                                  | **                                   | 12                                            |
| Crushed Stone Pipe Bedding                                      | **                                  | **                                   | 12                                            |
| In place Subgrade Beneath Structures                            | 98                                  | 95                                   | Top 12-inches                                 |

\* Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope.

\*\* The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.

- B. Field density tests will be made by the materials testing consultant or City Materials Testing Laboratory to determine if the specified densities have been achieved, and these tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. The Engineer in conjunction with the materials testing consultant or City Materials Testing Laboratory will be the judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to re-compact the material or remove it as required. The Contractor shall, if necessary, increase his compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the thickness of the layers. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.
- C. Testing will be performed as frequently as deemed necessary by the Engineer and/or materials testing consultant and/or City Materials Testing Laboratory. As a minimum, one in-place density test shall be performed for each 1000 cubic yards of embankment placed and 500 cubic yards of backfill placed or one test performed each day for either.

### 3.10 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

- A. The Contractor shall remove and dispose of off-site all unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.
- B. All unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state and local laws and regulations.

- C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.
- D. All excess and unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the propagation of dust.
- E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to the Owner and Owner(s) of the disposal site(s).

### 3.11 BORROW EXCAVATION

#### A. Description

The work covered by this section consists of the excavation of approved material from borrow sources and the hauling and utilization of such material as required on the Drawings or directed by the Engineer. It shall also include the removing, stockpiling, and replacement of topsoil on the borrow source; the satisfactory disposition of material from the borrow source which is not suitable for use; and the satisfactory restoration of the borrow source and haul roads to an acceptable condition upon completion of the work.

Borrow excavation shall not be used before all available suitable unclassified excavation has been used for backfill and incorporated into the embankments.

#### B. Coordination with Seeding Operations

The Contractor shall coordinate the work covered by this section with the construction of embankments so that the requirements of Section 02200 are met.

#### C. Materials

All material shall meet the requirements of Division 2 shown below:

Borrow Material ..... Section 02200, Subsection 2.01 - Select Fill

#### D. Construction Methods

##### 1. General

The surface of the borrow area shall be thoroughly cleared and grubbed and cleaned of all unsuitable material including all organics, topsoil, etc., before beginning the excavation. Disposal of material resulting from clearing and grubbing shall be in accordance with Section 02100.

Each borrow operation shall not be allowed to accumulate exposed, erodible slope area in excess of 1 acre at any one given time without the Contractor's beginning permanent seeding and mulching of the borrow source or other erosion control measures as may be approved by the Engineer.

The topsoil shall be removed and stockpiled at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Temporary erosion control measures shall be installed as may be necessary to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, the stockpiled topsoil shall be spread uniformly over the source.

Where it is necessary to haul borrow material over existing roads, the Contractor shall use all necessary precautions to prevent damage to the existing roads. The Contractor shall also conduct his hauling operations in such a manner as to not interfere with the normal flow of traffic and shall keep the traffic lanes free from spillage at all times.

## 2. Owner Furnished Sources

Where borrow sources are furnished by the Owner the location of such sources will be as designated on the Drawings or as directed by the Engineer.

The borrow sources shall be left in a neat and presentable condition after use. All slopes shall be smoothed, rounded, and constructed not steeper than 3:1. Where the source is to be reclaimed for cultivation the source shall be plowed or scarified to a minimum depth of 8 inches, disc harrowed, and terraces constructed. The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided.

All sources shall be seeded and mulched in accordance with Section 02910.

## 3. Contractor Furnished Sources

Prior to the approval of any off-site borrow source(s) developed for use on this project, the Contractor shall obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. A copy of this certification shall be furnished to the Engineer prior to performing any work on the proposed borrow source.

The approval of borrow sources furnished by the Contractor shall be subject to the following conditions:

- a. The Contractor shall be responsible for acquiring the right to take the material and any rights of access that may be necessary; for locating and developing the source; and any clearing and grubbing and drainage ditches necessary.

Such right shall be in writing and shall include an agreement with the Owner that the borrow source may be dressed, shaped, seeded, mulched, and

drained as required by these Specifications after all borrow has been removed.

- b. Except where borrow is to be obtained from a commercial source, the Contractor and the property owner shall jointly submit a borrow source development, use, and reclamation plan to the Engineer for his approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Contractor's plan shall address the following:

- (1) Drainage

- The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided. If drainage is not practical, and the source is to serve as a pond, the minimum average depth below the water table shall be 4 feet or the source graded so as to create wetlands as appropriate.

- (2) Slopes

- The source shall be dressed and shaped in a continuous manner to contours which are comparable to and blend in with the adjacent topography, but in no case will slopes steeper than 3:1 be permitted.

- (3) Erosion Control

- The plan shall address the temporary and permanent measures that the Contractor intends to employ during use of the source and as a part of the reclamation. The Contractor's plan shall provide for the use of staged permanent seeding and mulching on a continual basis while the source is in use and the immediate total reclamation of the source when no longer needed.

- 4. Maintenance

- During construction and until final acceptance the Contractor shall use any methods approved by the Engineer which are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

- END OF SECTION -

SECTION 02500  
SURFACE RESTORATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Provide all labor, equipment, and materials necessary for final grading, topsoil placement, and miscellaneous site work not included under other Sections but required to complete the work as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 - Earthwork
- B. Section 02276 - Erosion and Sedimentation Control
- C. Section 02910 - Final Grading and Landscaping

PART 2 -- MATERIALS

2.01 TOPSOIL

- A. Topsoil shall meet the requirements of Section 02200 – Earthwork.

PART 3 -- EXECUTION

3.01 FINAL GRADING

- A. Following approval of rough grading the subgrade shall be prepared as follows:
  - 1. For riprap, bare soil 24 inches below finish grade or as directed by Engineer.
  - 2. For topsoil, scarify 2-inches deep at 4 inches below finish grade.

3.02 TOPSOIL PLACEMENT

- A. Topsoil shall be placed over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped.
- B. Topsoil shall be spread in place for lawn and road shoulder seed areas at a 4-inch consolidated depth and at a sufficient quantity for plant beds and backfill for shrubs and trees.

- C. Topsoil shall not be placed in a frozen or muddy condition.
- D. Final surface shall be hand or mechanically raked to an even finished surface to finish grade as shown on Drawings.
- E. All stones and roots over 4-inches and rubbish and other deleterious materials shall be removed and disposed of.

- END OF SECTION -



## SECTION 02510

### PAVING AND SURFACING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and materials and perform all operations in connection with the construction of asphalt concrete pavement, asphalt concrete overlay, reinforced concrete pavement, gravel roads, concrete curb and gutter, repair and reconstruction of existing asphalt concrete pavement, repair of existing gravel roads, and pavement markings complete as specified herein and as detailed on the Drawings.
- B. All new roads including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses and types as shown on the Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt and/or gravel, depending upon the material encountered, unless otherwise indicated.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1, Division 2 and Division 3 of these Specifications.

##### 1.03 RELATED SECTIONS

- A. Section 02200 - Earthwork
- B. Section 03300 - Cast-In-Place Concrete

##### 1.04 STANDARD SPECIFICATIONS

- A. Except as otherwise provided in the Specifications or on the plans, all work shall be in accordance with the California Department of Transportation (Caltrans) 2015 Standard Specifications, or latest edition except that any reference to Caltrans, "Department" or "Unit" shall mean the "Owner".
- B. Materials shall be in accordance with the Standard Specifications for Public Works Construction ("Greenbook") 2015.
- C. Except with the approval of the Engineer, the placing of concrete or asphalt concrete surface paving shall be subject to the Seasonal and Weather Restrictions set forth in Caltrans Specifications.

## PART 2 -- MATERIALS

### 2.01 SELECT FILL

- A. The Contractor shall place select fill as necessary to complete the embankments, shoulders, subgrade foundation and replacement for removed unsuitable material in accordance with Caltrans Section 19 - Earthwork, and Section 02200, Earthwork.

### 2.02 AGGREGATE FOR SUBBASES

- A. All work, including materials, associated with aggregate for subbases shall be in accordance with Caltrans Section 25, Aggregate Subbases, except that Article 25-1.04 shall be deleted.

### 2.03 CEMENT TREATED BASES

- A. All work, including materials, associated with cement treating of bases for stabilization shall be in accordance with Caltrans Section 27, Cement Treated Bases, except that Article 27-1.04 shall be deleted.

### 2.04 AGGREGATE BASES (AB)

- A. Base materials should conform to Caltrans Section 26, Aggregate Base, except that the minimum Sand Equivalent shall equal 31.

### 2.05 HOT MIX ASPHALT (HMA) BINDER

- A. All work, including materials, associated with hot mix asphalt binder shall be in accordance with Section 39, Asphalt Concrete, except that Article 39-2.01D shall be deleted. Asphalt binder in HMA must comply with the specifications for asphalts or section 39-2.03A from the Caltrans 2015 Standard Specifications, latest edition. Grade PG 64-16 asphalt binder shall be used.

### 2.06 HOT MIX ASPHALT (HMA)

- A. Asphalt concrete materials should conform to current City of Santa Rosa (City) mix design requirements for 1/2-inch Maximum Coarse Asphalt Concrete. Provide a Certificate of Compliance from the Supplier that their material typically conforms with City of Santa Rosa CIP Specification requirements. Contact the City Materials Engineering Laboratory (CMEL, 707-543-3833) prior to paving. The CMEL will notify the Supplier with the specific asphalt binder content required for production.
- B. The job mix formulas shall be delivered to the Engineer at least two (2) weeks prior to beginning paving operations.

### 2.07 RIGID PORTLAND CEMENT CONCRETE PAVEMENT

- A. All work, including materials associated with rigid concrete pavement shall be in accordance with Section 03300, Cast-In-Place Concrete. Class A concrete shall be used. Placement

shall be in accordance with Section 03300 and Caltrans Section 40, Concrete Pavement, except that Article 40-1.04 shall be deleted.

## 2.08 RIGID CONCRETE PAVEMENT REINFORCING

- A. Reinforcing, if specified, shall be as shown on the Structural Drawings and as specified under Section 03200, Reinforcing Steel.

## 2.09 CONCRETE CURB AND GUTTERS

- A. Concrete shall be Class B in accordance with the requirements of Section 03300, Cast-In-Place Concrete, except that concrete shall be air-entrained to provide an air content of 6%  $\pm$  1.5%.
- B. Premolded expansion joint filler for expansion joints shall conform to ASTM D 1751 and shall be 1/2-inch thick, minimum.

## 2.10 ASPHALT TACK COAT

- A. All work, including materials, associated with asphalt tack coat shall be in accordance with Section 39, Hot Mix Asphalt from the Caltrans 2015 Standard Specifications, latest edition, except that Article 39-2.01D shall be deleted.

# PART 3 -- EXECUTION

## 3.01 SUBGRADE

- A. The subgrade, where shown on the Drawings, shall be aggregate stabilized by the addition and mixing of coarse aggregate with the top 3-inches of subgrade in accordance with Caltrans Section 25 – Aggregate Subbases. Aggregate stabilization shall be according to Caltrans Section 27 – Cement Treated Bases. Following the application of stabilizer aggregate shall be spread and compacted as per Section 25, and the subgrade shall be formed true to crown and grade as per the Contract Drawings.

## 3.02 BASE COURSE

- A. The finished base course of all paving shall be ABC and shall be of the thickness shown on the Drawings, formed true to crown and grade. Gravel roads, including repair to existing gravel roads shall be ABC and shall be of the thicknesses shown on the Drawings, formed true to crown and grade. No fill material except new ABC shall be placed on top of existing gravel.

## 3.03 ASPHALT PAVEMENT

- A. Asphalt Concrete courses shall be placed and compacted in accordance with Caltrans 2015 Standard Specifications, latest edition, Section 39 – Asphalt Concrete. Thicknesses shall be as shown on the Drawings.

- B. If more than one course of asphalt pavement is required by the Contract Drawings, the asphalt tack coat shall be applied to the surface of the approved lower pavement course, before application of the surface course as described in Caltrans Section 39-2.01C.
- C. Asphalt pavement shall be placed according to the requirements of the Construction Standards of the City of Santa Rosa.

#### 3.04 RIGID PORTLAND CEMENT CONCRETE

- A. The subgrade and base course beneath portland cement concrete pavement shall be prepared in accordance with the applicable Sections of these Specifications and referenced Standard Specifications, except that the Contractor shall use an approved automatically controlled fine grading machine to produce final subgrade and base surfaces meeting the lines, grades, and cross sections (thicknesses) shown on the Drawings or established by the Engineer.
- B. The surface of the base shall be damp at the time the concrete is placed. The Contractor shall sprinkle the base when necessary to provide a damp surface. The Contractor shall satisfactorily correct all soft areas in the subgrade or base prior to placing concrete.
- C. Hauling over the base course shall not be allowed except where specifically permitted by and in writing by the Engineer. The Engineer may allow equipment dumping concrete to operate on the base to the extent and under the conditions the Engineer deems necessary to facilitate placing and spreading the concrete.
- D. Installation of the rigid concrete pavement shall be in accordance with the details shown on the Drawings and Division 3 - Concrete. The rigid concrete pavement shall cure a minimum of ten (10) calendar days and until the concrete has attained a minimum flexural strength of 550 psi as indicated by flexural strength testing. The Contractor shall coordinate and pay for all flexural strength testing with a minimum of four (4) 6-inch by 6-inch by 20-inch beams for every fifty (50) cubic yards of pavement concrete installed.
- E. Contraction joints shall be spaced at intervals as shown on the Drawings. Transverse contraction joints shall be formed by an approved joint insert. Expansion joints shall be placed when the pavement abuts a structure using 1-inch expansion joint material (filler) and sealant as specified herein.

#### 3.05 CONCRETE CURB AND GUTTER

- A. The expansion joint filler for concrete curb and gutters shall be cut to conform with the cross section of the curb. Expansion joints shall be spaced at intervals of not more than 25-feet. Formed control joints shall be installed at intervals not exceeding 10 feet. Depth of joint shall be 1/3 the thickness. Curved forms shall be used where radii are indicated; straight segments shall not be permitted. Upon removal of the forms, exposed curb faces shall be immediately rubbed down to a smooth and uniform surface. No plastering shall be permitted.

#### 3.06 UNDERGROUND UTILITY LINES

- A. Where an underground utility line is beneath the new roadway, the backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a vibratory roller. Construction of the roadway over the trench shall be deferred as long as practicable.

### 3.07 JUNCTION WITH OTHER PAVING

- A. Where new asphalt concrete pavement abuts existing asphalt concrete pavement, the existing pavement shall be cut back to insure obtaining the specified compaction of the new pavement courses and interlocking adjoining courses. Existing subbase courses shall be cut back from the subgrade level of the new pavement on a one-on-one slope into the existing pavement, and the asphalt courses of the existing pavement shall be removed for an additional 6-inches back from the slope. The edge of the existing asphalt courses shall be saw cut straight and true. The faces between new and existing asphalt courses shall receive an application of tack coat.
- B. Where new rigid concrete pavement abuts existing rigid concrete or asphalt concrete paving, the existing paving shall be saw cut straight and true. An expansion joint of a 1/2-inch minimum thickness with filler material and sealant shall be placed between the new concrete pavement and the existing rigid concrete or asphalt concrete paving.

### 3.08 ASPHALT CONCRETE OVERLAY

- A. Where asphalt concrete is proposed to be placed over an existing asphalt or rigid concrete surface, the surfaces shall be thoroughly cleaned by power brooming and a tack coat shall be applied in accordance with Caltrans Section 39-2.01C, prior to installing the overlay. The overlay shall be applied in accordance with the Standard Details shown on the Contract Drawings.

-END OF SECTION-

SECTION 02604  
UTILITY STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery and installment of utility structures and appurtenances in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02200 – Earthwork
- B. Section 03200 – Reinforcing Steel
- C. Section 03250 – Concrete Accessories
- D. Section 03300 – Cast-in-Place Concrete
- E. Section 03400 – Precast Concrete
- F. Section 05540 – Castings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections
  - 2. ASTM C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
  - 3. ASTM C990 - Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.04 SUBMITTALS

- A. Submit samples and/or Shop Drawings in accordance with Section 01300, Submittals.
- B. In addition to items listed in Section 03400, Precast Concrete, Shop Drawings shall include, but not be limited to:

1. Complete layout and installation Drawings and schedules with clearly marked dimensions.
2. Material certificates on all piping materials.
3. Structural design calculations sealed by a P.E. registered in the State of California. Design calculations for precast manholes and vaults shall include confirmation structures adequately resist flotation when they are totally empty and subjected to groundwater full height of structure.
4. Results of leakage test

## PART 2 -- PRODUCTS

### 2.01 PRECAST MANHOLES, VAULTS, AND METER BOXES

- A. Precast utility structures shall be furnished with waterstops, sleeves and openings as noted on the Drawings. Box out for wall pipes shall conform accurately to the sizes and elevations of the adjoining pipes. Precast utility structures shall be watertight and conform to the requirements of ASTM C 478 and ASTM C857 with the following modifications there to:
  1. Materials shall conform to Section 03400, Precast Concrete.
  2. Manholes shall meet the following:
    - a. Manhole section shall have an internal diameter of 4'-0", unless noted otherwise.
    - b. Minimum manhole wall thicknesses shall be 5 inches for 4 foot and 5 foot diameter manholes, 6 inches for 6 foot diameter manholes and 7 inches for 7 foot diameter manholes.
    - c. Manholes and utility structures shall include ballast concrete and/or other means necessary to insure manholes resist flotation when empty and subjected to groundwater full height of structure.
    - d. Precast manholes and utility structures shall be as manufactured by NC Products/Oldcastle, Tindall Products, or equal.
  3. The date and name of manufacturer shall be marked inside each precast section.
  4. No more than two lift holes may be cast or drilled in each section.
  5. Dimensions shall be as shown on the Drawings.
  6. Covers and frames shall be as specified in Section 2.13.

- 7. Mechanical Details such as piping, electrical, and other details shall be as shown on the Drawings.
- B. Joints between manhole and utility structures riser sections and at base slabs shall be groove type.
- 2.02 BRICK
  - A. Brick shall be sound, hard-burned common brick conforming to ASTM C32, Grade MS.
- 2.03 MORTAR
  - A. Mortar shall conform to Section 04100 Mortar and Masonry Grout.
- 2.04 CONCRETE
  - A. Concrete shall conform to Section 03300, Cast-in-Place Concrete.
- 2.05 REINFORCING
  - A. Reinforcing shall conform to Section 03200, Reinforcing Steel.
- 2.06 PRECAST CONCRETE
  - A. Precast concrete shall conform to Section 03400, Precast Concrete.
- 2.07 CONCRETE BLOCK
  - A. Concrete block shall be solid, rectangular concrete masonry units conforming to ASTM C139.
- 2.08 CASTINGS
  - A. Castings shall conform to Section 05540, Castings. Casting shall be of the type and size indicated on the Drawings.
- 2.09 STEPS
  - A. Steps shall be constructed of Grade 60 steel reinforcing rod (min. 1/2-inch) and completely encapsulated with a wear resistant and chemical resistant rubber.
  - B. Each step shall have a minimum vertical load resistance of 800 pounds and a minimum pull-out resistance of 400 pounds.
  - C. The steps shall have 11-inch minimum tread width and shall be placed at 16-inches on center, as shown on the Drawings.
  - D. Steps shall be cast in place with the concrete.



- E. Steps shall only be installed as shown on the Drawings or required in the Specifications.

## 2.10 JOINT SEALANT

- A. Joint sealant shall be a preformed flexible sealant conforming to the requirements of ASTM C990, paragraph 6.2, Butyl Rubber Sealant. Joint sealant shall be Pro-Stik Butyl Sealant by Press-Seal, Butyl-Nek Join Sealant by Henry ,CS-102 Butyl Rubber Sealant for all Precast Structures by ConSeal, or equal.

## 2.11 FLEXIBLE RUBBER SLEEVE

- A. The spring set type shall have a stainless steel interior power sleeve or expander and shall be the PSX assembly by Press-Seal Gasket Corporation, the Kor-N-Seal assembly by National Pollution Control Systems, or Lock Joint Flexible Manhole Sleeve by Interpace Corp.
- B. The cast-in-place type shall conform to ASTM C923 and shall include stainless steel take up clamps.
- C. Flexible seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

## 2.12 RUBBER BLADDER

- A. The rubber bladder seal shall conform to ASTM C923 suitable for pressure testing at 10 psi minimum, with a 3/8 inch minimum wall thickness.
- B. The rubber bladder seal shall contain an environmentally safe, anti-bacterial compound which turns into a high viscosity gel when in contact with pressurized water.
- C. The rubber bladder seal shall be NPC Contour Seal by Kor-N-Seal, or equal.

## 2.13 COVERS AND FRAMES

- A. Covers and frames shall comply with Section 05540, Castings and City Standards and shall be provided by the utility structure manufacturer.
- B. Manhole covers and frames shall meet the following requirements:
  - 1. Locate so that there is ready access to the manhole steps
  - 2. Clear opening shall be a minimum of 24 inches, unless otherwise indicated on the Drawings.
  - 3. Watertight manhole frames and covers shall be suitable for 20 psi internal pressure and shall be per City Engineer's List of Approved items.
  - 4. Non-watertight manhole covers shall be perforated and shall be per City Engineer's List of Approved items.

- 5. Storm drain grated inlet frames and grates shall be per City Engineer's List of Approved items.
  - 6. Curb inlet frames and grates shall be per City Engineer's List of Approved items.
  - C. Vault covers shall have lifting handles and shall be bolted with stainless steel bolts complying with Section 05050, Metal Fastening.
  - D. All frames and covers shall be given one shop coat of asphalt or coal tar varnish, unless otherwise specified.
  - E. Frames and covers shall be identical throughout the Contract.
- 2.14 GRATES
- A. Grates shall comply with Section 05540, Castings and City Standards.
- 2.15 CONCRETE BALLAST
- A. Concrete ballast shall be Class B concrete in conformance with Section 03300, Cast-in-Place Concrete. Ballast shall be provided as necessary to insure manhole resists flotation when empty and subjected to full height groundwater conditions.
- 2.16 FLEXIBLE JOINT SEALER
- A. Flexible joint sealer shall be a rubber ring waterstop as manufactured by Fernco Joint Sealer Co., or equal.
- 2.17 EPOXY BONDING AGENT
- A. Epoxy bonding agent shall conform to Section 03250, Concrete Accessories.

### PART 3 -- EXECUTION

#### 3.01 DESIGN CRITERIA

- A. Minimum structural design loading for underground precast concrete vaults shall be as indicated in ASTM C857, unless otherwise noted herein. Precast items subjected to vehicular traffic shall be designed for H-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.
- B. Walls of precast items shall be designed for a vertical surcharge of 100 psf.
- C. Precast manholes and vaults shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole/vault.

#### 3.02 FABRICATION AND CASTING

- A. Fabrication and casting shall conform to Section 03400, Precast Concrete, and to Section 03300, Cast-in-Place Concrete.
- B. All base sections designated to receive concrete ballast and all electrical manholes shall extend monolithically a minimum of 6 inches beyond the outside face of the wall for the entire periphery. All other utility structures shall have a standard base.
- C. Utility structures built around existing pipe shall have a cast-in-place base slab.

### 3.03 HANDLING, TRANSPORTING, AND STORING

- A. Handling, transporting and storing of precast items shall comply with Section 03400, Precast Concrete.

### 3.04 INSTALLATION

- A. Installation shall conform with Section 03400, Precast Concrete and with the manufacturer's recommendations or to Section 03300, Cast-in-Place Concrete.
- B. Frames and covers or grates shall be set so that tops are at elevations indicated on the Drawings or flush with finished grade where no elevation is indicated.
- C. Joints between riser sections shall be sealed with joint sealant.
- D. All openings in utility structures shall have flexible rubber sleeves sized to fit the connecting pipe and installed to provide watertight joints in accordance with the manufacturer's recommendations. The interior of the sleeve shall be filled with Class B concrete.
- E. Openings that are too large for flexible rubber sleeves shall utilize rubber bladder seals which are expanded by water injected using a pressure pump.
- F. All units shall be installed plumb and level.
- G. All lift holes and joints shall be filled with non-shrink grout conforming to Section 03600, grout inside and out.
- H. The manhole frames shall be set to their required elevations with grade rings.
- I. Concrete ballast shall be placed so that it bears directly on the utility structure base against the outer wall monolithically encircling the structure for the full height indicated on the Drawings. Additional ballast may be required where the depth or elevation of the structure varies from the Drawings.
- J. Brick or Concrete Block

Brick or concrete block shall be laid with broken joints and all horizontal and vertical joints filled with cement-sand mortar. Outside of walls shall be plastered with a minimum 1-inch thick coat of cement-sand mortar troweled smooth.

K. Connection to Existing Pipe

1. Verify the diameter and invert elevation of existing pipe to be connected to new utility structures prior to beginning work on the structures.
2. Provide adequate protection to prevent damage to the existing pipe.
3. Provide adequate means for plugging and/or transferring the existing flow in the pipe to allow for the construction of inverts and grouting.
4. Cut off the existing pipe sufficiently for connection to the new structure and remove.
5. Thoroughly clean all foreign matter and coat the pipe surface with epoxy adhesive where the pipe joins the new structure.
6. Install a flexible joint sealer around the pipe.
7. Grout inside and outside of wall penetration with nonshrink grout.

L. Backfill structures in accordance with Section 02200, Earthwork.

M. Clean all structures of any accumulation of silt, debris, or foreign matter and keep clean until final acceptance of the work.

N. Excavation shall conform to Section 02200, Earthwork.

O. Structure bases shall bear on a minimum of 8 inches of compacted stone unless otherwise indicated on the Drawings.

P. Channel Inverts

1. Inverts shall be placed using Class B concrete with forms sufficient to provide a smooth half-round shape as shown on the Drawings. Manhole bases employing full depth precast inverts are acceptable.
2. Where the slope of the line does not change through a manhole, a constant slope shall be maintained in the invert. Where slope changes occur within a given manhole, the transition shall be smooth and shall occur at the approximate center of the manhole.
3. Inverts shown on the Drawings are taken at the center of the manhole unless otherwise noted.

3.05 ADJUSTMENTS TO EXISTING UTILITY STRUCTURES

A. Adjust structures as indicated on the Drawings using concrete or cast iron adjustment rings by approved methods.

- B. Clean covers and inlet castings of all foreign material and paint with one coat of coal tar epoxy.

### 3.06 ADJUSTING COLLARS AND FINAL ADJUSTMENTS

- A. Adjusting collars shall be as shown on the Drawings. Final adjustments shall be made so that the manhole ring and cover will be smooth and flush with the finished grade of the adjacent surface, or as otherwise indicated on the Drawings for manholes shown above grade.

### 3.07 FLUSHING AND TESTING

- A. Obstruction - After backfilling, all sewers shall be inspected for obstructions and shall be flushed with water. Flushing shall be a minimum velocity of 2.5 feet per second for a duration acceptable to the Engineer. Flushing shall remove all dirt, stones, pieces of wood and other debris which accumulated in the sewer during construction. The Contractor shall provide a means acceptable to the Engineer for removal of debris flushed from each section of sewer. If after flushing, any obstructions remain, they shall be removed at the Contractor's expense.
- B. Visual Inspection - Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras, or other devices for visual inspection, and the lines shall all exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet these qualifications.
- C. Leakage - Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Engineer and the Contractor. The Contractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. The Contractor shall, at his own expense, correct any excess leakage and repair any damage to the pipe and their appurtenances, or to any structures resulting from or caused by these tests.
- D. Leakage Test Procedure - Each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole with water to a point 6 feet above the crown of the open sewer in the upper manhole, or, if ground water is present, 6 feet above the sections average adjacent ground water level as indicated by a monitor well installed adjacent to each manhole. The line shall be filled with water prior to testing and allowed to stand until the pipe has reached its maximum absorption, but not less than two (2) hours. After maximum absorption has been reached, the head shall be re-established and tested for at least six (6) hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period.

If ground water is present to a height of at least 6 feet above the crown of the sewer at the upper end of the pipe section to be tested, the leakage test may be made by measuring the rate of infiltration using a suitable weir or other measuring device approved by the Engineer. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 100 gallons per day per inch of diameter per mile of sewer being tested.

Where the actual leakage exceeds the allowable, the Contractor shall discover the cause and correct it before the sewer will be accepted. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

- E. Low Pressure Compressed Air Test - If the leakage cannot be located by infiltration or exfiltration testing, this type test may be used. The pipeline shall be considered acceptable, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0030 cfm per sq. ft. of internal pipe surface.
- F. Deflection Test - No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using an electronic deflecto-meter or a rigid "Go-No-Go" device. Vertical deflection shall not exceed five (5) percent of the inside pipe diameter for PVC pipe.

Where the actual deflection exceeds the allowable, the Contractor shall discover the cause and correct it before the pipe will be acceptable. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

- G. Cost of Testing and Repairs - Any and all work necessary to bring the line into conformance with the infiltration and deflection specifications shall be performed by the Contractor at no extra cost to the Owner. All apparent sources of infiltration and excessive deflection shall be repaired by the Contractor.

The Contractor shall provide all water, plugs, hoses, pumps, equipment, etc. necessary for the proper flushing and testing of the sewers.

- END OF SECTION -

## SECTION 02831

### STEEL FENCING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install steel fencing, posts, gates, etc., where shown on the Drawings and in compliance with these Special Provisions, the details shown on the Project Plans, Section 80 of the Standard Specifications and as directed by the Engineer.
- B. Fencing shall be of the chain link type not topped with barbed wire. The 8-foot high fabric shall clear the final grade by 3 inches. All components which are to be galvanized shall be hot dipped galvanized, coating to be 1.8 ounces per square foot of surface. Alternate coatings which employ a zinc coating of less than 1.8 ounces per square foot are not acceptable.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete.

##### 1.03 SUBMITTALS

- A. Shop Drawings shall be furnished in accordance with Section 01300, Submittals.

#### PART 2 -- PRODUCTS

##### 2.01 CHAIN LINK FABRIC

- A. Chain link fence fabric shall be galvanized steel fabric conforming to the specifications of AASHTO Designation M-181. The fabric shall be #9 gauge, Type IV, Class B bonded vinyl-coated, black. Fabric shall be woven into approximately a one-inch mesh.
- B. The strength of the bond between the coating material and the steel of the bonded vinyl-coated chain link fabric or posts shall be equal to or greater than the cohesive strength of the polyvinyl chloride (PVC) coating material. The color of the vinyl coatings shall be black.
- C. Install fabric 3 inches above ground level. Fence shall be stretched tight and securely fastened to posts at points spaced 12 inches apart maximum.

##### 2.02 POSTS

- A. All posts, gate frames, and rails shall be steel pipe galvanized and vinyl clad according to the specifications of AASHTO Designation M-111 and as specified on the Plans. All line and

corner posts shall be a minimum of 11 feet in length and gate posts a minimum of 12 feet in length.

1. Line Posts: Line posts shall be Schedule 40, 2-3/8 inch O.D. galvanized pipe with minimum bending strength of 201 pounds under a 6-foot cantilever load. Line posts shall be spaced at a maximum 10-foot O.C.
2. Terminal Posts: All end, corner, intermediate, and pull posts and gate leaves 6'0" wide and less shall be 2-7/8 inch O.D. galvanized Schedule 40. Gate posts for gate leaves shall be Schedule 40 pipe complying with ASTM F1083 of diameters as follows:

| <u>Gate Leaf Width</u> | <u>Pipe O.D.</u> | <u>Weight per Ft.</u> |
|------------------------|------------------|-----------------------|
| 0' to 6'               | 2-7/8"           | 5.79 lbs.             |
| Over 6' to 13'         | 4"               | 9.1 lbs.              |
| Over 13' to 18'        | 6-5/8"           | 18.97 lbs.            |
| Over 18'               | 8-5/8"           | 24.7lbs.              |

## 2.03 TENSION WIRE

- A. Top and bottom tension wire shall be No. 7 gauge aluminum coated steel wire. Fabric shall be securely tied to tension wire at intervals not to exceed 24-inches.

## 2.04 POST TOPS

- A. Gate, end, corner and line post tops shall be malleable iron or pressed steel and shall be vinyl clad hot dipped galvanized.

## 2.05 BRACES AND TOP RAILS

- A. Braces and top rails (where shown on the Drawings) shall be 1.66-inch O.D., vinyl clad Schedule 40 galvanized pipe with minimum vertical bending strength of 202 pounds on 10-foot span.
- B. Top rails shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion. Brace rails shall be provided at all terminal posts, located between the top and grade lines and extend from the terminal post to the first adjacent post. Braces shall be securely fastened at both ends. Brace ends for receiving brace rails shall be malleable iron or castings of 356.0 (formerly SG70A) alloy, or equivalent of ASTM B26 or B108.
- C. Truss and stretcher bands shall be 1/8-inch x 7/8-inch pressed steel, supplied with carriage bolts and nuts. Bolts shall be 5/16-inch by 1-1/4-inch. Truss rods shall be 3/8-inch nominal diameter vinyl coated galvanized steel.

## 2.07 FABRIC TIES

- A. Wire ties shall be preformed 0.148-inch diameter (9 gauge) vinyl coated aluminum. Flat band type ties shall be 1100-H18 or 3003-H14, .064-inch thick by 1/2-inch wide.



- B. Hog rings for attaching tension wire to fabric shall be 0.105-inch diameter, Alloy 1100-H14.

## 2.08 GATES

- A. Gates shall be constructed in accordance with these Special Provisions and as shown on the Plans. Placement and widths shown may need to be slightly altered due to field conditions at the time of construction. It shall be the contractor's responsibility to coordinate with the Engineer for final placement, as determined by field measurements, prior to gate fabrication.
- B. Gate frames shall be made of 1-7/8-inch O.D. ASTM F1083 pipe, 2.72 lbs. per foot vinyl coated hot dipped galvanized. Fabric shall match fence. Gate frames shall be welded or assembled with riveted corner castings. Gate frames shall be equipped with 3/8-inch diameter adjustable truss bars. Hinges shall be ball and socket.
- C. Gate shall be equipped with positive latching device with provision for padlocking. Personnel gates shall be minimum 36-inch clear opening.
- D. Swinging double panel chain link fence gate shall be provided with catch and locking attachment of an approved design that will not rotate around the latch post. Stops to hold gate open and a center rest with catch shall be provided. Double panel swing gate hinges shall provide a 90 degree (minimum) opening for each side. All fittings shall be hot dip galvanized with vinyl coating as specified herein.

## PART 3 -- EXECUTION

### 3.01 CLEARING

- A. Site preparation for new fence shall be done per Section 16 of these Special Provisions, as shown on the Project Plans, and any additions herein. The Contractor may, at their discretion, either remove the existing fence entirely prior to construction of the new fence, or as needed during erection of the new fence.
- B. Existing post footings shall be completely removed to a minimum 12 inches below grade, and the voids filled and compacted to 85% RC with native or other approved material.
- C. All removed and unused fencing material shall become the property of the Contractor and shall be disposed of away from the construction site in compliance with all laws and regulations.

### 3.02 INSTALLATION

- A. All line posts shall be spaced equidistant in the fence line on a maximum of 10-foot centers. Posts shall be set plumb in concrete bases as detailed on Drawings. The top of the posts shall be brought to a smooth grade line. The wire fence shall be set accurately to line and grade and shall be plumb.

- B. End, corner, pull or intermediate posts shall be placed in the following locations: corners; changes in direction; abrupt changes in grade; intervals no greater than 500 feet in the fence line. Each end or gate post shall have one brace assembly and each corner or intermediate post shall have two brace assemblies.
- C. Horizontal braces shall be provided at all terminal posts, corner posts, and intermediate posts between top rail and ground and shall extend from the above-mentioned posts to the first adjacent line posts. Braces shall be securely fastened to the line posts by brace ends and brace bands and to the terminal posts by approved rail end connectors. Diagonal brace rods shall be trussed from the brace end on the line post back to the terminal post, corner post or intermediate post and fastened to it by an approved connector.

### 3.03 POST FOUNDATIONS

- A. Post holes shall be in true alignment and of sufficient size to provide a permanent foundation of concrete. Holes shall be well centered on the posts. Line and corner posts for perimeter fence shall be set in concrete foundations a minimum of 36 inches deep and gate posts a minimum of 48 inches deep. Concrete foundations shall be no less than three times the diameter of the posts.
- B. Post foundations shall be carefully rodded or tamped into place. The top of concrete shall extend 2 inches above ground line and shall be neatly troweled and leveled up from edges to the posts so as to have a pitch outward in all directions.
- C. No materials shall be installed on the posts, nor shall any load be applied to the posts within 3 days after the individual post foundation is completed.
- D. All concrete shall be Class "B" in conformance with Section 03300, Cast-in-Place Concrete.

### 3.04 TEMPORARY FENCING

- A. For site security purposes, the Contractor shall install and maintain a complete perimeter fence in place at all times consisting of existing, new and/or approved temporary fencing. No existing or temporary fencing material shall be reused on the new fence. Any additional temporary fencing required to maintain site security will be provided, maintained, and removed by the Contractor at no additional charge to the City.
- B. Temporary perimeter fence shall be a minimum of 6 feet with galvanized chain link fabric and either wood or steel posts.

- END OF SECTION -

SECTION 03100  
CONCRETE FORMWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03200 - Reinforcing Steel
- B. Section 03250 - Concrete Accessories
- C. Section 03290 - Joints in Concrete
- D. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- 1. California Building Code
- 2. ACI 318 - Building Code Requirements for Structural Concrete
- 3. ACI 301 - Specifications for Structural Concrete for Buildings
- 4. ACI 347 - Recommended Practice for Concrete Formwork
- 5. U.S. Product Standard for Concrete Forms, Class I, PS 1
- 6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Manufacturer's data on proposed form release agent

2. Manufacturer's data on proposed formwork system including form ties

## 1.05 QUALITY ASSURANCE

- A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

## PART 2 -- PRODUCTS

### 2.01 FORMS AND FALSEWORK

- A. All forms shall be smooth surface forms unless otherwise specified.
- B. Wood materials for concrete forms and falsework shall conform to the following requirements:
  1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.
  2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.
- C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

### 2.02 FORMWORK ACCESSORIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Greenstreak Group, Inc., or approved equal. Friction fit plugs shall not be used.
- C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall

not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

### PART 3 -- EXECUTION

#### 3.01 FORM DESIGN

- A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.
- B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
- C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

#### 3.02 CONSTRUCTION

- A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.
- B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.
- C. Forms shall be true to line and grade, and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.
- D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form.

- E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
- F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.
- G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.
- H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.
- I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.
- J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
- K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

### 3.03 TOLERANCES

- A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.
- B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.
- C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- D. Regardless of the tolerances specified, no portion of the building shall extend beyond the legal boundary of the building.

### 3.04 FORM ACCESSORIES

- A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.
- B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to water or enclosed surfaces above the water surface, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

### 3.05 APPLICATION - FORM RELEASE AGENT

- A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

### 3.06 INSERTS AND EMBEDDED ITEMS

- A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

### 3.07 FORM CLEANING AND REUSE

- A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

### 3.08 FORM REMOVAL AND SHORING

- A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
- B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

#### **Ambient Temperature (°F.) During Concrete Placement**

|                | <b><u>Over 95°</u></b> | <b><u>70°-95°</u></b> | <b><u>60°-70°</u></b> | <b><u>50°-60°</u></b> | <b><u>Below 50°</u></b>                                   |
|----------------|------------------------|-----------------------|-----------------------|-----------------------|-----------------------------------------------------------|
| Walls          | 5 days                 | 2 days                | 2 days                | 3 days                | Do not remove until directed by Engineer (7 days minimum) |
| Columns        | 7 days                 | 2 days                | 3 days                | 4 days                |                                                           |
| Beam Soffits   | 10 days                | 7 days                | 7 days                | 7 days                |                                                           |
| Elevated Slabs | 12 days                | 7 days                | 7 days                | 7 days                |                                                           |

- C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.
- D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.



### 3.09 RESHORING

- A. When reshoring is permitted or required the operations shall be planned in advance and subjected to approval by the Engineer.
- B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.
- C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.
- D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.
- E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

- END OF SECTION -

SECTION 03200  
REINFORCING STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

- A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.
- B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 03400 - Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. California Building Code
  - 2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice
  - 3. ACI SP66 - ACI Detailing Manual
  - 4. ACI 315 - Details and Detailing of Concrete Reinforcing
  - 5. ACI 318 - Building Code Requirements for Structural Concrete
  - 6. ICC-ES AC193 Acceptance Criteria for Expansion and Screw Anchors (Concrete)
  - 7. WRI - Manual of Standard Practice for Welded Wire Fabric
  - 8. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing

9. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

#### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.
2. Mill test certificates - 3 copies of each.
3. Description of the reinforcing steel manufacturer's marking pattern.
4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.
5. Proposed supports for each type of reinforcing.
6. Request to use splices not shown on the Drawings.
7. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.
8. Request for placement of column dowels without the use of templates.
9. Request and procedure to field bend or straighten partially embedded reinforcing.
10. International Code Council-Evaluation Services Report (ICC-ES ESR) for dowel adhesives.
11. Certification that all installers of dowel adhesive are certified as Adhesive Anchor Installers in accordance with the ACI-CRSI Anchor Installer Certification Program.

12 Adhesive dowel testing plan.

#### 1.05 QUALITY ASSURANCE

- A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.
- B. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the

installer name, date of training, products included in the training and trainer name and contact information.

- C. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.
- D. Special inspections for adhesive dowels shall be conducted in accordance with an approved ESR published by the manufacturer, and in accordance with Chapter 17 of the California Building Code. Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

## PART 2 -- PRODUCTS

### 2.01 REINFORCING STEEL

- A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type and grade. All reinforcing bars shall be deformed bars. Smooth reinforcing bars shall not be used unless specifically called for on Drawings.
- B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 1064 and the details shown on the Drawings.
- C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.
- D. Field welding of reinforcing steel will not be allowed.
- E. Use of coiled reinforcing steel will not be allowed.

### 2.02 ACCESSORIES

- A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers and other devices to position reinforcing during concrete placement. Slab bolsters shall have gray plastic-coated legs. Wire bar supports shall be plastic protected (CRSI Class 1).
- B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

### 2.03 MECHANICAL COUPLERS

- A. Mechanical couplers shall develop a tensile strength which exceeds 100 percent of the ultimate tensile strength and 125 percent of the yield strength of the reinforcing bars being spliced. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.
- B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.
- C. Hot forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio, or approved equal. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.
- D. Where the threaded rebar to be inserted into the coupler reduces the diameter of the bar, the threaded rebar piece shall be provided by the coupler manufacturer.

#### 2.04 DOWEL ADHESIVE SYSTEM

- A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions.
- B. All holes shall be drilled in accordance with the manufacturer's instructions except that core drilled holes shall not be permitted unless specifically allowed by the Engineer. Cored holes, if allowed by the manufacturer and approved by the Engineer, shall be roughened in accordance with manufacturer's requirements.
- C. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with manufacturer's instructions prior to installation of adhesive and reinforcing bar.
- D. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer.
- E. Injection of adhesive into the hole shall be performed in a manner to minimize the formation of air pockets in accordance with the manufacturer's instructions.
- F. Embedment Depth:
  - 1. The embedment depth of the bar shall be as shown on the Drawings. Although all manufacturers listed below are permitted, the embedment depth shown on the Drawings is based on "HIT-HY 200 Adhesive Anchoring System" as manufactured by Hilti, Inc ESR 3187 issued 03/2018. If the Contractor submits one of the other named dowel adhesives from the list below, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

2. Where the embedment depth is not shown on the Drawings, the embedment depth shall be determined to provide the minimum allowable bond strength equal to the tensile strength of the rebar according to the manufacturer's ICC-ES ESR.
  3. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum, or more than the maximum, embedment depths stated in the manufacturer's ICC-ES ESR.
- G. Engineer's approval is required for use of this system in locations other than those shown on the Drawings.
- H. The adhesive system shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories and shall be "Epcon C6+ Adhesive Anchoring System" as manufactured by ITW Redhead, "HIT-HY 200 Adhesive Anchoring System" as manufactured by Hilti, Inc. "SET-XP Epoxy Adhesive Anchors" as manufactured by Simpson Strong-Tie Co. or "Pure 110+ Epoxy Adhesive Anchor System" by DeWalt. Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved.
- I. All individuals installing dowel adhesive system shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program.

### PART 3 – EXECUTION

#### 3.01 TEMPERATURE REINFORCING

- A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

#### 3.02 FABRICATION

- A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.
- B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.
- C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved to be bent in the field. Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.

- D. Welded wire fabric with longitudinal wire of W9.5 size or smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.

### 3.03 DELIVERY, STORAGE AND HANDLING

- A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.
- B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.
- C. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.
- D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

### 3.04 PLACING

- A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or plastic protected (CRSI Class 1) metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.
- B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8 inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
- D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.
- E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.
- F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than

one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

- G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.
- H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.
- I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations and as required in Article 2.04 above. A representative of the manufacturer must be on site prior to adhesive dowel installation to provide instruction on proper installation procedures for all adhesive dowel installers. Testing of adhesive dowels shall be as indicated below. If the dowels have a hook at the end to be embedded in subsequent work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate adhesive dowel testing while maintaining required hook embedment in subsequent work.
- J. All adhesive dowel installations in the horizontal or overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-17.8.2. Current AAI Certificated must be submitted to the Engineer of Record for approval prior to commencement of any adhesive anchor installations.
- K. Adhesive Dowel Testing
  - 1. At all locations where adhesive dowels are shown on the Drawings, at least 25 percent of all adhesive dowels installed shall be tested to the value indicated on the Drawings, with a minimum of one tested dowel per group. If no test value is indicated on the Drawings but the installed dowel is under direct tension, the Contractor shall notify the Engineer to verify the required test value.
  - 2. Contractor shall submit a plan and schedule indicating locations of dowels to be tested, load test values and proposed dowel testing procedure (including a diagram of the testing equipment proposed for use) prior to conducting any testing. The testing equipment shall have a minimum of three support points and shall be of sufficient size to locate the edge of supports no closer than two times the anchor embedment depth from the center of the anchor.
  - 3. Where Contract Documents indicate adhesive dowel design is the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of dowels to be tested and load test values, sealed by a Professional Engineer currently registered in the State of California. The Contractor shall also submit documentation indicating the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable.
  - 4. Adhesive Dowel shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the dowel after loading shall be considered a failure. Dowels exhibiting damage shall be removed and



replaced. If more than 5 percent of tested dowels fail, then 100 percent of dowels shall be proof tested.

5. Proof testing of adhesive dowels shall be performed by an independent testing laboratory hired directly by the Contractor. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

### 3.05 SPLICING

- A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.
- B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.
- C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- D. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer.
- E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

### 3.06 INSPECTION

- A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.
- B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

### 3.07 CUTTING OF EMBEDDED REBAR

- A. The Contractor shall not cut embedded rebar cast into structural concrete without prior approval.

- END OF SECTION -

SECTION 03250  
CONCRETE ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, and epoxy bonding agent.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03290 - Joints in Concrete
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Fillers, Sealants, and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
  - 2. ASTM D412 Standard Tests for Rubber Properties in Tension
  - 3. ASTM D 624 Standard Test method for Rubber Property - Tear Resistance
  - 4. ASTM D 638 Standard Test Method for Tensile Properties of Plastics
  - 5. ASTM D1751 Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types)
  - 6. ASTM D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
  - 7. ASTM D 1171 Standard Test Method for Ozone Resistance at 500 pphm

8. ASTM D 471 Standard Test Method for Rubber Properties

#### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
1. Manufacturer's literature on all products specified herein including material certifications.
  2. Proposed system for supporting PVC waterstops in position during concrete placement
  3. Samples of products if requested by the Engineer.

### PART 2 -- PRODUCTS

#### 2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

- A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.
- B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.
- C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.
- D. The required minimum physical characteristics for this material are:
1. Tensile strength - 1,750 psi (ASTM D-638).
  2. Ultimate elongation - not less than 280% (ASTM D-638).
- E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.
- F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.
- G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

## 2.02 RETROFIT WATERSTOPS

- A. Retrofit waterstops shall be used where specifically shown on Drawings for sealing joints between existing concrete construction and new construction.
- B. Retrofit waterstops shall be PVC waterstops fabricated from material as described in Section 2.01 of this Specification.
- C. Retrofit waterstop shall be attached to existing concrete surface as shown on Drawings.
- D. Use of split waterstop in lieu of specially fabricated retrofit waterstop will not be acceptable.
- E. Retrofit Waterstop manufacturer must provide a complete system including all Waterstop, stainless steel anchoring hardware, and epoxy for installation.
- F. For construction joints, retrofit waterstop shall be style number 609 by Sika Greenstreak, RF-638 by BoMetals, Inc., Type 18 kit by DuraJoint Concrete Accessories, or approved equal. For expansion joints, retrofit waterstop shall be style number 667 by Sika Greenstreak, RF-912 by BoMetals, Inc., Type 18-9 kit by DuraJoint Concrete Accessories, or approved equal.

## 2.03 CHEMICAL RESISTANT WATERSTOPS

- A. Where specifically noted on Contract Drawings, chemical resistant waterstops shall be used instead of PVC waterstops.
- B. Chemical resistant waterstops for construction joints shall be ribbed with a center bulb. They shall be 6 inches wide with a minimum thickness at any point of 3/16 inches.
- C. Chemical resistant waterstops for expansion joints shall be ribbed tear web. They shall be 9 inches wide with a tear web designed to accommodate 1 inch of free movement minimum.
- D. Chemical resistant retrofit waterstop shall be a minimum of 2½" wide along the ribbed side and a minimum 5" wide along the side attached to the existing concrete surface. Retrofit waterstop shall include a centerbulb and shall have a minimum thickness of 3/16". Retrofit waterstop manufacturer shall provide a complete system including waterstop, stainless steel anchoring hardware and epoxy for installation.
- E. Chemical resistant waterstops shall be manufactured from a fully crosslinked thermoplastic vulcanizate rubber.
- F. Waterstops shall be TPER by BoMetals, Inc., Earth Shield TPV/TPE-R by JP Specialties, Inc., Westec TPER by Westec Barrier Technologies, or TPE-R by DuraJoint Concrete Accessories.

## 2.04 HYPALON RUBBER WATERSTOPS

- A. Hypalon rubber waterstops shall be Sikadur Combiflex by Sika Corporation or approved equal. Minimum width of waterstop material shall be twelve (12) inches unless shown otherwise on Contract Drawings.

## 2.05 EXPANDING RUBBER WATERSTOP

- A. Expanding rubber shall be designed to expand under hydrostatic conditions. Waterstops shall be Adeka Ultra Seal MC-2010MN by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak, for concrete thickness greater than nine inches. For thicknesses less than nine inches, Adeka Ultra Seal KBA-1510FF or Hydrotite CJ-1020-2K shall be used.
- B. Waterstop shall be a chemically modified natural rubber product with a hydrophilic agent.
- C. Waterstop has a stainless steel mesh or coextrusion of non-hydrophilic rubber to direct expansion in the thickness direction and restrict the expansion in the longitudinal direction.

## 2.06 WATERSTOP ADHESIVE

- A. Adhesive between waterstops and existing concrete shall be Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.
- B. Hydrophilic, non-bentonite water swelling elastic sealant shall be used to bond expanding rubber waterstops to rough surfaces. Hydrophilic elastic sealant shall be P-201 by Adeka Ultra Seal/OCM, Inc., Leakmaster LV-1 by Sika Greenstreak, or approved equal.

## 2.07 JOINT SEALANTS

- A. Joint sealants shall comply with Section 07900, Joint Fillers, Sealants, and Caulking.

## 2.08 EXPANSION JOINT MATERIAL

- A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:
  - 1. Type I - Sponge rubber, conforming to ASTM D1752, Type I.
  - 2. Type II - Cork, conforming to ASTM D1752, Type II.
  - 3. Type III - Self-expanding cork, conforming to ASTM D1752, Type III.
  - 4. Type IV - Bituminous fiber, conforming to ASTM Designation D1751.

## 2.09 EXPANSION JOINT SEAL

- A. Expansion Joint Seal System shall consist of a preformed neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive and pressurized during the adhesive cure time.

- B. The expansion joint system shall be Hydrozo/Jeene Structural Sealing joint system by Hydrozo/Jeene, Inc.

#### 2.10 CONTRACTION JOINT INSERTS

- A. Contraction joint inserts shall be Zip-Cap by Greenstreak Plastic Products, Zip-Joint by BoMetals, Inc. control joint formers.

#### 2.11 EPOXY BONDING AGENT

- A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, MasterInject 1500 by BASF Master Builder Solutions (BASF).

#### 2.12 EPOXY RESIN BINDER

- A. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J., Flexocrete Gel manufactured by DuraJoint Concrete Accessories or Euco #352 Gel, Euclid Chemical Company, MasterEmaco ADH 327 or 327 RS by BASF Master Builder Solutions.

### PART 3 -- EXECUTION

#### 3.01 PVC AND CHEMICAL RESISTANT WATERSTOPS

- A. PVC and chemical resistant waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.
- B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.
- C. Splices in PVC waterstops and chemical resistant waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.
- D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would

reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.

- E. Retrofit waterstops shall be installed as shown on Contract Drawings using approved waterstop adhesive and Type 316 stainless steel batten bars and expansion anchors.
- F. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:
  - 1. Tensile strength not less than 80 percent of parent material.
  - 2. Overlapped (not spliced) Waterstop.
  - 3. Misalignment of Waterstop geometry at any point greater than 1/16 inch.
  - 4. Visible porosity or charred or burnt material in weld area.
  - 5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

### 3.02 HYPALON RUBBER AND EXPANDING RUBBER WATERSTOPS

- A. Waterstops shall be installed only where shown on the Drawings.
- B. Waterstops shall be installed in strict accordance with manufacturer's recommendations.

### 3.03 WATERSTOP ADHESIVE

- A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.
- B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

### 3.04 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

- A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.
- B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.
- C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall

be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

- D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.
- E. Type 1 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.
- F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.
- G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

### 3.05 EXPANSION JOINT SEAL

- A. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

### 3.06 CONTRACTION JOINT INSERTS

- A. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.
- B. For contraction joints in walls, inserts shall be secured in place prior to casting wall.
- C. Inserts shall be installed true to line at the locations of all contraction joints as shown on the Drawings.
- D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.
- E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

### 3.07 EPOXY BONDING AGENT

- A. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.
- B. Bonding surface shall be clean, sound and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.



- C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.
- D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

### 3.08 EPOXY RESIN BINDER

- A. Epoxy resin binder shall be used to seal all existing rebar cut and burned off during demolition operations. Exposed rebar shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

- END OF SECTION -

## SECTION 03290

### JOINTS IN CONCRETE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENTS

- A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.
- B. Types of joints in concrete shall be as follows:
  - 1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.
  - 2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.
  - 3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03250 - Concrete Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 07900 - Joint Fillers, Sealants and Caulking

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. ACI 301 - Specifications for Structural Concrete for Buildings
  - 2. ACI 318 - Building Code Requirements for Structural Concrete
  - 3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
  - 4. ACI 224.3 – Joints in Concrete Construction

#### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Layout drawings showing location and type of all joints to be placed in each structure.
  - 2. Details of proposed joints in each structure.
  - 3. For sawcut contraction joints submit documentation indicating the following:
    - a. Proposed method of sawcutting indicating early entry or conventional sawing.
    - b. Description of how work is to be performed including equipment to be utilized, size of crew performing the work and curing methods.
    - c. Description of alternate method in case of time constraint issues or failure of equipment.

#### PART 2 -- MATERIALS

##### 2.01 MATERIALS

- A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Fillers, Sealants and Caulking.

#### PART 3 -- EXECUTION

##### 3.01 CONSTRUCTION JOINTS

- A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.
- B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 45'-0". For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25'-0".

- D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.
- E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.
- F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

### 3.02 EXPANSION JOINTS

- A. Size and location of expansion joints shall be as shown on the Drawings.
- B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

### 3.03 CONTRACTION JOINTS

- A. Location of contraction joints shall be as shown on the Drawings.
- B. Contraction joints shall be formed either by sawcutting or with contraction joint inserts as specified in Section 03250, Concrete Accessories. Sawcutting of joints will not be permitted unless specifically approved by the Engineer.
- C. If approved by the Engineer, sawcutting of contraction joints in lieu of forming shall conform to the following requirements:
  - 1. Joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.
  - 2. Curing shall be performed using wet curing methods as indicated in Section 03370 – Concrete Curing. Curing mats, fabrics or sheeting materials shall remain in place to the extent possible while cutting of joint is being performed. Curing materials shall only be removed as required and shall be immediately reinstalled once cutting of the joint has been completed.
  - 3. Depth of joint shall be as shown on the drawings or noted in these specifications. At locations where the joint cannot be installed to full depth due to curbs or other stopping points hand tools shall be used to complete joints.
  - 4. Saw cut joints shall meet the requirements of ACI 224.3, Section 2.8, Jointing Practice.

- D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

#### 3.04 JOINT PREPARATION

- A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.
- C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.
- D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

- END OF SECTION -

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Provide all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.
- B. The requirements in this section shall apply to the following types of concrete:
  - 1. Class A2 Concrete: Normal weight structural concrete in all structures other than structures qualifying as environmental concrete structures, and for all sidewalks and pavement.
  - 2. Class A3 Concrete: Normal weight structural concrete to be used for interior slabs where a Type "D" Steel Troweled Finish or Type "G" Hardened Finish is required. Class A3 concrete shall not contain entrained air.
  - 3. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 - Concrete Formwork
- B. Section 03200 - Reinforcing Steel
- C. Section 03250 - Concrete Accessories
- D. Section 03290 - Joints in Concrete
- E. Section 03350 - Concrete Finishes
- F. Section 03370 - Concrete Curing
- G. Section 03600 - Grout

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced

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specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. California Building Code
2. ACI 214 Guide to Evaluation of Strength Test Results of Concrete
3. ACI 301 Specifications for Structural Concrete
4. ACI 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 305 Guide to Hot Weather Concreting
6. ACI 306 Guide to Cold Weather Concreting
7. ACI 309 Guide for Consolidation of Concrete
8. ACI 318 Building Code Requirements for Structural Concrete and Commentary
9. ACI 350 Code Requirements for Environmental Engineering Concrete Structures
10. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
11. ASTM C 33 Standard Specification for Concrete Aggregates
12. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
13. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
14. ASTM C 88 Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
15. ASTM C 94 Standard Specification for Ready-Mixed Concrete
16. ASTM C 114 Standard Test Method for Chemical Analysis of Hydraulic Cement
17. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
18. ASTM C 138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
19. ASTM C 143 Standard Test Method for Slump of Hydraulic Cement Concrete

20. ASTM C 150 Standard Specification for Portland Cement
21. ASTM C 172 Standard Practice for Sampling Freshly Mixed Concrete
22. ASTM C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
23. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
24. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete
25. ASTM C 295 Standard Guide for Petrographic Examination of Aggregates for Concrete
26. ASTM C 457 Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete
27. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
28. ASTM C 595 Standard Specification for Blended Hydraulic Cements
29. ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
30. ASTM C 989 Standard Specification for Slag Cement for Use in Concrete and Mortars
31. ASTM C 1077 Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
32. ASTM C 1260 Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
33. ASTM C 1567 Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
34. ASTM C 1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
35. ASTM C 1778 Reducing the Risk of Deleterious Alkali – Aggregate Reaction in Concrete

#### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.



1. Sources of all materials and certifications of compliance with specifications for all materials.
2. Certified current (less than 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.
3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.
4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, potential reactivity, aggregate soundness tests, petrographic analysis, mortar bar expansion testing, etc.
5. Manufacturer's data on all admixtures stating compliance with required standards.
6. Concrete mix design for each class of concrete specified herein.
7. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.

#### 1.05 QUALITY ASSURANCE

- A. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.
- B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.
- C. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a materials testing consultant or City Materials Testing Laboratory employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

### PART 2 -- PRODUCTS

#### 2.01 HYDRAULIC CEMENT

##### A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.02 or 2.03 respectively.

2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:
    - a. For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of  $\text{Na}_2\text{O}$  plus 0.658 times the percentage of  $\text{K}_2\text{O}$ ) shall not exceed 0.40%.
    - b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalies in the Portland Cement (calculated as the percentage of  $\text{Na}_2\text{O}$  plus 0.658 times the percentage of  $\text{K}_2\text{O}$ ) shall not exceed 0.85%.
  3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalies in the cement shall not exceed 1.0%.
  4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.
- B. Blended Cement
1. Blended cements shall be Type IP (Portland Fly Ash Cement) or Type IS (Portland Slag Cement) conforming to ASTM C 595.
  2. Type IP cement shall be an interground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.
  3. Type IS cement shall be an interground blend of Portland Cement and slag cement in which the slag constituent is between 35% and 50% of the weight of the total blend.
  4. Fly ash and slag cement used in the production of blended cements shall meet the requirements of Articles 2.02 and 2.03, respectively.
  5. When reactive aggregates as defined in Article 2.05 are used in concrete mix, the total alkalies in the Portland Cement (calculated as the percentage of  $\text{Na}_2\text{O}$  plus 0.658 times the percentage of  $\text{K}_2\text{O}$ ) shall not exceed 0.85%. The percentage of fly ash or slag cement shall be set to meet provisions of Article 2.05.G.2.
- C. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.
- D. Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

## 2.02 FLY ASH

- A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618.
- B. For fly ash to be used in the production of type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.
- C. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.
- D. For Type A1 concrete as required for use in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

## 2.03 SLAG CEMENT

- A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.
- B. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag. The percentage of slag cement shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.
- C. For Type A1 concrete as required for use in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- D. Additional slag cement shall not be included in concrete mixed with type IS or IP cement.

## 2.04 WATER

- A. Water used for mixing concrete shall be clear, potable and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts and other impurities.
- B. Water shall not contain more than 100 PPM chloride.
- C. Water shall not contain more than 500 PPM dissolved solids.
- D. Water shall have a pH in the range of 4.5 to 8.5.
- E. Water shall meet requirements of ASTM C 1602.

## 2.05 AGGREGATES

- A. All aggregates used in normal weight concrete shall conform to ASTM C 33.
- B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.
- C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.
- D. For Class A4 concrete, coarse aggregate shall be Size #8 in accordance with ASTM C33.
- E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.
- F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using either magnesium sulfate or sodium sulfate.
- G. All aggregates shall be evaluated in accordance with ASTM C 1778 to determine potential reactivity. All aggregates shall be considered reactive unless they meet the requirements below for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.
  - 1. Non-reactive aggregates shall meet the following requirements:

A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

    - (a) Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.
    - (b) Chert or chalcedony, 3.0%, maximum.
    - (c) Tridymite or cristobalite, 1.0%, maximum.
    - (d) Opal, 0.5%, maximum.
    - a) Natural volcanic glass in volcanic rocks, 3.0%, maximum.
  - 2. Concrete mixed with reactive aggregates shall meet the following requirements:
    - (a) If aggregates are deemed potentially reactive as per ASTM C-1778 and fly ash or slag cement is included in proposed concrete mix design, proposed

concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

- (b) If aggregates are deemed potentially reactive as per ASTM C-1778 and a straight cement mix without fly ash or slag cement is proposed for concrete mix design, aggregates shall be evaluated by ASTM C-1260. Mean mortar bar expansions at 16 days shall be less than 0.08%.

- H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

## 2.06 STRUCTURAL MACRO FIBERS

- A. Not Used

## 2.07 ADMIXTURES

- A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be obtained and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.
- B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall conform to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.
  - 1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are "Eucon Series" by the Euclid Chemical Company, "Master Pozzolith Series" by BASF, and "Plastocrete Series" by Sika Corporation.
  - 2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at either the batch plant or at the job site and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are "Eucon 37" or Plastol 5000 by the Euclid Chemical Company, "Master Rheobuild 1000 or Master Glenium Series" by BASF, and "Daracem 100 or Advaflo Series" by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E, and shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are "Accelguard 80/90 or NCA" by the Euclid Chemical Company and "Daraset" by W.R. Grace.
  4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more than 0.05% chloride ions. Acceptable products are "Eucon NR or Eucon Retarder 100" by the Euclid Chemical Company, "Pozzolith Retarder" by BASF, and "Plastiment" by Sika Corporation.
- C. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.
- D. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review.

## 2.08 CONCRETE MIX DESIGN

- A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all of the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.
- B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.
1. Compressive Strength (28-Day)
    - a. Concrete Class A2, A3      4,000 psi (minimum)
    - b. Concrete Class B          3,000 psi (minimum)
  2. Water/cementitious materials ratio, by weight
 

|                          | Maximum | Minimum |
|--------------------------|---------|---------|
| a. Concrete Class A2, A3 | 0.45    | 0.39    |



capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.

B. Ready-Mixed Concrete

1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.
2. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.
6. Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:
  - a. Date and truck number
  - b. Ticket number
  - c. Mix designation of concrete
  - d. Cubic yards of concrete
  - e. Cement brand, type and weight in pounds
  - f. Weight in pounds of fine aggregate (sand)
  - g. Weight in pounds of coarse aggregate (stone)
  - h. Air entraining agent, brand, and weight in pounds and ounces
  - i. Other admixtures, brand, and weight in pounds and ounces



- j. Water, in gallons, stored in attached tank
  - k. Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio
  - l. Water, in gallons, actually used (by truck driver)
  - m. Time of loading
  - n. Time of delivery to job (by truck driver)
7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.
  8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within  $\pm 0.4$  percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:
 

|                                    |                 |
|------------------------------------|-----------------|
| a. Cement, fly ash, or slag cement | $\pm 1$ percent |
| b. Water                           | $\pm 1$ percent |
| c. Aggregates                      | $\pm 2$ percent |
| d. Admixtures                      | $\pm 3$ percent |
3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.
4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.
5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.
7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.
8. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.
9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.
10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.
11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
12. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.
13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

### 3.03 CONCRETE PLACEMENT

- A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.
- B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.

- C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.
- D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.
- E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cementitious materials ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.
- F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.09 of this Section.
- G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise.
- H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.
- I. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.
- J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.

- K. When placing concrete which is to be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.
- L. Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.
- M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.
- N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.
- O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed.
- P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.
- Q. To prevent feathered edges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.
- R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.
- S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of

concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

#### 3.04 PLACING FLOOR SLABS ON GRADE

- A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant or City Materials Testing Laboratory.
- B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50° long enough to remove all frost from the subgrade.
- C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.
- D. Thirty-pound felt paper shall be provided between edges of slab-on-grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.
- E. Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03290 - Joints in Concrete.
- F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03350 - Concrete Finishes. Interior floor slabs shall be placed with non-air-entrained concrete (Class A3) if a steel troweled or hardened finish is required.

#### 3.05 PLACING CONCRETE UNDERWATER (CLASS A5 CONCRETE)

- A. Not Used

#### 3.06 PLACING CONCRETE UNDER PRESSURE

- A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.
- B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.

- C. No aluminum parts shall be in contact with the concrete during the entire placing of concrete under pressure at any time.
- D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a materials testing consultant or City Materials Testing Laboratory proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used; the same pump and operator shall be present and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.
- E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.
- G. The minimum diameter of the hose (conduits) shall be four inches.
- H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.
- I. Concrete samples for quality control in accordance with Article 3.10 will be taken at the placement (discharge) end of the line.

### 3.07 ORDER OF PLACING CONCRETE

- A. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

### 3.08 CONCRETE WORK IN COLD WEATHER

- A. Cold weather concreting procedures shall conform to the requirements of ACI 306.
- B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F, unless otherwise approved by the Engineer.
- C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature in excess of

100°F. in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

### 3.09 CONCRETE WORK IN HOT WEATHER

- A. Hot weather concreting procedures shall conform to the requirements of ACI 305.
- B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand and in position prior to each placing operation.
- C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.
- D. The temperature of the concrete mix when placed shall not exceed 90°F.
- E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.
- F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.
- G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

### 3.10 QUALITY CONTROL

- A. Field Testing of Concrete
  - 1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant or City Materials Testing Laboratory personnel as required for concrete testing.
  - 2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall provide assistance to the materials testing

consultant or City Materials Testing Laboratory in obtaining samples. The Contractor shall dispose of and clean up all excess material.

B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant or City Materials Testing Laboratory by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant and/or City Materials Testing Laboratory may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material or labor costs due to such eventualities.
2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant or City Materials Testing Laboratory and each time compressive strength samples are taken.
3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the materials testing consultant or City Materials Testing Laboratory in accordance with ASTM C 138.
2. Unit weight tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant or City Materials Testing Laboratory in accordance with ASTM C 231.
2. Air content tests will be performed as deemed necessary by the materials testing consultant or City Materials Testing Laboratory and each time compressive strength samples are taken.
3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength



1. Samples of freshly mixed concrete will be taken by the materials testing consultant or City Materials Testing Laboratory and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.
2. In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.
3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant or City Materials Testing Laboratory will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.
4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.
5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.
6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.
7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.
  2. The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.
    - a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.08).
    - b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.
  3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.
  4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, paragraph H shall be performed.
  5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:
    - a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.
    - b. Maintain or add temporary structural support as required.
    - c. Correct the mix for the next concrete placement operation, if required to remedy the situation.
  6. All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.
- G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.
- H. Additional Tests
1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.
  2. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

- a. Three cores shall be taken for each sample in which the strength requirements were not met.
  - b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant or City Materials Testing Laboratory approved by the Engineer.
  - c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.
  - d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.
  - e. The diameter of core specimens should be at least 3 times the maximum nominal size of the coarse aggregate used in the concrete, but must be at least 2-inches in diameter.
  - f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.
  - g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.
  - h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.
3. In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer or City Materials Testing Laboratory, to obtain and test samples for air content in accordance with ASTM Specification C 457.

### 3.11 CARE AND REPAIR OF CONCRETE

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily removed and replaced with acceptable concrete at no additional cost to the Owner.

- B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed.
- C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed.
- D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an approved epoxy injection system. Non-structural cracks shall be repaired using an approved hydrophilic resin pressure injected grout system, unless other means of repair are deemed necessary and approved. All repair work shall be performed at no additional cost to the Owner.
- E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be as directed by the Engineer.

- END OF SECTION -

SECTION 03350  
CONCRETE FINISHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 – Concrete Formwork
- B. Section 03300 – Cast-in-Place Concrete
- C. Section 03600 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. ACI 301 – Specifications for Structural Concrete for Buildings
  - 2. ACI 318 – Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – Submittals.
  - 1. Manufacturer's literature on all products specified herein.

PART 2 -- PRODUCTS

2.01 CONCRETE FLOOR SEALER

- A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, MasterKure CC 300 SB by BASF Master Builder Solutions.

## 2.02 CONCRETE LIQUID DENSIFIER AND SEALANT

- A. Concrete liquid densifier and sealant shall be a high performance, deeply penetrating concrete densifier and sealant. Product shall be odorless, colorless, VOC-compliant, non-yellowing silicate based solution designed to harden, dustproof and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The product must contain a minimum solids content of 20% of which 50% is silicate. Acceptable products are Diamond Hard by the Euclid Chemical Company, Seal Hard by L&M Construction Chemicals and MasterKure HD 210 WB by BASF Master Builder Solutions.

## 2.03 NON-METALLIC FLOOR HARDENER

- A. The specified non-metallic mineral aggregate hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory-blended mixture of specifically processed graded mineral aggregate, selected Portland cement, and necessary plasticizing agents. Acceptable products shall be "Surflex" by the Euclid Chemical Company, "Harcot" by Sonneborn, "Maximent" by BASF, and "Mastercon" by BASF.

## 2.04 NON-OXIDIZING HEAVY DUTY METALLIC FLOOR HARDENER

- A. Non-oxidizing heavy duty metallic floor hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specifically processed non-rusting aggregate, selected Portland cement, and necessary plasticizing agents. Product shall be "Diamond-Plate" by the Euclid Chemical Company, or Masterplate by BASF Construction Chemicals.

## 2.05 NON-SLIP FLOORING ADDITIVE

- A. Non-slip flooring additives for slip resistant floors shall be non-metallic. Non-slip flooring additives shall be Frictex NS by BASF Construction Chemicals, A-H Alox by Anti-Hydro, or Euco Grip by the Euclid Chemical Company.

# PART 3 -- EXECUTION

## 3.01 FINISHES ON FORMED CONCRETE SURFACES

- A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.
  - 1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than 1/4-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and

then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than 1/4-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type II finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

### 3.02 SLAB AND FLOOR FINISHES

- A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.
  1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2" minimum deep grooves prior to final set.
  2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.
4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.
5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.
6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout in accordance with Section 03600 shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.
7. Type "G" Hardened Finish: This finish shall be applied after completion of a Type "B" or Type "C" finish and prior to application of a Type "D" finish. Hardeners shall be applied in strict accordance with the manufacturer's requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type "D" finish shall be applied following completion of application of the hardener.
  - a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.0 pounds/ft.<sup>2</sup>.
  - b. Non-oxidizing heavy duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.<sup>2</sup>.
8. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip flooring additive concurrently with the application of a Type "D" finish and/or installation of floor sealants. Application procedure shall be in accordance with



manufacturer's instructions. Finish shall be applied where specifically required on the Contract Drawings or specified herein.

9. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of  $\pm 1/4$  inch.

### 3.03 CONCRETE SEALERS

- A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.
- B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.
- C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.
- D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.
- E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

### 3.04 FINISHES ON EQUIPMENT PADS

- A. Formed surfaces of equipment pads shall receive a Type III finish.
- B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to  $1/2$  inch deep.

### 3.05 CONCRETE FINISH SCHEDULE

| Item                                                                                                                                                                                                                      | Type of Finish |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere | II             |
| All interior finish floors of buildings and structures which are not continuously or intermittently wet                                                                                                                   | D              |
| Floors to receive tile, resilient flooring, or carpeting                                                                                                                                                                  | D              |
| Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather                                                                                                                          | E              |

- END OF SECTION -

SECTION 03370  
CONCRETE CURING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein. Concrete pad for electrical building floor shall be cured by burlap wet blanket.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100 – Concrete Formwork
- B. Section 03300 – Cast-In-Place Concrete
- C. Section 03350 – Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. ACI 301 – Specifications for Structural Concrete for Buildings
  - 2. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
  - 3. ACI 305 – Hot Weather Concreting
  - 4. ACI 306 – Cold Weather Concreting
  - 5. ACI 308 – Standard Practice for Curing Concrete
  - 6. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete
  - 7. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
  - 8. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

## 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Proposed procedures for protection of concrete under wet weather placement conditions.
  - 2. Proposed normal procedures for protection and curing of concrete.
  - 3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.
  - 4. Proposed method of measuring concrete surface temperature changes.
  - 5. Manufacturer's literature and material certification for proposed curing compounds.

## PART 2 -- PRODUCTS

### 2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

- A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m<sup>2</sup> when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, MasterKure CC 300 SB by BASF Master Builder Solutions, and Cure & Seal 30 Plus by Symons Corporation.
- B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

### 2.02 EVAPORATION REDUCER

- A. Evaporation reducer shall be BASF, "MasterKure ER 50", or Euclid Chemical "Euco-Bar".

## PART 3 -- EXECUTION

### 3.01 PROTECTION AND CURING

- A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
- B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the

period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.

- C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.
- D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.
  - 1. Ponding or continuous fogging or sprinkling.
  - 2. Application of mats or fabric kept continuously wet.
  - 3. Continuous application of steam (under 150°F).
  - 4. Application of sheet materials conforming to ASTM C171.
  - 5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.
- E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.
- F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

### 3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

- A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.
- B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.
- C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.

- D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

### 3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

- A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.
- B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.
- C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.
- D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least six (6) additional days using one of the methods listed in paragraph 3.01D.
- E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

### 3.04 USE OF CURING COMPOUND

- A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.
- B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.
- C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.
- D. Any curing compound allowed for use on exposed concrete surfaces shall not leave behind any noticeable residue or pigment.

- E. No curing compound shall be applied to the building pad or other concrete within the building that is to receive a clear coat waterproof finish.

### 3.05 EARLY TERMINATION OF CURING

- A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:
  - 1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.
  - 2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

- END OF SECTION -

## SECTION 03400

### PRECAST CONCRETE

#### PART 1 -- GENERAL

##### 1.01 REQUIREMENTS

- A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02604 - Utility Structures
- B. Section 03200 - Reinforcing Steel
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 03350 - Concrete Finishes
- E. Section 03370 - Concrete Curing
- F. Section 03600 - Grout
- G. Section 05010 - Metal Materials
- H. Section 05035 - Galvanizing
- I. Section 05050 - Metal Fastening

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the end of the Bid.
  - 1. California Building Code
  - 2. ACI 318-Building Code Requirements for Structural Concrete
  - 3. PCI Standard MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
  - 4. PCI Design Handbook



#### 1.04 SUBMITTALS

- A. The Contractor shall submit the following for review in accordance with Section 01300, Submittals.
  - 1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.
  - 2. A list of the design criteria used by the manufacturer for all manufactured, precast items.
  - 3. Design calculations, showing at least the design loads and stresses on the item, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer registered in the State of California.
  - 4. Certified reports for all lifting inserts, indicating allowable design loads.
  - 5. Information on lifting and erection procedures.

#### 1.05 QUALITY ASSURANCE

- A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all of the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.
- B. Manufacturer Qualifications

The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. Certification is only required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.
- C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years experience in precast concrete work.

### PART 2 -- PRODUCTS

#### 2.01 CONCRETE

- A. Concrete materials including portland cement, aggregates, water, and admixtures shall conform to Section 03300, Cast-in-Place Concrete.

- B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.
- C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4000 psi unless otherwise specified.

## 2.02 GROUT

- A. Grout for joints between panels shall be a cement grout in conformance with Section 03600, Grout.
- B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

## 2.03 REINFORCING STEEL

- A. Reinforcing steel used for precast concrete construction shall conform to Section 03200, Reinforcing Steel.

## 2.04 PRESTRESSING STRANDS

- A. Not Used

## 2.05 STEEL INSERTS

- A. Steel inserts shall be in accordance with Section 05010, Metal Materials.
- B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized in accordance with Section 05035, Galvanizing.

## 2.06 WELDING

- A. Welding shall conform to Section 05050, Metal Fastening.

## 2.07 BEARING PADS

- A. Not Used

# PART 3 -- EXECUTION

## 3.01 FABRICATION AND CASTING

- A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position with the form work system. Form materials shall be steel and the systems free from leakage during the casting operation.

- B. All cover of reinforcing shall be the same as detailed on the Drawings.
- C. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.
- D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.
- E. Concrete shall be finished in accordance with Section 03350, Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.
- F. Curing of precast members shall be in accordance with Section 03370, Concrete Curing. Use of a membrane curing compound will not be allowed.
- G. The manufacturer shall provide lifting inserts or other approved means of lifting members.

### 3.02 HANDLING, TRANSPORTING AND STORING

- A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.
- B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.
- C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.
- D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.
- E. Precast concrete members shall not be used as storage areas for other materials or equipment.
- F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

### 3.03 ERECTION

- A. Erection shall be carried out by the manufacturer or under his supervision using labor, equipment, tools and materials required for proper execution of the work.
- B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.

- C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.
- D. Connections which require welding shall be properly made in accordance with Section 05050, Metal Fastening.
- E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.
- F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).
- G. No Contractor, Subcontractor or any of his employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.
- H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

- END OF SECTION -

## SECTION 03600

### GROUT

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work and as bearing surfaces for base plates, in accordance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- |    |             |                                                                                                                                               |
|----|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | CRD-C 621   | Corps of Engineers Specification for Non-shrink Grout                                                                                         |
| 2. | ASTM C 109  | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens)                              |
| 3. | ASTM C 531  | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing |
| 4. | ASTM C 579  | Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing                                                   |
| 5. | ASTM C 827  | Standard Test Method for Early Volume Change of Cementitious Mixtures                                                                         |
| 6. | ASTM C 144  | Standard Specification for Aggregate for Masonry Mortar                                                                                       |
| 7. | ASTM C 1107 | Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)                                                                   |

##### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300 - Submittals.

1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.
2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

#### 1.05 QUALITY ASSURANCE

##### A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. The specimens will be made by the Engineer or its representative.
  - a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.
  - b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.
3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

### PART 2 -- PRODUCTS

#### 2.01 MATERIALS

##### A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall

consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.

2. The minimum compressive strength at 28 days shall be 4000 psi.
3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.
4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "Euco N-S" by the Euclid Chemical Company, "Sikagrout 212" by Sika Corporation, "Conspec 100 Non-Shrink Non-Metallic Grout" by Conspec, "Masterflow 555 Grout" by BASF Master Builder Solutions.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "Euco #452 Series" by Euclid Chemical, "MasterEmaco ADH 1090 RS" by BASF Master Builder Solutions.
2. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be "Sikadur 42, Grout-Pak" by Sika Corporation, or "Masterflow 648" by BASF Master Builder Solutions.

## 2.02 CURING MATERIALS

- A. Curing materials shall be as specified in Section 03370, Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

## PART 3 -- EXECUTION

### 3.01 GENERAL

- A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.
  - 1. Cement grout shall be used for grout toppings and for patching of fresh concrete.
  - 2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.
  - 3. Epoxy grout shall be used for bonding new concrete to hardened concrete.
  - 4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.
- B. New concrete surfaces to receive cement grout shall be as specified in Section 03350, Concrete Finishes, and shall be cleaned of all dirt, grease and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370, Concrete Curing.
- C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.

### 3.02 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

### 3.03 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.



### 3.04 GROUT INSTALLATION

- A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry- packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be poured from one side only and thence flow across to the open side to avoid air-entrapment.

- END OF SECTION -

## SECTION 04100

### MORTAR AND MASONRY GROUT

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
  - 1. Mortar for unit masonry work.
  - 2. Grout for grouting masonry.
  - 3. Mortar for pointing and touchup.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04150 - Masonry Accessories
- B. Section 04200 - Unit Masonry

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the Specifications, the Work shall conform to the applicable requirements of the following documents:
  - 1. ASTM C91                      Standard Specification for Masonry Cement
  - 2. ASTM C144                  Standard Specification for Aggregate for Masonry Mortar
  - 3. ASTM C150                  Standard Specification for Portland Cement
  - 4. ASTM C207                  Standard Specification for Hydrated Lime for Masonry Purposes
  - 5. ASTM C270                  Standard Specification for Mortar for Unit Masonry
  - 6. ASTM C476                  Standard Specification for Grout for Masonry
  - 7. ASTM C979                  Pigments for Integrally Colored Concrete
  - 8. ASTM C1019                Standard Methods of Sampling and Testing Grout

## 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturer's data and mixing instructions for each product.
  - 2. Certificate of compliance with these specifications for each material specified below.
  - 3. Test reports.
  - 4. Samples of colored masonry mortar.

## 1.05 DELIVERY AND STORAGE

- A. Deliver materials in manufacturer's original containers, bearing labels indicating product and manufacturer's name.
- B. Store cementitious materials in waterproof locations to prevent damage by elements. Reject containers showing evidence of damage.
- C. Store aggregates in separate bins to prevent intrusion of foreign particles. Do not use bottom 6 inches of sand or other aggregate stored in contact with the ground.

PART 2 -- PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products manufactured by one of the following:
  - 1. LaFarge
  - 2. Lehigh Cement Company
  - 3. Holcim, Inc.
  - 4. SPEC MIX

## 2.02 MATERIALS

- A. Mortar and Grout Materials
  - 1. Portland Cement: ASTM C-150, Type I above grade and Type II below grade.
  - 2. Hydrated lime: ASTM C-207, Type "S".

3. Sand: Clean, coarse, free of loam, salt, organic and foreign matter and conforming to ASTM C-144.
4. Coarse and fine aggregates for grout: ASTM C-404.
5. Fly Ash: ASTM C618, Class F.
6. Masonry Cement: ASTM C 91, Type S and meet the following criteria:
  - a. Prepackaged masonry cement shall contain Portland Cement, hydrated lime and plasticizing admixtures or hydraulic hydrated lime. Masonry cements which contain other materials, including ground limestone, ground slag, or other cementitious and non-cementitious materials, are not acceptable.
7. Water - clean, fresh, potable and free from injurious amounts of oil, acids, alkalies, salts, organic matter or other deleterious substances.

B. Admixtures

1. Do not use calcium chloride.
2. Provide water repellant admixture in mortar used for architectural concrete masonry units. Admixture shall be compatible with Architectural CMU water repellant admixture.
3. Do not use admixtures, without written approval of Engineer.

C. Mortar pigment

1. Natural or synthetic iron oxide and chromium oxides meeting the requirements of ASTM C979.
2. Pigment shall not exceed 10% of the weight of Portland cement. Carbon black shall not exceed 2% of Portland cement.
3. Color shall be selected by the Owner from the manufacturer's full range of colors.

2.03 GROUT AND MORTAR MIXES

- A. Masonry mortar shall be Type "S" according to ASTM C-270 unless otherwise required to achieve required masonry strength see Specification 04200 paragraph 2.02 B 4. Proportions for masonry mortar shall be one of the following:
1. Proportions by volume: 1 part Portland cement to 1/4 - 1/2 parts hydrated lime, and aggregate volume of not less than 2-1/4 or more than 3 times the sum of the volumes of cement and lime.

2. Proportions by volume: 1/2 part Portland cement to 1 part masonry cement, and aggregate volume of not less than 1-1/4 or more than 3 times the sum of the volumes of cement and lime.
- B. Proportions for pointing mortar.
  1. Proportions by volume: 1 part Portland cement to 1/4 part hydrated lime and 2 parts extra fine sand.
- C. Masonry Grout shall conform to the requirements of ASTM C 476 and TMS 602, strength of grout, tested in accordance with ASTM C 1019 shall be equal to f'm as specified in Section 04200, but not less than 2,000 psi. Grout designs utilizing fly ash shall be approved by the Engineer. Provide grout with a sump of 8-11 inches.
  1. Test grout for every 5,000 square feet of masonry, with a minimum of one test per structure.

### PART 3 -- EXECUTION

#### 3.01 FIELD MORTAR MIXING

- A. Mixing shall be by mechanically operated batch mixer. Entirely discharge before recharging. Mix sand, lime, cement and admixtures dry for two (2) minutes minimum, add water and mix for three (3) minutes minimum. Control batching procedures by measuring materials by volume. Measurement by shovel count shall not be permitted. Mix mortar with less water than the maximum amount, consistent with workability, to provide near maximum tensile bond strength. Mix only quantity that can be used before initial set, or within the first one-half hour.
- B. Mixers, wheel barrows, mortar boards, etc., shall be kept clean.
- C. Retempering of mortar will not be permitted and mortar allowed to stand more than one (1) hour shall not be used.

#### 3.02 INSTALLATION

- A. Install mortar and grout in accordance with TMS 602.

#### 3.03 REPOINTING MORTAR

- A. Prehydrate the mortar by mixing ingredients together dry, and then add only enough water to make a damp, stiff mix that will retain its form when pressed into a ball. After one to two hours, add water to bring it to the proper consistency.

- END OF SECTION -

SECTION 04150  
MASONRY ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
  - 1. Metal joint reinforcement for masonry.
  - 2. Accessories for masonry construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04100 - Mortar and Masonry Grout
- B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications, Work shall conform to the applicable requirements of the following documents:
  - 1. ASTM A82                      Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
  - 2. ASTM A153                   Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
  - 3. ASTM A 951                  Standard Specification for Steel Wire Masonry Joint Reinforcement
  - 4. TMS 602                       Specifications for Masonry Structures

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:
  - 1. Provide manufacturer's complete product data.

2. Provide manufacturer's certification attesting compliance of material and source of each material specified below.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS FOR MASONRY REINFORCEMENT

- A. Subject to compliance with the Specifications, provide products manufactured by the following:
  1. Wire-bond
  2. Dur-O-Wal, Inc.
  3. Heckmann Building Products, Inc.
  4. Holman and Barnard, Inc.

### 2.02 MATERIALS

- A. Single Wythe Joint Reinforcement

Steel ladder type reinforcement conforming to ASTM A 951 with 3/16 inch side rods and 9 gauge continuous cross rods; manufactured with wire conforming to ASTM A 82, with widths 2-inches less than nominal wall thickness.

- B. Finish

1. Reinforcements, anchorages and ties shall be hot dipped galvanized, Class B-2, after fabrication in accordance with ASTM A153.

### 2.03 ACCESSORIES

- A. Hardware Cloth

1. Waterproof paper backed with 1/2 inch hardware cloth.

## PART 3 -- EXECUTION

### 3.01 REINFORCEMENT AND ANCHORAGE

- A. In masonry wall panels, place horizontal joint reinforcement at a vertical spacing of 16 inches on center, unless otherwise noted.
- B. Lap side rods at each end joint a minimum of 6 inches.
- C. Install prefabricated corner and tee assemblies at each wall corner and intersection.

- D. Mitre and butt end joints are prohibited.
- E. Place horizontal joint reinforcement in approximate center of out-to-out wall assembly and assuring a 5/8 inch, minimum, mortar coverage on exterior face and 1/2 inch on interior face.
- F. Adjustable anchor assemblies may be offset no more than that which is stated in manufacturer's published instructions. Pintles may be installed either up or down.
- G. Install horizontal joint reinforcement continuous.
- H. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend 24 inches minimum each side of opening.
- I. Place reinforcing bars supported and secured against displacement. Maintain position with 1/2 inch to true dimension.
- J. Coordinate and verify that dowels and anchorages embedded in concrete and attached to structural steel members are properly placed.

### 3.02 BENDING, CUTTING AND SPLICING REINFORCEMENT

- A. Make bends and splices in reinforcement only where indicated, or prior-approval by Engineer. Bend reinforcement only when cold, and prior to any placement in construction, forming around a steel pin of diameter at least 6 times the reinforcement size. Cut bars only by approved sawing, shearing or welding methods. Make ends of reinforcement straight, square, clean and free of defects before splicing. Do not heat or weld bends and splices at points of maximum stress. Clip and bend any tie wires as required to direct the ends away from external surfaces of masonry walls.
- B. Where welding is necessary, provide materials and perform welding in accordance with AWS requirements.
- C. All lap splices to be 48 bar diameters, unless otherwise noted.

- END OF SECTION -



## SECTION 04200

### UNIT MASONRY

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified work.

1. Principal items of work include:

- a. Exterior masonry wall construction.
- b. Installation of masonry reinforcement and accessories.
- c. Masonry unit lintels.
- d. Building into masonry work all anchors, inserts, hangers and the like provided under other Sections.
- e. Pointing and cleaning of exposed masonry surfaces.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04100 – Mortar and Masonry Grout
- B. Section 04150 – Masonry Accessories
- C. Section 07210 – Building Insulation

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, the Work shall conform to the applicable requirements of the following documents:

1. TMS 402 Building Code Requirements for Masonry Structures
2. TMS 602 Specifications for Masonry Structures
  - a) TMS 602, jointly published by The Masonry Society, hereafter referred to as TMS 602 shall be considered minimum specifications for all materials, workmanship, methods and techniques for all masonry work.

- b) Obtain a copy of the above Specifications prior to beginning any work in this Section.
- 3. ASTM C90 Standard Specification for Load-Bearing Concrete Masonry Units
- 4. ASTM C140 Standard Methods for Sampling and Testing Concrete Masonry Units
- 5. ASTM C744 Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units
- 6. ANSI A41.1 R70 Code Requirements for Masonry

#### 1.04 TESTING

##### A. Tests

The Owner reserves the right to test materials for compliance with these specifications. Sampling and testing will be done in accordance with the ASTM standard, by an independent testing agency employed by the Owner. Materials that fail to meet requirements are considered defective. Subsequent tests to establish compliance (of the same or new materials) shall be paid for by the Contractor.

#### 1.05 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:
  - 1. Samples of each material to be used showing full range of colors.
  - 2. Manufacturer's specifications and certifications of compliance to the Specifications, including results of tests on masonry units showing such compliance, for each type of masonry. Provide handling, storage, and installation instructions along with protection instructions. Indicate by transmittal that installer has received copies of each instruction.
  - 3. Cold and/or hot weather construction procedures in accordance with TMS 602 sections 1.8.C and 1.8.D.
  - 4. Cleaning procedures and cleaner for each masonry type.

#### 1.06 MOCK-UPS

- A. Build 4'-0" x 4'-0" mock-up at the site utilizing different color combinations. Obtain Engineer's acceptance of visual qualities of the mock-up before start of masonry work. Remove mock-up at completion of and acceptance of masonry work.

## 1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in the manufacturer's original unbroken, undamaged and unopened packaging with labels bearing the name of the manufacturer and the product. Masonry units and brick shall be factory packaged and strapped, delivered to the site and stored on skids.
- B. Store and handle materials to prevent inclusion of water or foreign matter and to prevent damage of any nature.
- C. Distribute materials on floor slabs to prevent overloading. Designated live loads shown for floor shall not be exceeded.

## PART 2 -- PRODUCTS

### 2.01 GENERAL

- A. Provide special shape, type or size indicated or for application requiring a form, size or finish which cannot be produced from standard masonry units by sawing. Provide solid units where masonry unit is exposed. Provide sill blocks below window, louver, and other openings with masonry veneer sills.

### 2.02 MATERIALS

#### A. Mortar

- 1. In accordance with Section 04100 - Mortar and Masonry Grout

#### B. Architectural Concrete Masonry Units

- 1. Ground face and split-face CMU shall be manufactured by firm producing architectural concrete masonry units for a minimum of five years.
- 2. Units shall conform to ASTM C-90, Type I, normal weight.
- 3. Provide units with integral water repellant admixture. Absorption shall not exceed 10 lbs per cubic foot. Integral repellant admixture shall be coordinated with mortar to be supplied.
- 4. Compressive strength of masonry ( $f'_m$ ) shall be a minimum of 2,000 psi in accordance with TMS 602 when these units are used with the mortar specified in Section 04100. Strength shall be verified as required by the California Building Code Section 2105.1.
- 5. Exterior exposed surfaces shall be finished consistently. Provide lintels and other special shapes with finished faces.

6. Color shall be selected from manufacturer full line of colors. Up to two colors shall be selected per site. Each site may have colors selected specific to the site.

### PART 3 -- EXECUTION

#### 3.01 GENERAL

- A. Examine areas and conditions under which masonry is to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.
- B. Do not wet concrete masonry units.
- C. Clean reinforcing, removing loose rust, ice or other coatings from bars, before placement.
- D. Build single wythe walls to the actual size of masonry units.
- E. Build chases and recesses as shown and as required for the work of other trades.
- F. Build other work into masonry work as shown, fitting masonry units around other work and grouting to assure anchorage.
- G. Cut masonry units with motor driven saw designed to cut masonry with clean, sharp, unchipped edges. Cut units as required to provide pattern shown or specified, and to fit adjoining work neatly.
- H. Cold and hot weather construction.
  1. No masonry shall be erected when ambient temperature has dropped below 45°F unless it is rising and at no time when it has dropped below 40°F. Provisions shall be made for heating and drying of materials, and the complete work shall be protected in accordance with the TMS 602 Section 1.8.C. Masonry shall not be laid with ice or frost on its surfaces, and no masonry shall be laid on frozen work. Any work which freezes before the mortar has set shall be removed and replaced at the Contractor's own expense. Do not use any admixtures or antifreeze in the mortar.
  2. When the temperature is above 100°F or 90°F with a wind velocity greater than 8 mph, mortar beds shall be spread no more than 4 feet ahead of masonry and masonry units shall be set within one minute of spreading mortar.

#### 3.02 CONSTRUCTION TOLERANCES

- A. Variation from plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not

exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10', 1/2" maximum.

- B. Variation from level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.
- C. Variation of Linear Building Line: For position shown on plan and related portion of columns, walls, and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.
- D. Variation in Cross Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

### 3.03 LAYING MASONRY WALLS

- A. Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs, and wherever possible at other locations.
- B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.
- C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below.
- D. Stopping and Resuming Work: Rack back 1/2 unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, and remove loose masonry units and mortar prior to laying fresh mortar.
- E. Cover top of walls at the end of each day. Protect wall from water infiltration from the top until wall is capped.
- F. Built-In Work: As work progresses, build-in items specified under this and other sections of these Specifications. Fill in solidly with masonry around built-in items.
  - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
  - 2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of hardware cloth in the joint below and rod grout into core.

3. Fill cores in hollow masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise noted.
4. Seal masonry tight around wall penetrations such as beams, joists, pipes, ducts, and conduit by cutting masonry units to fit as tightly as possible, then closing final gap all around with mortar, or joint filler and caulking as necessary.

#### 3.04 MORTAR BEDDING AND JOINTING

- A. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
- B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs with mortar in starting courses on footing or floors, and where adjacent cells are to be reinforced or filled with grout. For starting courses where cells are not grouted, spread full mortar bed including areas under cells.
- C. Maintain joint widths of 3/8", except for minor variations required to maintain bond alignment.
- D. Tooling: Joints shall be tooled to a uniform concave joint. Head joints first and then the bed joints.
- E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners and jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean and reset in fresh mortar.

#### 3.05 JOINT REINFORCING

- A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints not more than 16" o.c. vertically.
- B. Reinforced masonry openings greater than 12" wide, with horizontal joint reinforcing placed in 2 horizontal joints immediately above the lintel and immediately below the sill. Extend reinforcements 2'-0" beyond jambs of the opening except at control joints.
- C. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, pipe enclosures and other special conditions.

#### 3.06 LINTELS

- A. Install galvanized steel lintels where indicated.
- B. Provide masonry lintels where shown and wherever openings of more than 8" for block size units are shown without structural steel or other supporting lintels. Provide precast or poured-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels. Exposed lintels shall match the color of the field masonry unless otherwise noted.

- C. For hollow concrete masonry unit walls, use specially formed "U"-shaped lintel units with reinforcement bars placed as shown and filled with grout.
- D. Provide minimum bearing of 8" at each jamb.

### 3.07 REINFORCED UNIT MASONRY

- A. Vertical reinforcement shall be held in place by means of frames or other suitable means. Place horizontal joint reinforcement as masonry work progresses. Provide minimum clear distance between longitudinal bars equal to nominal diameter of bar. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4", except 6 gage or smaller wires may be laid in 3/8" mortar joints. Collar joints which contain both horizontal and vertical reinforcement shall have a minimum width of 1/2" larger than the diameter of the horizontal and vertical reinforcement.
- B. Bar splices shall be contact lap splices. Length of splice shall be in accordance with structural drawings and specifications and not less than 30" for #5 bars.
- C. Low lift grouting shall be used when grout space is less than 2" in width. Place grout at maximum intervals of 24" in lifts of 6 to 8 inches as the work progresses. Cores to be grouted shall be clean of mortar, mortar dropping and debris. Agitate grout to assure complete filling and coverage of reinforcement. Hold grout 1-1/2 inches below to top of masonry if work is discontinued for more than an hour.
- D. High lift grouting may be used when the grout space is greater than 2". Grout shall not be placed in lifts greater than 4 feet. Grout core shall be kept clean of mortar, mortar dripping and debris. Provide cleanout holes as required for inspection and cleaning. Replace cleanout plugs after inspection and acceptance. Do not place grout until entire wall has been in place a minimum of 3 days. Hold grout 1-1/2 inches below top of masonry if work is discontinued for more than an hour.
- E. Forms and shoring shall be substantial and tight to prevent leakage of mortar or grout. Brace and shore forms to maintain position and shape. Do not remove forms or shoring until masonry gains enough strength to sufficiently carry its own weight and any other loads, temporary or permanent, placed on it during construction.

### 3.08 PROTECTION OF WORK

- A. Exposed masonry surfaces shall be protected from staining. Tops of wall shall be covered with nonstaining waterproof coverings when work is not in progress. Installed material shall be secure in high winds.
- B. Protection shall be provided for all openings in the walls to prevent damage to sills, jambs, etc., from all causes. Aluminum or steel frames and other finish materials shall be protected from damage during masonry work.

### 3.09 REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing of Masonry: At the completion of the masonry work, all holes in exposed masonry shall be pointed. Defective joints shall be cut out and tuckpointed solidly with mortar. Pointing and tuckpointing shall be done with a pre-hydrated mortar. The mortar cement shall be controlled so that, after curing of the mortar, no difference in texture or color exists with that of adjacent masonry.
- C. Masonry Cleaning: While laying masonry units, good workmanship and job housekeeping practices shall be used so as to minimize the need for cleaning the masonry work. Protect the base of the wall from mud splashes and mortar droppings. The technique for laying masonry shall be such that mortar does not run down the face of the wall or smear onto the face.
  - 1. After the joints are tooled, cut off mortar failings with the trowel and brush excess mortar burrs and dust from the face of the masonry, use a bricklayer's brush made with medium soft hair.
  - 2. Remove all large mortar particles with a hardwood scraper.
  - 3. If, after using the above outlined techniques, additional cleaning of the walls is found necessary, allow the walls to cure one month prior to initiating further cleaning processes.
- D. Clean masonry to comply with the masonry manufacturer's directions. Cleaning methods shall be demonstrated on the sample wall.

- END OF SECTION -



SECTION 05010  
METAL MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Materials for fasteners are included in Section 05050, Metal Fastening.
- B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM A36           Standard Specification for Structural Steel
- B. ASTM A47           Standard Specification for Malleable Iron Castings
- C. ASTM A48           Standard Specification for Gray Iron Castings
- D. ASTM A53           Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- E. ASTM A167          Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- F. ASTM A276          Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
- G. ASTM A307          Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
- H. ASTM A446          Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality
- I. ASTM A500          Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- J. ASTM A501          Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

- |    |            |                                                                                                                                 |
|----|------------|---------------------------------------------------------------------------------------------------------------------------------|
| K. | ASTM A529  | Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness) |
| L. | ASTM A536  | Standard Specification for Ductile Iron Castings                                                                                |
| M. | ASTM A570  | Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality                                          |
| N. | ASTM A572  | Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel                                          |
| O. | ASTM A992  | Standard Specification for Structural Steel Shapes                                                                              |
| P. | ASTM A666  | Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications            |
| Q. | ASTM A1085 | Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)                                     |
| R. | ASTM B26   | Standard Specification for Aluminum-Alloy Sand Castings                                                                         |
| S. | ASTM B85   | Standard Specification for Aluminum-Alloy Die Castings                                                                          |
| T. | ASTM B108  | Standard Specification for Aluminum-Alloy Permanent Mold Castings                                                               |
| U. | ASTM B138  | Standard Specification for Manganese Bronze Rod, Bar, and Shapes                                                                |
| V. | ASTM B209  | Standard Specification for Aluminum-Alloy Sheet and Plate                                                                       |
| W. | ASTM B221  | Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes                                          |
| X. | ASTM B308  | Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded                                        |
| Y. | ASTM B574  | Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod                                                                 |
| Z. | ASTM F468  | Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use                                          |
| a. | ASTM F593  | Standard Specification for Stainless Steel Fasteners                                                                            |

#### 1.04 SUBMITTALS

- A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

#### 1.05 QUALITY ASSURANCE

- A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

## PART 2 -- PRODUCTS

### 2.01 CARBON AND LOW ALLOY STEEL

- A. Material types and ASTM designations shall be as listed below:

|    |                                                           |                       |
|----|-----------------------------------------------------------|-----------------------|
| 1. | Steel W Shapes                                            | A992                  |
| 2. | Steel HP Shapes                                           | A572 Grade 50         |
| 3. | Steel M, S, C, and MC shapes and Angles, Bars, and Plates | A36                   |
| 4. | Rods                                                      | F 1554 Grade 36       |
| 5. | Pipe - Structural Use                                     | A53 Grade B           |
| 6. | Hollow Structural Sections                                | A500 Grade C or A1085 |
| 7. | Cold-Formed Steel Framing                                 | A 653                 |

### 2.02 STAINLESS STEEL

- A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.

- B. Material types and ASTM designations are listed below:

|    |                         |                           |
|----|-------------------------|---------------------------|
| 1. | Plates and Sheets       | ASTM A167 or A666 Grade A |
| 2. | Structural Shapes       | ASTM A276                 |
| 3. | Fasteners (Bolts, etc.) | ASTM F593                 |

### 2.03 ALUMINUM

- A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

- B. Material types and ASTM designations are listed below:

|    |                   |                        |
|----|-------------------|------------------------|
| 1. | Structural Shapes | ASTM B308              |
| 2. | Castings          | ASTM B26, B85, or B108 |

- |    |                                 |                        |
|----|---------------------------------|------------------------|
| 3. | Extruded Bars                   | ASTM B221 - Alloy 6061 |
| 4. | Extruded Rods, Shapes and Tubes | ASTM B221 - Alloy 6063 |
| 5. | Plates                          | ASTM B209 - Alloy 6061 |
| 6. | Sheets                          | ASTM B221 - Alloy 3003 |

- C. All aluminum structural members shall conform to the requirements of Section 05140, Structural Aluminum.
- D. All aluminum shall be provided with mill finish unless otherwise noted.
- E. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

## 2.04 CAST IRON

- A. Material types and ASTM designations are listed below:

- |    |           |                          |
|----|-----------|--------------------------|
| 1. | Gray      | ASTM A48 Class 30B       |
| 2. | Malleable | ASTM A47                 |
| 3. | Ductile   | ASTM A536 Grade 60-40-18 |

## 2.05 BRONZE

- A. Material types and ASTM designations are listed below:

- |    |                       |                          |
|----|-----------------------|--------------------------|
| 1. | Rods, Bars and Sheets | ASTM B138 - Alloy B Soft |
|----|-----------------------|--------------------------|

## 2.06 HASTELLOY

- A. All Hastelloy shall be Alloy C-276.

## 2.07 DISSIMILAR METALS

- A. Dielectric isolation shall be installed wherever dissimilar metals are connected according to the following table.

|            | Zinc | Galvanized Steel | Aluminum | Cast Iron | Ductile Iron | Mild Steel/<br>Carbon Steel | Copper | Brass | Stainless Steel |
|------------|------|------------------|----------|-----------|--------------|-----------------------------|--------|-------|-----------------|
| Zinc       |      |                  | •        | •         | •            | •                           | •      | •     | •               |
| Galvanized |      |                  | •        | •         | •            | •                           | •      | •     | •               |

|                                                                                                                                          |   |   |   |   |   |   |   |   |   |
|------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|
| Steel                                                                                                                                    |   |   |   |   |   |   |   |   |   |
| Aluminum                                                                                                                                 | • | • |   | • | • | • | • | • | • |
| Cast Iron                                                                                                                                | • | • | • |   |   |   | • | • | • |
| Ductile Iron                                                                                                                             | • | • | • |   |   |   | • | • | • |
| Mild Steel/<br>Carbon Steel                                                                                                              | • | • | • |   |   |   | • | • | • |
| Copper                                                                                                                                   | • | • | • | • | • | • |   |   | • |
| Brass                                                                                                                                    | • | • | • | • | • | • |   |   | • |
| Stainless Steel                                                                                                                          | • | • | • | • | • | • | • | • |   |
| 1. "•" signifies dielectric isolation is required between the two materials noted.<br>2. Consult Engineer for items not listed in table. |   |   |   |   |   |   |   |   |   |

### PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 05035

### GALVANIZING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. California Building Code
2. ASTM A123 - Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
4. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
5. ASTM A780 - Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings
6. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

#### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

### PART 2 -- PRODUCTS

#### 2.01 GALVANIC COATING

- A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

### PART 3 -- EXECUTION

#### 3.01 FABRICATED PRODUCTS

- A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.
- B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.
- C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

#### 3.02 HARDWARE

- A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153 and ASTM F2329.

#### 3.03 ASSEMBLED PRODUCTS

- A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.
- B. Assemblies shall be provided with vent and drain holes as required by the fabricator. Vent and drain hole sizes and locations shall be included in the structural steel shop drawings

required in Specification 05120 Structural Steel for approval. All vent and drain holes shall be plugged and finished to be flush with and blend in with the surrounding surface. Where water intrusion can occur, the plug shall be carefully melted into the surrounding zinc coating using an appropriate fluxing agent.

#### 3.04 METAL DECK

- A. Unless noted otherwise, metal deck shall be galvanized in accordance with ASTM A653 G60 minimum. In moist environments or as indicated on the Contract Drawings, galvanizing shall meet the requirements of ASTM A653 G90.
- B. Galvanized metal deck shall meet the requirements of ASTM A924.

#### 3.05 REPAIR OF GALVANIZING

- A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

- END OF SECTION -



SECTION 05050  
METAL FASTENING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05120 - Structural Steel

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- |    |                          |                                                                              |
|----|--------------------------|------------------------------------------------------------------------------|
| 1. | California Building Code |                                                                              |
| 2. | AC 193                   | Acceptance Criteria for Mechanical Anchors in Concrete Elements              |
| 3. | AC 308                   | Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements |
| 4. | ACI 318                  | Building Code Requirements for Structural Concrete                           |
| 5. | ACI 355.2                | Qualifications of Post-Installed Mechanical Anchors in Concrete              |
| 6. | ACI 355.4                | Qualifications of Post-Installed Adhesive Anchors in Concrete                |
| 7. | ICC-ES AC193             | Acceptance Criteria for Expansion and Screw Anchors (Concrete)               |
| 8. | AISC 348                 | The 2009 RCSC Specification for Structural Joints                            |

|     |                      |                                                                                                    |
|-----|----------------------|----------------------------------------------------------------------------------------------------|
| 9.  | AISC                 | Code of Standard Practice                                                                          |
| 10. | AWS D1.1             | Structural Welding Code - Steel                                                                    |
| 11. | AWS D1.2             | Structural Welding Code - Aluminum                                                                 |
| 12. | AWS D1.6             | Structural Welding Code – Stainless Steel                                                          |
| 13. | Aluminum Association | Specifications for Aluminum Structures                                                             |
| 14. | ASTM A572/A572M-94C  | Standard Specification for High Strength Low-Alloy<br>Columbium-Vanadium Structural Steel Grade 50 |
| 15. | ASTM A36             | Standard Specification for Carbon Structural Steel                                                 |
| 16. | ASTM A325            | Standard Specification for High-Strength Bolts for<br>Structural Steel Joints                      |
| 17. | ASTM A489            | Standard Specification for Eyebolts                                                                |
| 18. | ASTM A490            | Standard Specification for Quenched and Tempered<br>Alloy Steel Bolts for Structural Steel Joints  |
| 19. | ASTM A563            | Standard Specifications for Carbon and Alloy Steel<br>Nuts                                         |
| 20. | ASTM D1785           | Standard Specification for Polyvinyl Chloride (PVC)<br>Plastic Pipe                                |
| 21. | ASTM E488            | Standard Test Methods for Strength of Anchors in<br>Concrete and Masonry Elements                  |
| 22. | ASTM F436            | Standard Specification for Hardened Steel Washers                                                  |
| 23. | ASTM F467            | Standard Specification for Nonferrous Nuts for<br>General Use                                      |
| 24. | ASTM F593            | Standard Specification for Stainless Steel Bolts; Hex<br>Cap Screws, and Studs                     |
| 25. | ASTM F594            | Standard Specification for Stainless Steel Nuts                                                    |
| 26. | ASTM F1554           | Standard Specification for Anchor Bolts, Steel, 36,<br>55, and 105-ksi Yield Strength              |

#### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
2. Anchor design calculations sealed by a Professional Engineer currently registered in the State of California. Only required if design not shown on Contract Drawings.
3. A current ICC-ES Evaluation Service Report shall be submitted for all anchors that will be considered for use on this project.
4. Manufacturer's installation instructions.
5. Copy of valid certification for each person who is to perform field welding.
6. Certified weld inspection reports, when required.
7. Welding procedures.
8. Installer qualifications.
9. Certification of Installer Training.
10. Inspection Reports.
10. Results of Anchor Proof Testing.

#### 1.05 QUALITY ASSURANCE

- A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.
- B. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.
- C. Installer Training: For concrete adhesive, expansion and screw anchors, conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:
1. Hole drilling procedure.
  2. Hole preparation and cleaning technique.
  3. Adhesive injection technique and dispenser training/maintenance.

4. Concrete adhesive anchor preparation and installation.
  5. Proof loading/torquing.
  6. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the installer name, date of training, products included in the training and trainer name and contact information
  7. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.
- D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.
  - E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.
  - F. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.
  - G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.
  - H. Inspections of the adhesive dowel system shall be made by the Engineer or other representatives of the Owner in accordance with the requirements of the ESR published by the manufacturer. Provide adequate time and access for inspections of products and anchor holes prior to injections, installation, and proof testing.

## PART 2 -- PRODUCTS

### 2.01 ANCHOR RODS (ANCHOR BOLTS)

- A. Anchor rods shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor rods are shown on the Drawings. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.
- B. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.

- C. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

## 2.02 HIGH STRENGTH BOLTS

- A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC 348 "The 2009 RCSC Specification for Structural Joints".
- B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

## 2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
- B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

## 2.04 CONCRETE ANCHORS

### A. General

- 1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:
  - a. Expansion anchors shall be mechanical anchors of the wedge, sleeve, drop-in or undercut type.
  - b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.
  - c. Concrete screw anchors shall be one piece, heavy duty screw anchor with a finished hex head.

2. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.
3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.
4. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Expansion, concrete screw or mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to the California Building Code and ACI 318 Chapter 17 requirements as applicable, including seismic test requirements.
5. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire-resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.
6. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.

**B. Concrete Anchor Design:**

An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, it shall be considered an engineered design and anchors shall be installed to the prescribed size, spacing, embedment depth and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the anchors will be considered an engineered design and the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

1. **Structural Anchors:** All concrete anchors shall be considered structural anchors if they transmit load between structural elements; transmit load between non-structural components that make up a portion of the structure and structural elements; or transmit load between life-safety related attachments and structural elements. Examples of structural concrete anchors include but are not limited to column anchor bolts, anchors supporting non-structural walls, sprinkler piping support anchors, anchors supporting heavy, suspended piping or equipment, anchors supporting barrier rails, etc. For structural anchors, the Contractor shall submit an engineered design with signed and sealed calculations performed by an Engineer currently registered in the State of California. Structural anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Chapter 17.
2. **Non-Structural Anchors:** All other concrete anchors may be considered non-structural concrete anchors. The Contractor shall perform an engineered design for non-structural anchors. The Engineer may request the Contractor provide

anchor design details for review, but submission of a signed, sealed design is not required. Non-structural anchors shall be designed by the contractor for use in uncracked concrete.

3. Embedment Depth

- a. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design. Although all manufacturers listed are permitted, the embedment depth indicated on the Drawings is based on "Pure 110+ by DeWalt" ESR 3298 issued 7/2017. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.
- b. Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).
- c. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer's literature.

C. Structural Anchors:

1. Mechanical Anchors:

- a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Power-Stud+SD1" or "Power-Stud+ SD-2" by DeWalt.
- b. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Screw-Bolt+" by DeWalt. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
- c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by DeWalt.
- d. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by DeWalt
- e. Shallow Embedment Internally Threaded Insert (3/4" max embedment): "Mini-Undercut +Anchor" by DeWalt, "HSC-A" by Hilti, Inc. or approved

equal.

2. Adhesive Anchors:

- a. Adhesive anchors shall be “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET-XP Epoxy Adhesive Anchors” by Simpson Strong-Tie Co., or “Pure 110+ Epoxy Adhesive Anchor System” by DeWalt.
- b. Structural adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

D. Non-Structural Anchors: In addition to the acceptable non-structural anchors listed below, all structural anchors listed above may also be used as non-structural anchors.

1. Mechanical Anchors:

- a. Wedge Anchors: Wedge anchors shall be “Kwik Bolt 3” by Hilti, Inc., “Power-Stud+ SD1” by DeWalt, “Wedge-All” by Simpson Strong-Tie Co. or “TruBolt” by ITW Redhead.
- b. Screw Anchors: Screw anchors shall be “Kwik HUS” by Hilti, Inc., “Screw Bolt+” or 316 Stainless Steel Wedge-Bolt” by DeWalt, “Large Diameter Tapcon (LDT) Anchor” by ITW Redhead, or “Titen HD” by Simpson Strong-Tie Co. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
- c. Sleeve Anchors: Sleeve anchors shall be “HSL Heavy Duty Sleeve Anchors” by Hilti, Inc. “Power-Bolt+” by DeWalt “Dynabolt Sleeve Anchor” by ITW Redhead, or “Sleeve-All” by Simpson Strong-Tie Co.
- d. Drop-In Anchors: Drop-in anchors shall be “Drop-In” by Simpson Strong-Tie Co., “HDI Drop-In Anchor” by Hilti, Inc., “Smart DI” by DeWalt or “Multi-Set II Drop-In Anchor” by ITW Redhead.
- e. Undercut Anchors: Undercut anchors shall be “HDA Undercut Anchor” by Hilti, Inc., “Atomic Undercut+” by DeWalt or “Torq-Cut” by Simpson Strong-Tie Co.

2. Adhesive Anchors:



- a. Adhesive anchors shall be “Epcon A7” or “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET Epoxy Tie High Strength Anchoring Adhesive” or “AT High Strength Anchoring Adhesive” by Simpson Strong-Tie Co., or AC100+ Gold” Adhesive Anchoring System” by DeWalt
- b. Non-structural adhesive anchors systems shall be IBC compliant and capable of resisting short term wind and seismic (Seismic Design Categories A and B) as well as long term and short term sustained static loads in uncracked concrete.
- c. Non-structural adhesive anchor embedment depth of the rod shall provide a minimum allowable bond strength that is equal to the allowable yield capacity of the rod unless noted otherwise on the Drawings.
- d. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

E. Concrete Anchor Rod Materials:

- 1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.
- 2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.
- 3. Nuts, washers, and other hardware shall be of a material to match the anchors.

## 2.05 MASONRY ANCHORS

- A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.
- B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust prior to installation of adhesive and anchor. Contractor shall follow manufacturer’s installation instructions. The adhesive system shall be “HIT HY-70 System” as manufactured by Hilti, Inc., or “AC100+ Acrylic Adhesive” by DeWalt, “SET-XP” as manufactured by Simpson Strong-Tie Co.
- C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system, but shall not have a yield strength (fy) less

than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.

- D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.
- E. Although all manufacturers listed are permitted, the masonry anchor design is based on "SET-XP by Simpson Strong-Tie ER 265 Revised 1-31-2018. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the proposed product and the Contractor shall provide the conditions stipulated by the Engineer specific to the approved adhesive anchor.

## 2.06 WELDS

- A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).
- B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.
- C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

## 2.07 WELDED STUD CONNECTORS

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

## 2.08 EYEBOLTS

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

## 2.09 HASTELLOY FASTENERS

- A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

## 2.10 ANTISEIZE LUBRICANT

- A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

# PART 3 -- EXECUTION

## 3.01 MEASUREMENTS

- A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

### 3.02 ANCHOR INSTALLATION

#### A. Anchor Rods, Concrete Anchors, and Masonry Anchors

1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.
2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.
4. All stainless steel threads shall be coated with antiseize lubricant.

#### B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

#### C. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and shall be at least 50 degrees F.
2. Concrete anchors designed by the Contractor shall be classified as structural or non-structural based on the requirements indicated above.
3. Concrete Anchor Testing:
  - a. At all locations where concrete anchors meet the requirements for structural anchors at least 25 percent of all concrete anchors installed shall be proof tested to the value indicated on the Drawings, with a minimum of one tested anchor per anchor group. If no test value is indicated on the Drawings but the installed anchor meets the requirements for structural anchors, the Contractor shall notify the Engineer to allow verification of whether anchor load proof testing is required.
  - b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure

(including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors shall be in accordance with ASTM E488 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.

- c. Where Contract Documents indicate anchorage design to be the Contractor's responsibility and the anchors are considered structural per the above criteria, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State of California. The Contractor's Engineer shall also submit documentation indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E488.
  - d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.
  - e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.
- 4. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.
  - 5. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. . Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.
  - 6. All adhesive anchor installations in the horizontal to vertically overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-14 17.8.2. Current AAI Certificate must be submitted to the Engineer of Record prior to commencement of any adhesive anchor installations.

D. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
2. All stainless steel bolts shall be coated with antiseize lubricant.

3.03 WELDING

- A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.
- B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

- A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Rejected bolts shall be either replaced or retightened as required.
- B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.
- C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

- A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

- END OF SECTION -

SECTION 05120  
STRUCTURAL STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.
  - 1. California Building Code
  - 2. AISC - "Code of Standard Practice."
  - 3. AISC - "Specification for Structural Steel Buildings".
  - 4. AISC 348 - "The 2009 RCSC Specification for Structural Joints".
  - 5. AWS - "Structural Welding Code".

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Certified Mill Test Reports
  - 2. Affidavit of Compliance with grade specified
  - 3. Shop Drawings which include the following:
    - a. Layout drawings indicating all structural shapes, sizes, and dimensions.

- b. Beam and column schedules.
- c. Detailed drawings indicating jointing, anchoring and connection details and vent and drain holes where required.

#### 1.05 QUALITY ASSURANCE

- A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.
- B. The erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category ACSE.
- C. The fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD.

### PART 2 -- PRODUCTS

#### 2.01 MATERIALS

- A. Structural Steel
  - 1. Structural steel for W shapes shall conform to ASTM A992 unless otherwise indicated.
  - 2. Structural steel for HP shapes shall conform to ASTM A572 Grade 50 unless otherwise indicated.
  - 3. Structural steel for S, M, C, and MC shapes and angles and plates shall conform to ASTM A36 unless otherwise indicated.
  - 4. Steel pipe shall be ASTM A53, Grade B.
  - 5. HSS shall be ASTM A500, Grade C or ASTM A1085. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.
  - 6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.

7. Fasteners for structural steel shall be in accordance with Section 05050, Metal Fastening.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

### PART 3 -- EXECUTION

#### 3.01 MEASUREMENT

- A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

#### 3.02 FABRICATION

- A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.
- B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.
- C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods, vent and drain holes or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.
- D. All materials shall be properly worked and match-marked for field assembly.
- E. Where galvanizing of structural steel is required, it shall be done in accordance with Section 05035, Galvanizing.

#### 3.03 DELIVERY, STORAGE AND HANDLING

- A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.
- B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

#### 3.04 ERECTION



- A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.
- B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.
- C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.
- D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.
- E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.
- F. All bolted connections shall use high strength bolts in accordance with Section 05050, Metal Fastening. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Bolts specified or noted on the Drawings to be a tension or slip critical "SC" type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.
- G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.
- H. Misfits at Bolted Connections
  - 1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.
  - 2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.
  - 3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.
- I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.
  2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.
  3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.
  4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.
- J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

### 3.05 PAINTING

- A. Painting shall be performed according to Section 09900, Painting and the following additional requirements.
1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.
  2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.
  3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.
  4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

- END OF SECTION -

## SECTION 05300

### METAL DECKING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all labor, equipment, materials and services to install all metal deck complete with all accessories for a complete installation in accordance with the Drawings and as specified herein.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening
- D. Section 05120 - Structural Steel
- E. Section 05425 – Pre-Engineered Cold-Formed Steel Trusses

##### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AISI - Specification for the Design of Cold-Formed Steel Structural Members
- B. SDI - Design Manual for Floor Decks and Roof Decks and Manual of Construction with Steel Deck.
- C. ASTM Standards for Test Methods.
- D. AWS D1.3 – Structural Welding Code – Sheet Steel
- E. ANSI/SDI RD-2010 – Standard for Steel Roof Deck
- F. ANSI/SDI NC1.0-2006 – Standard for Non-Composite Steel Floor Deck

##### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Complete layout and installation drawings and schedules with clearly marked dimensions.

2. Detail and location drawings for all framing, supports, type and location of all welds and fasteners.
3. Details of all accessories showing welding washers, studs and reinforcing strips.
4. Manufacturer's design calculations or published literature for the structural properties of the metal decking.
5. Qualifications of welders.

#### 1.05 QUALITY ASSURANCE

- A. All materials, workmanship and production methods shall be in accordance with ANSI/SDI RD-2010 for Roof Deck and ANSI/SDI NC1.0-2006 for Non-Composite Floor Deck.
- B. Manufacturer shall be regularly engaged in the manufacture of metal decking.

### PART 2 -- PRODUCTS

#### 2.01 MATERIALS

- A. Steel sheet shall be flat rolled carbon steel sheets meeting the requirements of ASTM A653 Grade 80 for galvanized metal deck or ASTM A1008 Grades 80 for bare metal deck.
- B. Minimum yield strength shall be 33 ksi.
- C. Unless noted otherwise, metal deck shall be galvanized in accordance with Section 05035, Galvanizing.
- D. Mechanical fasteners used for sidelap connections shall be SDI standard.

### PART 3 -- EXECUTION

#### 3.01 FABRICATION AND DESIGN

- A. Design, fabrication and erection of decking shall comply with references listed in Section 1.03 and manufacturer's recommendations.
- B. Deck units shall conform to the SDI standard type and gage shown on the Drawings.

#### 3.02 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered in unbroken, undamaged, original packages bearing manufacturer's labels.

- B. Metal decking shall be stored off the ground with one end elevated for drainage and covered with vented water-proof material in accordance with decking manufacturer's recommendations.
- C. Decking shall be handled so as to preclude damage from any source.
- D. Metal decking units may not be used for any purpose (such as scaffold decking) prior to incorporation in the work. Any units which have been so used will be rejected.

### 3.03 INSPECTION

- A. Verify correct layout and alignment of supporting members and clean all support surfaces of debris. All defects shall be corrected prior to installation of metal decking.

### 3.04 INSTALLATION

- A. Install deck units and accessories in accordance with shop drawings and manufacturer's recommendations. Deck units shall be installed where called for on the Drawings.
- B. Position deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened. Extend deck units over three or more supports unless shown otherwise on the Drawings. Lap ends not less than 2 inches. Place deck units flat and square, secured to adjacent framing without warp or deflection.
- C. Secure deck units to supporting members as shown on the Drawings. Weld pattern shall be as indicated on the Drawings in accordance with SDI and AWS D1.3. The Contractor may use an equivalent pattern of mechanical fasteners in lieu of welded fastening.
- D. Attach deck at sidelaps with screws as indicated on the Drawings or as recommended by the manufacturer.
- E. Cut and fit deck units around openings. Deck manufacturer shall approve openings larger than 6" diameter prior to cutting.

### 3.05 REPAIR OF GALVANIZING

- A. Galvanizing shall be repaired at all welds, scarred areas, and rust spots in accordance with Section 05035, Galvanizing.

### 3.06 CONSTRUCTION GUIDELINES

- A. Do not use deck units as a working platform or storage area until units are permanently attached in position.
- B. Construction loads shall not exceed the load carrying capacity of the deck.
- C. All units damaged during construction shall be repaired or replaced by the Contractor.

- END OF SECTION -

## SECTION 05425

### PRE-ENGINEERED COLD-FORMED STEEL TRUSSES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all materials, labor and services for the design, delivery, handling, storing and erecting of cold-formed steel trusses in accordance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 – Metal Materials
- B. Section 05035 – Galvanizing
- C. Section 05050 – Metal Fastening
- D. Section 05300 – Metal Decking

##### 1.03 REFERENCE STANDARDS

- A. AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute.
- B. AISI S200 – North American Standard for Cold-Formed Steel Framing – General Provisions.
- C. AISI S214 - North American Standard for Cold-Formed Steel Framing - Truss Design.
- D. AISI - Practice Guide - CF05-1: Code of Standard Practice for Cold-Formed Steel Structural Framing
- E. ASTM A 370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
- F. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- G. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- H. LGSEA - Field Installation Guide for Cold-Formed Steel Trusses; Light Gauge Steel Engineers Association.

- I. LGSEA 551d - Design Guide for Construction Bracing of Cold-Formed Steel Trusses; Light Gauge Steel Engineers Association.
- J. LGSEA 551e - Design Guide for Permanent Bracing of Cold-Formed Steel Trusses; Light Gauge Steel Engineers Association.

#### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:
  - 1. Product Data: Truss Component Manufacturer's descriptive literature for each item of cold-formed metal framing and each accessory specified in this section.
  - 2. Shop Drawings signed and sealed by a Professional Engineer registered in the State of California: Detailed drawings including:
    - a. Special components and installations not fully detailed in product data.
    - b. Layout placement drawings with the number, types, location, and spacing of trusses, diagonal bracing, blocking, and other framing members.
    - c. Indicate details of truss loading, reactions, uplifts, support locations, material sizes and gauges, finish, permanent truss diagonal bracing and/or blocking, truss to truss connections, truss to structure connections, and splices as required for a complete installation.
  - 3. Design Data: Results of design analysis, bearing the seal and signature of Truss Design Engineer who is registered in the State of California. Design Data shall include but not limited to:
    - a. Description of design criteria.
    - b. Engineering analysis depicting member stresses and truss deflection.
    - c. Truss member sizes and thickness and connections at truss joints.
    - d. Truss support reactions and connections to structure.
    - e. Top chord, Bottom chord and Web bracing requirements.
  - 4. Installation Instructions: Truss Component Manufacturer's printed instructions for handling, storage, and installation of each item of cold-formed metal framing and each accessory specified in this section.

#### 1.05 QUALITY ASSURANCE

- A. All materials, workmanship and production methods shall be in accordance with standards in the industry.

B. Pre-Installation Meeting: Prior to the scheduled beginning of installation, attendees must meet at job site to review requirements:

1. Attendees: Require attendance by representatives of the following:
  - a. Truss Fabricator, if requested by installer.
  - b. Installer of this section.
  - c. Other entities directly affecting, or affected by, construction activities of this section, including but not limited to, the following:
    - 1) Installer of truss support framing.
    - 2) Installer of mechanical systems.
    - 3) Installer of electrical systems.
2. Review potential interface conflicts; coordinate layout and support provisions.

#### 1.06 QUALIFICATIONS

- A. The Truss Fabricator shall be a specialist in assembly of trusses with at least 5 years of experience in production of Cold-Formed Steel Trusses.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. Acceptable Truss Component Manufacturers: Alpine TrusSteel Products, a division of ITW Building Components Group Inc: [www.trussteel.com](http://www.trussteel.com), Aegis Metal Framing, LLC ULTRA-SPAN®: [www.aegismetalframing.com](http://www.aegismetalframing.com), or equal.

#### 2.02 MATERIALS

- A. For all chord and web members: Fabricate components of structural quality steel sheet per ASTM A653 with a minimum yield strength of 50,000 psi.
- B. Bracing, bridging and blocking members: Fabricate components of commercial quality steel sheet per ASTM A653 with a minimum yield strength of 33,000 psi.
- C. Fasteners Used in Fabricating Trusses: Corrosion-resistant plated finish screw fasteners recommended by Truss Component Manufacturer, bearing stamp of Truss Component Manufacturer for ready identification.
- D. Welding shall be in accordance with the provisions of AWS D1.1 and AWS D1.3.
- E. Finish: Provide components with protective zinc coating complying with ASTM A653, minimum G60 coating.



## PART 3 – EXECUTION

### 3.01 FABRICATION AND DESIGN

- A. Pre-Engineered Cold-Formed Steel Trusses: Truss component system by the Manufacturer; providing a complete horizontal framing system, ready for deck installation, meeting specified requirements.
1. Truss Type, Span, and Height: As indicated on drawings.
  2. Each truss shall be marked and labeled for identification.
  3. Comply with requirements of the California Building Code.
  4. Deflection Under All Loads: 1/120 th of span, maximum. Deflection Under Live Loads: 1/180 th of span, maximum.
  5. Shop fabricate in accordance with shop drawings, using jiggling systems to ensure consistent component placement and alignment of components, and to maintain specified tolerances; field fabrication is strictly prohibited unless performed by authorized Truss Fabricator using Truss Fabricator's shop assemblers and proper jiggling systems.
  6. Shop fabrication of other cold-formed steel framing components into assemblies prior to erection is permitted; fabricate assemblies in accordance with shop drawings.
  7. Fasten connections within truss assembly with Truss Component Manufacturer's screws only and as shown on the shop drawings; welding and other fasteners are prohibited.
  8. Fabricate straight, level, and true, without rack, and to following tolerances:
    - a. Trusses up to 30 feet long: Maximum 1/2 inch variation from design length.
    - b. Trusses over 30 feet long: Maximum 3/4 inch variation from design length.
    - c. Trusses up to 5 feet high: Maximum 1/4 inch variation from design height.
    - d. Trusses over 5 feet high: Maximum 1/2 inch variation from design height.

### 3.02 DELIVERY AND STORAGE

- A. Handle, transport and store trusses in a manner to prevent distortion or damage affecting their structural integrity. Store all items off the ground in a well drained location protected from the weather and easily accessible for inspection and handling.
- B. Any damaged trusses shall not be accepted.

### 3.02 INSTALLATION

- A. Install trusses in accordance with Truss Component Manufacturer's instructions and Truss Fabricator's shop drawings.
- B. Place components at spacings indicated on the shop drawings.
- C. Install permanent bracing and bridging before application of any loads.
- D. Install permanent bracing and bridging as shown in the Contract Documents and the Truss Fabricator's shop drawings.
- E. Removal, cutting, or alteration of any truss chord, web or bracing member in the field is prohibited, unless approved in advance in writing.
- F. Repair or replace damaged chords, webs, and complete trusses as directed and approved in writing in advance by the Truss Component Manufacturer.

### 3.03 FIELD QUALITY CONTROL

- A. Engineer will provide inspection service to inspect field connections; see Section 01400.

- END OF SECTION -

SECTION 05520  
HANDRAILS AND RAILINGS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all handrails and railings in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. California Building Code
  - 2. Aluminum Association Specifications for Aluminum Structures
  - 3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Complete fabrication and erection drawings of all metal work specified herein.
  - 2. Other submittals as required in accordance with Section 05010, Metal Materials and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for handrails and railings shall conform to Section 05010, Metal Materials, unless noted otherwise.

## 2.02 METAL FASTENING

- A. All welds and fasteners used in handrails and railings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

## 2.03 HANDRAILS AND RAILINGS

- A. General - Handrail systems shall consist of all railings, posts, toeboards, baseplates, anchors, and accessories required for a complete and rigid installation.
  - 1. All handrail systems shall be fabricated from extruded aluminum alloy 6061-T6 or 6105-T5, with Aluminum Association M12C22A41 finish, unless otherwise noted.
  - 2. Metal railings shall be fabricated from 1-1/2 inch Schedule 40 pipe. Metal railing support posts shall be fabricated from 1-1/2 inch Schedule 80 pipe.
  - 3. The centerline of the top guard rail shall be 42 inches above the walking surface for level rail. For stair rail, the centerline of the top guard rail shall be 42 inches above the leading edge of the tread nosing. Stair handrail shall be 34 inches above the leading edge of the tread nosing. See Standard Detail 0552000.
  - 4. Posts
    - a. Maximum horizontal spacing between posts for level rail shall be six feet.
    - b. Maximum horizontal spacing between posts for stair rail shall be five feet.
  - 5. All rail joints shall be finished flush and shall occur only at supports. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.
  - 6. Toeboards
    - a. Toeboards shall project 4-inches above the walking surface and shall not infringe on the minimum required walkway width.
    - b. Aluminum toeboards shall be extruded from aluminum alloy 6063-T6 unless otherwise noted.
    - c. Toeboards shall have a minimum thickness of 1/8" at any point. Geometry of toeboard shall closely resemble geometry shown on Drawings.
  - 7. Expansion joint splices shall be provided at 30 foot maximum spacing and at all expansion joints in the structure supporting the handrail.
  - 8. The handrail system shall be designed to resist the design loads specified by both OSHA and the California Building Code.

9. Provide handrail extensions at top and bottom of stairs and ramps in accordance with the California Building Code.
- B. For metal handrail, the Contractor shall have the option of providing a handrail system of either an all welded type construction or a component type construction.
  1. With both the all welded or component type construction, the baseplates and toeboards shall be furnished as shown on the Drawings.
  2. Component Type System
    - a. All fittings and brackets shall be designed for stainless steel concealed set screws with internal tyne type connectors.
    - b. Exposed fittings shall be cast or extruded aluminum, or stainless steel to match ladder material, except where corrosion-resistant steel is employed as a standard fabricator's item for use.
    - c. Component type handrail shall be as manufactured by Thompson Fabricating Company, Inc., or Hollaender Manufacturing Company, Inc.
  3. Welded handrail may be field assembled using component type fittings as described herein.
- C. Handrail shall be either Type I or Type II handrail as shown on the Drawings. If no type is indicated on Drawings, handrail shall be Type I.
  1. Type I handrail shall be a two-rail system. The centerline of the intermediate rail shall be 21 inches above the walking surface.
  2. Type II handrail shall be a three-rail system with vertical posts spanning between the two intermediate rails.
    - a. The centerline of the lower intermediate rail shall be 7 inches above the walking surface.
    - b. The centerline of the upper intermediate rail shall be 5-3/4" below the centerline of the top rail.
    - c. Vertical posts spanning between the intermediate rails shall be 1/2" diameter schedule 40 pipe or fiberglass rod.
    - d. Spacing of vertical posts shall be as required to prevent passage of a 4-inch sphere at any point.
- D. Where gates are required in handrails as shown on the Drawings, they shall be self-closing and shall be provided by the same manufacturer as the handrail. Gates shall swing away from the opening being protected by the handrail.

- E. Where safety chains are required in handrails as shown on the Drawings, chains shall be constructed of Type 304 stainless steel. Chains shall be straight link style, 3/16-inch diameter, with at least twelve links per foot, and with snap hooks on each end. Snap hooks shall be boat type and eye bolts for attachment of chains shall be 3/8-inch bolts with 3/4-inch eye diameter welded to the railing posts. Two (2) chains, four inches longer than the anchorage spacing shall be supplied for each guarded area.

### PART 3 -- EXECUTION

#### 3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. Concrete anchors and bolts for attachment of handrail baseplates to supporting members shall conform to Section 05050, Metal Fastening.
- G. All fabricated items shall be shop painted in accordance with Section 09900, Painting.

#### 3.02 INSTALLATION

- A. Assembly and installation of handrails and railings shall be performed in strict accordance with manufacturer's recommendations.
- B. All handrails and railings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

## SECTION 05531

### GRATINGS, ACCESS HATCHES, AND ACCESS DOORS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all gratings, floor plates, and hatches in accordance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
  - 1. California Building Code
  - 2. Aluminum Association Specifications for Aluminum Structures
  - 3. Occupational Safety and Health Administration (OSHA) Regulations

##### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Complete fabrication and erection Drawings of all gratings, access hatches, and access doors specified herein.
  - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

#### PART 2 -- PRODUCTS

060515BR

## 2.01 METAL MATERIALS

- A. Metal materials used for gratings, floor plates, and hatches shall conform to Section 05010, Metal Materials, unless noted otherwise.

## 2.02 METAL FASTENING

- A. All welds and fasteners used for gratings, floor plates, and hatches shall conform to Section 05050, Metal Fastening, unless noted otherwise.

## 2.03 GRATING

- A. General - Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.

1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.
2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.
3. Grating shall be designed for a loading of 150 psf unless otherwise required by the Drawings. Grating deflection shall not exceed 1/4 inch under a uniform load of 100 psf. Minimum grating depth shall be 1-1/2 inches, unless structural requirements based on clear span require more depth.
4. Grating installed in cast-in-place concrete shall be provided with embedded support frames on all perimeter and bearing edges. Support frames shall include anchor straps or headed studs at a maximum of 18" on-center, a minimum of two each side. Support frames shall be fabricated from the same material as the grating.

### B. Aluminum Grating

1. Aluminum grating shall be of I-bar type and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.
2. Grating shall be "19-SI-4 I-Bar Swage Locked" by Alabama Metal Industries Corporation (AMICO), "IB" by Harsco Industrial IKG, "I-Bar 19SGI4", by Ohio Grating Inc., or "I-Bar" by Thompson Fabricating LLC.

### C. Aluminum Plank Grating



1. Aluminum plank grating shall be unpunched planks of extruded aluminum welded together to form panels. Panel ends shall have an extruded aluminum end bar welded in place. All support members shall be aluminum. Plank clips for grating holdowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.
2. Aluminum plank grating shall be HD-P manufactured by Harsco Industrial IKG., Heavy Duty Series manufactured by Ohio Gratings, Inc., or Unpunched Duo-Grip Extruded Series manufactured by Alabama Metal Industries Corporation (AMICO).

D. Heavy Duty Steel Grating

1. Heavy duty steel grating shall be galvanized according to Section 05035, Galvanizing.
2. Main bearing bars shall conform to ASTM A36. Cross bars shall be flush with the top of the grating. Provide embedded galvanized steel support frames for cast-in-place concrete installations.
3. Grating span shall be 36 inches maximum and shall satisfy AASHTO loading for H-20 truck.
4. Grating shall be manufactured by Harsco Industrial IKG, Alabama Metal Industries Corporation (AMICO), and Ohio Gratings, Inc.

2.04 ACCESS HATCHES

- A. Access hatches shall be aluminum unless noted otherwise.
- B. All access hatches shall be checker plate with an approved raised pattern, non-skid surface.
- C. Access hatches shall be designed to carry a minimum live load of 150 psf, or a concentrated load of 300 pounds at the center, whichever produces the greatest stress.
- D. Access hatches shall not exceed an allowable fiber stress of 16,000 psi. Live load deflection shall be limited to  $L/240$  of the span, but not more than 1/4-inch.
- E. All access hatches shall be fabricated from 1/4" plate, minimum and shall be stiffened as required to maintain allowable stress and deflection requirements specified herein. Stiffeners shall consist of angles or bars welded to the bottom of the plate.
- F. Hinges, where indicated on the Drawings, shall be insulated, heavy-duty, cadmium plated bronze with stainless steel pins and fasteners.
- G. All access hatches as indicated on the Drawings shall be provided with recessed handles. Handle material shall be as shown on the Contract Drawings.

- H. Air-tight and water-tight access hatches shall be provided with a 1/8 inch thick neoprene gasket between the checkered plate and the support frame. Gasket material shall be bonded to the support frame and access hatches shall be bolted to the structural support frame with countersunk stainless steel flathead screws.

## 2.05 ACCESS DOORS

### A. General

1. Door opening sizes, number and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the clear opening dimensions.
2. All doors shall be aluminum unless otherwise noted.
3. Openings larger than 42 inches in either direction shall have double leaf doors.
4. Doors shall be designed for flush mounting and for easy opening from both inside and outside.
5. All doors shall be provided with an automatic hold-open arm with release handle.
6. Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.
7. A stainless steel slam lock with fixed turn handle shall be mounted on the underside of the cover. A removable exterior latch handle shall be provided, and the latch release shall be protected by a flush gasketed removable screw plug. The doors shall have a lift handle that is designed to be flush with the walking surface when not in use. A recessed vandal proof padlock hasp with cover shall be provided for all exterior doors.
8. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be stainless steel.
9. All doors shall be watertight with a continuous gasket. All single door applications shall include a continuous EPDM odor reduction gasket.
10. Door frames shall be extruded and equipped with a 1-1/2 inch minimum drain pipe located by the manufacturer. The drain pipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.

### B. Floor, Wet Well and Dry Pit Access Doors

1. Door leaves shall be 1/4 inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain

allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.

2. Access doors designated Traffic Rated in the plans, or to be installed outside within driveways, sidewalks, street ROW, etc., shall be designed to withstand AASHTO H-20 wheel loading with a maximum deflection of 1/150th of the span. Access doors designated Non-Traffic Rated in the plans or to be installed inside a building or planter area where vehicular traffic is not probable, shall be designed to withstand a live load of 300 pounds per square foot with a maximum deflection of 1/150 of the span.
3. Doors shall be designed for flush mounting and for easy opening from both inside and outside.
4. All doors shall have an enclosed compression spring assist and open to 90 degrees.
5. Exterior doors shall be Type "J-AL" or "JD-AL", by Bilco Company, Type "W1S" or "W2S" by Halliday Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., Type "THG" or "THG-D", by Thompson Fabricating LLC.
6. Interior doors shall be Type "K" or "KD", by Bilco Company, Type "S1S" or "S2S" by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., Type "TH" or "TH-D", by Thompson Fabricating LLC.
7. Doors rated for H-20 traffic loading shall be "JAL-HD" or "JDAL-HD" by the Bilco Company, Type "H1C" or "H2C" by Halliday Products, Inc., or Type "THS" or "THD" by U.S.F. Fabrication Inc.

#### C. Roof Access Doors

1. Doors shall be designed for 50 psf live load unless noted otherwise.
2. Doors for service stairs shall be Bilco Type L roof Scuttles.
3. Doors for ladder access shall be Bilco Type S or SS Roof Scuttles.

#### D. Fixed Ladders

1. Where the Contract Documents indicate fixed ladders are required under access doors, they shall be provided with "LadderUp, Model LU-4" by Bilco Company, "L1E Ladder Extension" by Halliday Products Inc., or "Ladder Climb-out Device" by Thompson Fabricating.
2. The safety posts shall be manufactured of the same material as the access door with telescoping tubular sections that lock automatically when fully extended.
3. Upward and downward movement shall be controlled by a stainless steel balancing mechanism.

4. Safety posts shall be assembled in strict accordance with manufacturer's recommendations.

## 2.06 FALL THROUGH PREVENTION SYSTEM

- A. All access hatches and access doors covering openings measuring 12 inches or more in its least dimension through which persons may fall shall be equipped with a fall through prevention system, except where noted on the Contract Drawings. Access hatches and access doors shall be provided with a permanent installed fall through prevention grate system that provides continuous safety assurance in both its closed and open positions. The grate system shall be made with 6061-T6 aluminum or FRP and be designed for a 300 psf minimum live load, unless noted otherwise.

## PART 3 -- EXECUTION

### 3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

### 3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

- B. All gratings, access hatches, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions. Embedded support frames shall be set level and square.
- C. Grating shall not be field cut or modified unless approved by Engineer.
- D. Grating shall not be used for equipment support or anchorage.

- END OF SECTION -

## SECTION 05540

### CASTINGS

#### PART 1 -- GENERAL

##### 1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all castings in accordance with the requirements of the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02604 – Utility Structures
- B. Section 05010 - Metal Materials

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- 1. California Building Code

##### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
  - 1. Complete fabrication and erection drawings of all castings specified herein.
  - 2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

#### PART 2 -- PRODUCTS

##### 2.01 METAL MATERIALS

- A. Metal materials used for castings shall conform to Section 05010, Metal Materials, unless noted otherwise.

##### 2.02 METAL FASTENING

- A. All welds and fasteners used for castings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

## 2.03 IRON CASTINGS

- A. General - Iron Castings shall include, but not be limited to frames, covers, and grates for trench drains, catch basins, and inlets/.
  - 1. Castings shall be of gray iron of uniform quality, free from defects, smooth and well cleaned by shotblasting.
  - 2. Catalog numbers on the Drawings are provided only to show required types and configuration. All covers shall be cast with raised letters as designated on the Drawings.
  - 3. Castings shall be as manufactured by Dewey Brothers, or Neenah Foundry Company.
- B. Covers and Grates
  - 1. Covers and grates shall be provided with matching frames. Cover shall fit flush with the surrounding finished surface. The cover shall not rock or rattle when loading is applied.
  - 2. Round covers and frames shall have machined bearing surfaces.
  - 3. Design loadings:
    - a. Where located within a structure, a minimum design loading of 300 psf shall be used, unless noted otherwise.
    - b. At all locations not within a structure, the design loading shall be a standard AASHTO H-20 truck loading, unless otherwise noted.
- C. Watertight gasketing, bolting, locking devices, patterns, lettering, pickholes, vents, or self-sealing features shall be as detailed on the Drawings.

## PART 3 -- EXECUTION

### 3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

- C. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

### 3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All castings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -



SECTION 06100  
ROUGH CARPENTRY

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on the Drawings and specified herein.
- B. Principal items of work include:
  - 1. Wood plates, studs, joist, rafters, blocking, nailers, grounds, furring, ties, centering, etc., necessary or required for attachment or support of work under this Section, and other Sections.
  - 2. Plywood and other manufactured boards.
  - 3 Fasteners, including nails, screws, bolts, anchors and other fastenings, required to secure work under this Section.
  - 4. Temporary enclosures and protective boarding.
  - 5. Wood preservative treatment for all wood members in contact with roofing, masonry, concrete, and exposed to the elements.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
  - 1.     AWPA-CA     Preservative Standards, Lumber and Plywood.
  - 2.     AWPA-C20    Structural Lumber Fire-Retardant Treatment by Pressure Process.
  - 3.     AWPC-C27    Plywood Fire-Retardant Treatment by Pressure Process.
  - 4.     AWPA-M4     Standards for Care of Preservative Treated Wood Products.
  - 5.     APA          Guide to Plywood Grades.
  - 6.     WCLIB       Standard Grading and Dressing Rules No. 16 of the West Coast Lumber Inspection Bureau
  - 7.     WWPAStandard Grading Rules for Western Lumber, Western Wood Products Association.

### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Certifications of Preservative and Fire Retardant Treatment.
  - 2. Warranty of treatment manufacturer.
  - 3. Certification of type and grade of lumber to be used.
  - 4. Certification of type, rating and conformance to APA Standards.
  - 5. Certification that all treatments meet requirements of California environmental regulations.
- B. Shop Drawings of fabricated wood trusses and other fabricated structural members or engineered products indicating materials, dimensions, details of construction, methods of fastening and erection details.
- C. Calculations for design glue-laminated beams, wood trusses, rafters, and joists signed by a Registered Professional Engineer in the State of California. Loads shall be calculated in accordance with the California State Building Code and in accordance with the Structural Drawings.
- D. Manufacturer's product data for rough hardware including metal framing devices, panel clips, bolts, screws, etc.

### 1.04 DELIVERY AND STORAGE

- A. Take all measures necessary to protect products against damage during delivery and storage.
- B. Store lumber in enclosed places in such a manner to provide ventilation and protection from the weather.

## PART 2 -- PRODUCTS

### 2.01 MATERIALS

- A. Blocking, nailers, grounds and the like: Douglas Fir - No. 3 or equal Dimension Lumber or Construction Grade, with a moisture content not to exceed 19%.
- B. Plates, blocking, and nailers in contact with masonry: Pressure treated.
- C. Plywood: Identified with APA Grade trademarks of the American Plywood Association, in thickness as shown on the Drawings.

1. Exterior: AC-EXT-APA where exposed to view or a finish is required, CD-EXT-APA where concealed.
  2. Interior: AC-INT-APA where exposed to view or a finish is required, CD-INT-APA where concealed.
- D. Structural Framing Lumber for Load Bearing Walls and Trusses: Douglas Fir No.1 or equal grade or better with fb = 1,500 pounds per square inch and E = 1,700,000 pounds per square inch, 19 percent moisture content.
- E. Fasteners: Provide clamps, connectors, straps, nails, bolts, screws, anchors, ties and other accessories and fasteners shown or required to properly secure all rough carpentry. Fasteners and accessories shall be stainless steel, galvanized, or other noncorrosive metal recommended for use.
- F. Wood Preservative Treatment: Pressure treatment in conformance with the American Wood Preservers' Association standard P5. Retention shall be in accordance with AWWA Standards and be a minimum of 0.40 pounds per cubic foot. Stamp each piece of treated wood with a trademark identifying the classification of the treatment or a certificate from the processor for each shipment.
- G. Fire Retardant Treatment: Fire-retardant lumber and plywood must have an Underwriters Laboratories stamp signifying a FR-S rating and certifying a 25 or less flame spread and smoke developed value, when tested in accordance to UL 723, ASTM E 84, and NFPA 255 "Tunnel Test", and when the test is extended for 20 additional minutes. Treatment formulation shall contain no halogens, sulfates, chlorides or ammonium phosphate. Smoke toxicity shall be no more than that of untreated wood.

### PART 3 -- EXECUTION

#### 3.01 COORDINATION

- A. Coordinate with all trades as to nailers, blocking, grounds and the like required for the attachment of their work and other items requiring same. Carry out all work as required to cooperate work of other trades.

#### 3.02 INSTALLATION

- A. Perform work in conformance manufacturer's recommendations and specifications, industry, national and local standards and codes.
- B. Layout, cut, fit and erect rough blocking, nailers, furring and other rough carpentry. Do cutting work in connection with carpentry and finish for other trades. Brace plumb and level all members in true alignment and rigidly secure in place with sufficient nails, spikes, screws and bolts. Defects which render any piece or part unable to serve its intended purpose shall be discarded or, cut out and replaced.
- C. Provide all bracing, supports and shoring required to support construction.

- D. Protect all masonry including edges of concrete platforms and similar items. Remove protective covering when directed. Take special precautions at masonry openings and corners of the building.
- E. Set all rough hardware, such as plates, spikes, bolts, nails, lag screws, lagging bolts, anchors, etc., as required to hold woodwork together or to anchor or secure it to other materials and construction.
- F. Provide wood grounds, nailing strips and similar items wherever necessary or required throughout the project for the support, proper erection or installation of the work and support of mirrors, cabinets, shelf cleats, base and similar items. Thoroughly secure in place by approved means.
- G. Secure wood grounds, nailing strips and similar items to metal plugs set in masonry, toggle or expansion bolts. Give the mason all necessary information to enable him to lay out correctly the location for metal wall plugs. Wood plugs will not be accepted.
- H. Construct joints to support dead loads, live loads, snow loads, wind loads, or combinations in conformance with "National Design Specifications for Stress Grade Lumber and its Fastenings", recommended by National Forest Products Association.
- I. Nailers and Blocking: Provide and secure wood nailers, blocking, for the reception of roof curbs, roofing, etc.
  - 1. Provide nailers of sizes, shapes and profiles indicated on the Drawings or as required. Provide with anchors as indicated, recommended or required for secure attachment.

### 3.03 TEMPORARY PROTECTION

- A. Provide and install all temporary protection in accordance with applicable provisions of the Contract Documents, OSHA regulations, and as follows:
  - 1. Temporary protection shall include wood doors, railings, protection of floor or roof openings, temporary partitions, and the like; adequately maintained in good repair during the life of the Contract.
  - 2. Furnish and set temporary partitions with wood doors at all exterior doorways, exterior openings or in locations exposed to weather. Substantially build and hang, with proper hinges, locks and other necessary hardware, and remove and reset whenever required to accommodate the Work and keep in good repair.
  - 3. Provide substantial temporary wood covering or guards for openings left in floor or roof slabs for ducts, shafts, etc., using rough planking at least 2 inch thick, cleated together and otherwise made sufficiently strong and put in place wherever required immediately after the forms have been removed.

### 3.04 JOB CONDITIONS

- A. If the installation of metal frames and glass does not promptly follow the completion of the exterior enclosures, and if the absence of enclosures would cause damage, close in all such openings temporarily by the use of heavy polyethylene plastic sheeting, or canvas stretched over and nailed to frames of 1 inch x 2 inch or heavier strips.

### 3.05 REMOVAL OF TEMPORARY WORK

- A. Remove all temporary protection when so directed, or prior to acceptance of this project.

- END OF SECTION -

SECTION 07100  
WATERPROOFING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.
- B. Principal items of work include:
  - 1. Waterproofing on the exterior sides of walls below grade as shown on the Drawings.
  - 2. Crystalline waterproofing as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
  - 1. ASTM D146 Sampling and Testing Felted and Woven Fabrics Saturated with Bituminous Substances for Use in Waterproofing and Roofing
  - 2. ASTM D412 Tests for Rubber Properties in Tension
  - 3. ASTM E96 Tests for Water Vapor Transmission of Materials in Sheet Form

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturers product literature, specification data sheets and installation instructions.
  - 2. Samples of composite drainage panel and waterproofing.
  - 3. Complete layout and installation drawings and schedules with clearly indicated dimensions.

4. Detail drawings showing all anchoring details and construction details at corners, penetrations and flashing.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.
- B. Store materials in dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have been damaged and remove from the job site.

### PART 2 -- PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products manufactured by one of the following:
  1. Grace Construction Products.
  2. Carlyle Coating and Waterproofing
  3. Polyguard Products.

#### 2.02 PRODUCTS

- A. Waterproofing Membrane: Self-adhering membrane consisting of a minimum 56 mils of rubberized asphalt laminated to a minimum 4 mils of polyethylene to form a minimum of 60 mil membrane. Provide a cold-applied membrane which requires no special adhesives or heating equipment.
- B. Physical Properties

| PROPERTIES                   | TEST METHOD   | RESULT                      |
|------------------------------|---------------|-----------------------------|
| Pliability (@ -25 f)         | ASTM D-146    | No Effect                   |
| Tensile Strength Membrane    | ASTM D-412    | 250 psi min.                |
| Tensile Strength Film        | ASTM D-412    | 4000 psi min.               |
| Elongation                   | ASTM D-412    | 300% min.                   |
| Puncture Resistance Membrane | ASTM E-154    | 40 lbs. min.                |
| Puncture Resistance Film     | ASTM D-781    | 250 in. oz. tear            |
| Permeance                    | ASTM E-96 (B) | 0.1 max. grains/sf/hr/in.Hg |
| Water Absorption             | ASTM D-570    | 0.2 max. (% by weight)      |

| PROPERTIES           | TEST METHOD | RESULT                  |
|----------------------|-------------|-------------------------|
| Adhesion to Concrete | ASTM D-903  | 5.0 lbs./in. width max. |

- C. Primer: As recommended by manufacturer.
- D. Mastic: As recommended by manufacturer. Use mastic to seal cut edge terminations.

## 2.03 COMPOSITE DRAINAGE PANEL

- A. Composite drainage panel: Three dimensional, high impact, polystyrene core with a nonwoven filter fabric bonded to the core. Provide an polymeric sheet adhered to the flat side of the polystyrene core. Extend filter fabric beyond the edges to provide total filtering integrity of the drainage system.

### B. Physical Properties

| PROPERTIES                            | TEST METHOD | RESULTS                          |
|---------------------------------------|-------------|----------------------------------|
| Compressive Strength (Core)           | ASTM D-1621 | 15,000 psf                       |
| Apparent Opening Size (Filter Fabric) | ASTM D-4751 | 100 United States Standard Sieve |
| Water Flow Rate (Filter Fabric)       | ASTM D-4491 | 150 gpm/ft                       |
| Water Flow (Composite System)         | ASTM D-4716 | 15 gpm/ft. width                 |

### C. Composite System Requirements

1. Provide one inch flange on longitudinal edge.
2. Bond filter fabric to each dimple of polymeric core.
3. Extend filter fabric beyond toe edge of polymeric core to provide total filtering integrity of the drainage system.
4. System shall be approved for use over waterproofing membrane.

## 2.04 CRYSTALLINE WATERPROOFING

- A. Crystalline Waterproofing: Concrete waterproofing material of the cementitious crystalline type that chemically and permanently fixes non-soluble crystalline growth throughout the capillary voids of the concrete. Apply at a rate of 2 lb./sq. yd. Apply second coat while first coat is still green. Crystalline waterproofing shall be as manufactured by Xypex Chemical Corporation, Vandex, HEY'DI K11 by Tamms, or equal.

## PART 3 -- EXECUTION



### 3.01 EXAMINATION OF SURFACES

- A. Examine all surfaces and installation of work done by other trades.
- B. Coordinate all work under this Section with contiguous work of other trades.

### 3.02 APPLICATION

- A. Install waterproofing membrane and composite drainage system in strict accordance with manufacturer's printed instructions and recommendations.
- B. Where drainage piping is shown on Drawings, extend systems to allow for proper drainage.
- C. Cover and seal all terminal edges. Cut systems and seal around penetrations.
- D. Crystalline waterproofing shall be applied to "green" or existing concrete which has been thoroughly saturated with clean water. Prepare surfaces in strict accordance with manufacturer's recommendations and instructions. Mix and apply in accordance with manufacturer's literature.
- E. Provide a written report from the Manufacturer's representative stating that the waterproofing membrane and composite drainage system were installed correctly.

- END OF SECTION -

## SECTION 07180

### LIQUID APPLIED WATER REPELLANTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENTS

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on the Drawings and specified herein.
- B. Principal items of work
  - 1. Seal all masonry exposed to exterior weather conditions.

##### 1.02 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturer's product data.
  - 2. Test reports confirming compliance with specifications.
  - 3. Certification that product meets State and Local VOC regulations.

##### 1.03 SHIPPING, HANDLING AND STORAGE

- A. Deliver material in manufacturer's original sealed containers.
- B. Store materials in such a way as to prevent any damage to container or product and protect from freezing temperatures.

#### PART 2 -- PRODUCTS

##### 2.01 ACCEPTABLE MANUFACTURERS

- A. L&M Construction Chemicals
- B. BASF Master Builder Solutions
- C. Tex-Cote
- D. Tnemec
- E. Prosoco

## 2.02 ACCEPTABLE MATERIALS

- A. Liquid applied water repellant shall be a clear penetrating, water based Silane and/or Siloxane product. Product shall meet State and Local VOC limits.

## 2.03 PERFORMANCE CRITERIA

- |                           |            |                      |
|---------------------------|------------|----------------------|
| A. Water Permeance        | ASTM E514  | 99% Improvement      |
| B. Moisture Vapor         |            |                      |
| Transmission Rate         | ASTM D1653 | 24.4 gm/sq ft/24 hrs |
| C. Freeze Thaw Resistance | ASTM C672  | No Scaling           |
| D. Resistance to chloride | Excellent  |                      |

## PART 3 -- EXECUTION

### 3.01 INSPECTION

- A. Verify that masonry surfaces are ready to receive water repellant. Report any unacceptable conditions to the Engineer and do not begin application until unacceptable conditions have been corrected.

### 3.02 SURFACE PREPARATION

- A. Alkali or efflorescence shall be removed or neutralized prior to application. Neutralizing shall be in accordance with manufacturer's recommendations.
- B. Caulking, glazing, painting and other materials shall be protected from damage prior to application.

### 3.03 APPLICATION

- A. Flood surface with water repellant as recommended by manufacturer. Apply material to assure that water repellant has soaked into surface and penetrated, hairline cracks and similar opening. Apply product at a minimum rate of 100 square feet per gallon.

### 3.04 CLEANING

- A. Clean windows, metals, caulking, and other materials not required to coated, which get coated, immediately in manner approved by manufacturer of item coated.

- END OF SECTION -

## SECTION 07190

### VAPOR BARRIER

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, material, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
  - 1. Vapor barrier below structural slabs on grade.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturer's data and installation instructions.

#### PART 2 -- PRODUCTS

##### 2.01 VAPOR BARRIER

- A. Vapor Barrier: A reinforced laminate membrane with a minimum tensile strength of 75 lbs/in. in accordance with ASTM D-882, vapor transmission rating of 0.02 perms in accordance with E-96, and a puncture resistance of 25 lbs in accordance with ASTM D-4833.
- B. Adhesive/Tape: Type approved by the Manufacturer of the vapor material.
- C. Penetration sealing: Provide manufacturer's recommended penetration seals at all pipe, conduit, and similar penetrations.

##### 2.02 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
  - 1. Viper Vapercheck 10 by Insulation Solutions, Inc.

2. Griffolyn Type-85, by Reef Industries, Inc.
3. Or Equal

### PART 3 -- EXECUTION

#### 3.01 VAPOR BARRIER

- A. Vapor barrier shall be placed on top of 4 inches minimum of compacted structural fill stone, free of debris and protrusions, as shown on the Drawings for structural slabs.
- B. Lap edges 12 inches and seal with adhesive tape. Lay with seams perpendicular to and lapped in the direction of placement. Do not penetrate vapor barrier.
- C. Protect from damage until concrete is placed. Punctures and tears in vapor barrier shall be repaired using patches of the material which overlaps puncture or tear a minimum of 12 inches; seal with tape or adhesive.
- D. Penetrations through vapor barrier, such as pipe, drains, conduits and similar penetrations, shall be sealed in strict accordance with manufacturer's recommended instructions.

- END OF SECTION -

SECTION 07210  
BUILDING INSULATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete
- B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications Work shall conform to applicable requirements of the following documents:
  - 1. HH-I-526C Insulation Board, Thermal (Mineral Fiber).
  - 2. HH-I-1972/1 Insulation Board, Thermal, Polyurethane or Polyisocyanurate, Faced with Aluminum Foil On one side.
  - 3. TT-S-001657 Sealing Compound Single Component, Butyl Rubber Based, Solvent Release Type (For Buildings and other Types of Construction).
  - 4. ASTM C 578 Specification for Preformed, Block Type Cellular Polystyrene Thermal Insulation
  - 5. ASTM C 665 Specification for Mineral fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturer's literature, specifications, installation instructions, technical data, and general recommendations.
  - 2. Samples of each type of insulation specified.

## 1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in unopened, undamaged original packaging with bearing the manufacturer's name.
- B. Store materials in clean, dry, protected areas. Do not leave materials exposed to the weather or sunlight, except to the extent necessary to perform the work.
- C. Protect against ignition.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the requirements, provide products as manufactured by the following:
  - 1. Manufacturers of Polyisocyanurate Foam Insulation
    - a. Apache Products Company.
    - b. Atlas Energy Products.
    - c. The Celotex Corporation.
  - 2. Manufacturers of Sprayed Polyurethane Foam (Gap Sealant):
    - a. The Dow Company
    - b. Or approved equal

### 2.02 MATERIALS

- A. Unit Masonry Insulation: Fill ungrouted cells of masonry with foamed in place two component thermal insulation. Insulation shall be a Class A material with an R value of 4.9 per inch. Provide masonry insulation as manufactured by CORE-FILL 500 as manufactured by Tailored Chemical Products, Hickory, NC, or acceptable equal.
- B. Roof Insulation: Provide a minimum of 2" polyisocyanurate insulation. Provide a minimum of two staggered layers, unless otherwise indicated. Roof insulation shall be approved by roofing manufacturer in accordance with the requirements of the roofing warranty. Roof insulation shall meet the requirements of a UL Class A and FM Class 1 roof. Insulation shall have an aged R-value of 5 per inch. Secure insulation as required by the roofing manufacturer to achieve an FM 90 installation. Install ½" glass faced gypsum board where insulation is installed over metal deck.
- C. Rock Wool Insulation: Semi-rigid boards for use as fire stop and wall insulation. Materials shall conform to requirements of UL penetration systems. Safing material shall meet the requirements of ASTM E-136.

- D. Adhesive and Fasteners: Type compatible with insulation, masonry, concrete, or other substrate and as recommended or produced by the insulation manufacturer.
- E. Sealer and Tape: Type recommended by insulation manufacturer and having perm rating and fire resistance characteristics similar to that of the insulation.
- F. Gap Sealant: General Purpose Type: single-component polyurethane sealant. Gun-applied and Straw-applied products, Thermal Value R3.5 per inch. Provide GREATSTUFF PRO™ Gaps & Cracks Insulating Foam Sealant as manufactured by The Dow Chemical Company or approved equal. Provide Substrate Cleaner as recommended by foam sealer manufacturer.

## PART 3 -- EXECUTION

### 3.01 GENERAL

- A. Insulation shall be provided in walls, slabs and ceilings and where shown on Drawings.

### 3.02 INSTALLATION OF INSULATION

- A. Install in accordance with the manufacturer's printed installation instructions to provide maximum sound and thermal benefits for material specified. Install to fill or cover voids. Cut neatly to snugly fit angles, corners and irregular areas and carefully wrapped around pipes, conduits, outlets, switches, beams, etc., to maintain continuity of insulation. Avoid gaps or bridges.
- B. Foundation and Under-Slab Insulation
  - 1. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Stagger vertical joints, except ends over line of expansion joints.
  - 2. On horizontal surfaces, set units level, unless otherwise noted.
- C. Cavity Wall Insulation
  - 1. On vertical surfaces of masonry adhere to inner wythe of block.
  - 2. Joints between insulation board units shall coincide with masonry joint reinforcing.
- D. Block Insulation: Install foamed in place two component thermal insulation in all ungrouted cells of masonry in exterior walls.
- E. Thermal Batt Insulation: Friction fit, with vapor barrier on the warm side, during Winter, of wall between conditioned and unconditioned rooms or spaces. Follow manufacturer's recommendations and instructions.



- F. Roofing Insulation: Install roofing insulation in accordance with insulation and roofing manufacturer printed instructions and recommendations.
- G. Safing Insulation: Install safing insulation in accordance with UL design requirements and in accordance with manufacturer's recommendations.
- H. Sprayed Polyurethane Foam: Install in strict accordance with manufacturer's recommendations. Separate final installation with code approved thermal barrier.
- I. Gap Sealant: Seal all gaps at perimeter of walls and penetrations and openings. Install in strict accordance with manufacturer's recommendations.

### 3.03 ADJUSTMENT AND CLEANING

- A. Adequately protect Work from damage resulting from subsequent construction operations. Replace damaged or soiled Work.

- END OF SECTION -

## SECTION 07415

### STANDING SEAM METAL ROOFING AND WALL PANELS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of work shown on Drawings and specified herein.
- B. Work includes:
  - 1. Standing seam metal roofing, wall panels, trim, flashing and accessories associated with a complete and weathertight roofing system and as indicated on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 07210 - Building Insulation
- B. Section 07600 - Flashing and Sheet Metal
- C. Section 07700 - Roof Specialties and Accessories
- D. Section 07900 – Joint Fillers, Sealants and Caulking

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:
  - 1. Drawings of proposed work, including fastener type and spacing, roof panels, support framing, flashing, snow retention system, and accessory details.
  - 2. Manufacturer's product data, specifications and installation instructions.
  - 3. Submit calculations signed by a professional engineer indicating loads, uplifts, spacing of clips, fasteners, snow retention system, and accessories. Calculations shall be project specific in accordance with ASCE 7.
  - 4. Submit certification that installer is authorized by manufacturer.
  - 5. Letter indicating that installer has installed "T-batten" roof for a minimum of 5 years and is approved by manufacturer to install "T-batten".
  - 6. Drawing showing spacing of fasteners and supports.

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7. Letter verifying that panels are factory roll formed.
8. Sample warranties.
9. Copy of 20-year Manufacturer's warranty.

#### 1.04 DESIGN CRITERIA

- A. Use the following standards and criteria where applicable in the structural design of the roof support system:
  1. California Building Code
  2. "Steel Construction Manual", American Institute of Steel Construction
  3. "Cold Formed Steel Design Manual", American Iron and Steel Institute
  4. ASCE 7 - Minimum Design Loads for Buildings and Other Structures
- B. Design Loads
  1. Design loads include live, snow, wind, earthquake and dead loads.
  2. Loads and combination of loads shall be as prescribed and recommended in the standards and codes listed above.
  3. Design roof to withstand 100 mph winds.
  4. Thermal expansion and contraction expected for this location.

#### 1.05 WARRANTY

- A. Roof and Wall Panels
  1. Exterior finish shall be warranted by the manufacturer for twenty years against blistering, peeling, cracking, flaking, checking and chipping.
  2. Color change and chalking shall be warranted for twenty years. Color change shall not exceed 5 NBS units per ASTM D 224. Chalking shall be not less than a rating of 8 per ASTM D 4214.
- B. Weathertightness
  1. Single Source manufacturer's roof system warranty including roof panels, fascia, trim flashing, penetrations, and other materials integral to the roof system, against leaks for a period of twenty years.
  2. No dollar limit.

- C. Provide all materials required by roofing manufacturer to obtain specified warranty whether or not specifically indicated.

#### 1.06 QUALITY ASSURANCE

- A. Manufacturer shall have been regularly engaged in the fabrication of metal standing seam roof systems for at least ten years.
- B. Installer shall be authorized by the Manufacturer as trained and qualified to erect the Manufacturer's product. Installer shall have a minimum of 5 years installing "T-batten" roof systems.
- C. Conduct a preroofing conference with the following attendees; Contractor, metal-roofing Contractor, metal roofing systems manufacturer's representative, all sub-Contractors whose work penetrates the roof, the Owner and Engineer.
- D. Metal roofing system manufacturer's representative will observe the installation of the roof system at the start of the project and as required by the manufacturer to ensure warranty provisions are adhered to. The manufacturer's representative will produce a report based on observations of the roofing system that indicates that the roofing system, trim, accessories have been installed in accordance with all requirements of the manufacturer. If any deficiencies in materials or installation are found during this inspection the deficiencies shall be corrected.
- E. System shall be tested in accordance with UL 580 or ASTM E 1592.

### PART 2 -- PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products from one of the following:
  - 1. IMETCO, Series 300
  - 2. Centria, SRS 3
  - 3. The Garland Company, R MER SPAN
  - 4. Or Equal

#### 2.02 PRODUCTS

- A. Standing Seam Roof Panels
  - 1. Smooth finished 0.040 Aluminum sheets factory finished with two coat, baked-on full-strength (70% resin) fluorocarbon coating system. Color shall be selected by the Owner.

2. Panels shall be 16" or 18" wide by length required to cover roof to minimize end laps.

#### B. Roof System

1. Structural standing seam incorporating with continuous "T" batten and secured to concealed anchor clips allowing unlimited thermal movement, and of configurations that will prevent entrance or passage of water.
2. Roof system shall comply with UL90 classification.
3. Fastening system shall allow the roof covering to move independently of any differential thermal movement by the framing system.
4. Provide interlocking batten cap with a plant applied, and non-hardening sealant. Mechanically lock or crimp seams during installation.
5. Seal panel termination and perimeter flashing with sealant approved by manufacturer.
6. Provide metal closures matching roof profile at ridge, headwall, rake, jamb and hip conditions.
7. Panels length shall be full length from factory. Field formed panels will not be allowed.
8. Coordinate structural support locations for wall and roof panels. Provide additional structural support, if required by panel manufacturer to resist required design loads.
9. Roof and wall panels shall be furnished in continuous lengths from ridge to eave of top of wall to bottom of wall panel.
10. Seam height will be a minimum of 2-3/8".

#### C. Trim System

1. Design trim to provide for expected movement of roof panels due to thermal expansion.
2. Use manufacturer's standard trim pieces, except where field formed pieces are recommended by the manufacturer.
3. Use .032 or .040 Aluminum trim with factory finish to match roof panels.
4. Concealed fasteners shall be used to the greatest extent possible. Where exposed fasteners are used, they shall be installed neatly and aligned with other fasteners in straight rows and lines and finished to match roof panels.

D. Roof Accessories

1. Use EPDM roof jacks with aluminum sealing ring for openings 12 inches in diameter or less. Do not use roof jacks where ribs are altered.
2. Provide .032 gutters and downspouts with a 20 year factory applied fluorocarbon finish. Color shall match roof panels. Gutters shall drain to downspout.
3. Underlayment: Provide underlayment over entire roof area. Underlayment shall be 40 mil self adhesive membrane. Underlayment may not be shown on drawings.

F. Fascia and Soffit Panels

1. Shall be interlocking flush panels with concealed fasteners. Panels shall be nominal 12" wide by 1" deep and of lengths required to complete work. Finish to match roof panels with 20 year warranty.

PART 3 -- EXECUTION

3.01 INSPECTION

- A. Manufacturer shall inspect conditions of structural system and work below. Verify that work is complete to a point where this work can commence and installation can be performed in accordance with the manufacturer's recommendations and instructions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions and approved shop drawings.
- B. Replace damaged or defective items.

- END OF SECTION -

## SECTION 07460

### FIBER CEMENT SIDING AND TRIM

#### PART 1 -- GENERAL

##### 1.01 SECTION INCLUDES

- A. Factory-finished fiber cement lap siding, panels, trim, fascia, moulding and accessories.

##### 1.02 RELATED SECTIONS

- A. Section 06100 - Rough Carpentry
- B. Section 07210 - Building Insulation

##### 1.03 REFERENCES

- A. ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test, Tool and Tape.
- B. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

##### 1.04 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- B. Shop Drawings: Provide detailed drawings of atypical non-standard applications of cementitious siding materials which are outside the scope of the standard details and specifications provided by the manufacturer.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each finish product specified, two samples, minimum size 4 by 6 inches (100 by 150 mm), representing actual product, color, and patterns.

##### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum of 2 years experience with installation of products.

- B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

- 1. Do not proceed with remaining work until workmanship, color, and sheen are approved by Engineer.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store siding on edge or lay flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

#### 1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### 1.08 WARRANTY

- A. Product Warranty: Limited product warranty against manufacturing defects.
  - 1. Siding for 30 years.
  - 2. Soffit panels for 25 years.
  - 3. Trim boards for 10 years.
- B. Finish Warranty: Limited product warranty against manufacturing finish defects.
  - 1. When used for its intended purpose, properly installed and maintained according to published installation instructions, for a period of 15 years from the date of purchase: will not peel; will not crack; and will not chip. Finish warranty includes the cost of labor and material.
- C. Workmanship Warranty: Application limited warranty for 2 years.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. James Hardie Building Products, Inc. (Basis of Design).
- B. CertainTeed



- C. Or equal.

## 2.02 SIDING

- A. Code Compliance Requirement for Materials:

1. National Evaluation Report No. NER 405 (BOCA, ICBO, SBCCI, IBC, IRC).
2. Non-asbestos fiber-cement siding where required to be non-combustible shall be tested in accordance with ASTM E136.

- B. Lap Siding: HardiePlank Lap as manufactured by James Hardie Building Products, Inc.

1. Type: Select Cedarmill, size as indicated on the Drawings.

- C. Siding Panel: Hardie Panel siding as manufactured by James Hardie Building Products, Inc.

1. Type: Smooth siding panel 4 feet by 8 feet (1219 mm by 2438 mm). Panel shall be cut to size indicated on drawing.

- D. Trim:

1. HardieTrim boards as manufactured by James Hardie Building Products, Inc. or equal.
2. Provide sizes shown or if not shown with a minimum thickness of 1" for trim pieces and 0.25" thick for soffit and other panels.

## 2.03 FASTENERS

- A. Fasteners as recommended by siding manufacturer.

## 2.04 WEATHER RESISTIVE BARRIER SYSTEM

- A. Moisture Air Barrier Sheet:

1. Product: HardieWrap Weather Barrier as manufactured by James Hardie Building Systems.
2. Composition: Non-woven, non-perforated polyolefin.
3. Film: MicroTech Coating with micropores to balance water holdout and breathability.
4. Thickness: 11 mil (0.28 mm).
5. UV Stability: Up to 180 days.

6. Water Holdout (AATCC127): 128 inches (3250 mm).
7. Breathability/ Water Vapor Permeance (ASTM E-96A): 15 perms.
8. Air Resistance (TAPPI T-460): >1800 sec/ 100 cc.
9. Tear Strength (ASTM D1117): 15 to 18 ob (6.8 to 8.2 kg).
10. Basis Weight: 19.4 lbs/ 1000 sf (9.5 kgs/ 100 sm).

## 2.05 FINISHES

### A. Factory Primer: Provide factory applied universal primer.

1. Primer: Manufacturer's standard factory applied primer.

### B. Factory Finish:

1. Product: ColorPlus Technology by James Hardie.
2. Definition: Factory applied finish; defined as a finish applied in the same facility and company that manufactures the siding substrate.
3. Process:
  - a. Factory applied finish by fiber cement manufacturer in a controlled environment within the fiber cement manufacturer's own facility utilizing a multi-coat, heat cured finish within one manufacturing process.
  - b. Each finish color must have documented color match to delta E of 0.5 or better between product lines, manufacturing lots or production runs as measured by photospectrometer and verified by third party.
4. Protection: Factory applied finish protection such as plastic laminate that is removed once siding is installed
5. Accessories: Complete finishing system includes pre-packaged touch-up kit provided by fiber cement manufacturer. Provide quantities as recommended by manufacturer.

### C. Factory Finish Color for Trim, Soffit and Siding Colors:

1. Colors shall be selected by Owner from manufacturer's full range of colors.

## PART 3 -- EXECUTION

### 3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If framing preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.
- C. Install water-resistive barriers and claddings to dry surfaces.
- D. Repair any punctures or tears in the water-resistive barrier prior to the installation of the siding.
- E. Protect siding from other trades.

### 3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.03 INSTALLATION- WEATHER BARRIER SYSTEM

- A. Moisture Air Barrier Sheet:
  - 1. Weather barrier shall be installed before window and door installation. Do not install on saturated sheathing. Weather barrier can become slippery and should not be used in any application where it may be walked on.
  - 2. Begin by affixing weather barrier extending at least 6 inches (152 mm) around a building corner. Unroll horizontally (with print side facing out) around the building covering rough window and door openings.
  - 3. Fasten to studs or nailable sheathing material with galvanized construction grade staples a maximum of 18 inches (457 mm) in the vertical and horizontal direction.
  - 4. Attach weather barrier so that it is taut and flat. The vertical overlap shall have a minimum of 6 inches (152 mm) and the vertical seam shall be taped.
  - 5. Assure that the bottom edge of the weather barrier extends over the sill plate and foundation interface by at least 1 inch (25 mm).
  - 6. Overlap upper layers of weather barrier (in shingle lap fashion) by a minimum of 6 inches below the horizontal edge, and tape the horizontal seam line.
  - 7. At roof to wall intersection (or wall to deck), affix wrap to the wall such that it overlaps any step flashing already in place on the wall by at least 2 inches (51 mm).

### 3.04 INSTALLATION – SIDING

- A. Install materials in strict accordance with manufacturer's installation instructions.
- B. Starting: Install a minimum 1/4 inch (6 mm) thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 1-1/4 inches (32 mm) wide laps at the top. The bottom edge of the first plank overlaps the starter strip.
- C. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- D. Align vertical joints of the planks over framing members.
- E. Maintain clearance between siding and adjacent finished grade.
- F. Locate splices at least one stud cavity away from window and door openings.
- G. Use off-stud metal joiner in strict accordance with manufacturer's installation instructions.
- H. Wind Resistance: Where a specified level of wind resistance is required lap siding is installed to framing members and secured with fasteners described in Table No. 2 in National Evaluation Service Report No. NER-405.

### 3.05 INSTALLATION - PANEL SIDING

- A. Install materials in strict accordance with manufacturer's installation instructions.
- B. Place fasteners no closer than 3/8 inch (9.5 mm) from panel edges and 2 inches (51 mm) from panel corners.
- C. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- D. Maintain clearance between siding and adjacent finished grade.
- E. Specific framing and fastener requirements refer to Tables 2 and 3 in National Evaluation Service Report No. NER-405.
- F. Factory Finish Touch Up: Apply touch up paint to cut edges in accordance with manufacturer's printed instructions.
  - 1. Touch-up nicks, scrapes, and nail heads in pre-finished siding using the manufacturer's touch-up kit pen.
  - 2. Touch-up of nails shall be performed after application, but before plastic protection wrap is removed to prevent spotting of touch-up finish.
  - 3. Use touch-up paint sparingly. If large areas require touch-up, replace the damaged area with new pre-finished siding. Match touch up color to siding color through use of manufacturer's branded touch-up kits.

### 3.06 INSTALLATION - TRIM BOARDS

- A. Install materials in strict accordance with manufacturer's installation instructions. Install flashing around all wall openings.
- B. Fasten through trim into structural framing, code complying sheathing, or furring. Fasteners must penetrate minimum 3/4 inch (19 mm) or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
- C. Place fasteners no closer than 3/4 inch (19 mm) and no further than 2 inches (51 mm) from side edge of trim board and no closer than 1 inch (25 mm) from end. Fasten maximum 16 inches (406 mm) on center.
- D. Maintain clearance between trim and adjacent finished grade.
- E. Trim inside corner with single board.
- F. Outside Corner Board: For 3/4 inch (19 mm) trim only. Install single board of outside corner board then align second corner board to outside edge of first corner board. Do not fasten board to board.
- G. Outside Corner Board: For 1 inch (25 mm) and 1-1/2 inches (38 mm) trim only. Pre-build corners by fastening trim together with 16 ga. corrosion resistant finish nail 1/2 inch (13 mm) from edge spaced 16 inches (406 mm) apart, weather cut each end spaced minimum 12 inches (305 mm) apart.
- H. Allow 1/8 inch gap between trim and siding.
- I. Seal gap with high quality, paint-able caulk.
- J. Shim frieze board as required to align with corner trim.
- K. Install fascia over structural subfascia.
- L. Overlay siding with moulding at windows, doors and inside corners.
- M. Fasten through overlapping boards. Do not nail between lap joints.

### 3.07 FINISHING

- A. Factory finish: Finish shall be manufacturer's standard coating system.

### 3.08 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

- END OF SECTION -

## SECTION 07600

### FLASHING AND SHEET METAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04200 - Unit Masonry
- B. Section 07415 – Standing Seam Metal Roofing
- C. Section 07900 - Joint Fillers, Sealants and Caulking

##### 1.03 REFERENCES SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
  - 1. OF-506C Flux, Soldering, Paste, and Liquid
  - 2. ASTM A176 Stainless and Heat-Resisting Chromium Steel Plate, Sheet and Strip
  - 3. ASTM B32 Specifications for Solder Metal
  - 4. ASTM D1187 Test Method for Asphalt-Base Emulsions for use as Protective Coatings for Metal
  - 5. "Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association.

##### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturer's literature and installation instructions.
  - 2. Complete layout and installation Drawings and schedules with clearly indicated dimensions.

3. Color samples.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in a clean dry protected area in such manner to preclude damage by denting, warping, or other distortion.

### PART 2 -- MATERIALS

#### 2.01 MATERIALS

- A. Metal Flashing
  1. Exposed to View: Provide prefinished 0.050 inches aluminum. Finish shall a full-strength Kynar 500 baked-on paint finish with a 20 year warranty.
  2. Concealed from View: Provide a minimum of 22 ga. galvanized. steel sheet, stainless steel sheet, or mill-finished aluminum sheet.
- B. Nails, screws, rivets, bolts and other fasteners: same material as sheet metal being attached. Nails shall be 18 gauge diameter shank, 1/4 inch diameter flat head, annular-thread, diamond point, long enough to penetrate backing by at least 1 inch. Nails shall be spaced 3 inches on center unless other spacing is indicated. Exposed fasteners shall match finish of metal being fastened.
- C. Reglets shall be formed of 300 series stainless steel, minimum of 0.020 inch. Reglets shall be Model CO for insertion in concrete, MA-4 for insertion in masonry as manufactured by FRY Reglet Corporation. Corners shall be factory made, mitered and sealed. Furnish reglets to proper trade in sufficient time to be incorporated into the masonry or concrete work.
- D. Plastic cement shall conform to ASTM D2822.
- E. Sealants shall be silicone type.
- F. Sealer tape shall be polyisobutylene tape specifically manufactured for setting flanges on bituminous roofing such as Morrison and Company CL-50.

### PART 3 -- EXECUTION

#### 3.01 FABRICATION

- A. Shop fabricate Work to greatest extent possible. Comply with details shown and applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry standards. Fabricate for waterproof and weather resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, and damage or deterioration of the work. Comply with material manufacturer's instructions and

recommendations for forming material. Form exposed work without excessive oil-canning, buckling and tool marks, true to line and levels as indicated, with exposed edges folded back to form hems.

- B. Roof penetration sheet metal work shall be provided and coordinated with the roofing system. The design and details shall conform to SMACNA "Architectural Sheet Metal Manual". Sheet metal items shall be built into roofing in strict accordance with the instructions of the roofing manufacturer.

- END OF SECTION -



## SECTION 07900

### JOINT FILLERS, SEALANTS AND CAULKING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for the complete execution of Work shown on the Drawings and specified herein.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03250 - Concrete Accessories
- B. Section 03290 - Joints in Concrete

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- 1. ASTM C-920 Elastomeric Joint Sealants
- 2. ASTM D-1056 Flexible Cellular Materials - Sponge or Expanded Rubber
- 3. SWRI Sealant and Caulking Guide Specification

##### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:
  - 1. Manufacturers literature and installation instructions.
  - 2. Color samples of each type of sealant.

##### 1.05 QUALITY ASSURANCE

- A. Applicator shall be a company specializing in the installation of sealants with a minimum of five years experience.

##### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in unopened labeled packages.

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- B. Store materials in location protected from freezing or damages.
- C. Reject and remove from the site materials within broken or damaged packaging.

## PART 2 -- PRODUCTS

### 2.01 MATERIALS

#### A. Sealants

1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 50% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or Sonolastic NP-2, Sonneborn, or DynaTrol II by Pecora Corporation.
  2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by BASF Construction Chemicals.
  3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by BASF Construction Chemicals.
  4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, Sonolastic Omni Plus by BASF Construction Chemicals.
  5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-20+ Silicone by Pecora Corporation, Sonneborn Sonolac by BASF Construction Chemicals.
  6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal.
  7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Deck-O-Seal by W.R. Meadows, Tammsflex by DuraJoint Concrete Accessories, or Synthacalk GC2+ by Pecora Corporation.
  8. Type 8: Nonsag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type 19, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, Sonolastic Ultra by BASF Construction Chemicals.
- B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.

- C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 2.00 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.
- D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.
- E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.
- F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

## PART 3 -- EXECUTION

### 3.01 QUALITY CONTROL

- A. Coordinate work with details shown on approved shop drawings prepared by other trades.
- B. Verify conditions in the field.
- C. Schedule work to follow closely the installation of other trades.
- D. Apply sealants and related items in temperatures and dry conditions recommended by the manufacturers.
- E. Do not paint sealant, unless recommended by sealant and paint manufacturer.

### 3.02 PREPARATION

- A. Protect finished surfaces adjoining by using masking tape or other suitable materials.
- B. Clean and prime joints before starting any caulking or sealing work.
- C. Thoroughly clean joints and spaces of mortar and other foreign materials. Cleaning agent shall be Xylol or similar non-contaminating solvent to remove any film from metal surfaces. Masonry or concrete surfaces shall be brushed or air jet cleaned.
- D. Joint Requirements
  - 1. All joints and spaces to be sealed in exterior work shall be less than 1/2 inch deep and not less than 1/4 inch wide. If joints in masonry are less than that specified herein, the mortar shall be cut out to the required width and depth. All joints and spaces to receive sealant shall be completely prepared and thoroughly dry before installation of sealant.
  - 2. Unless otherwise specified, joints and spaces which are open to a depth of 1/2 inch or greater shall be solidly filled with back-up material to within 1/4 inch of the surface. Back-up material shall be packed tightly and made continuous throughout the length of the joints. Bond breaker shall be applied as required. If joints are less than 1/4 inch deep, the back-up material may be omitted, a bond breaker substituted

and the joint completely filled with sealant. The back-up material shall not project beyond the 1/4 inch depth of the open space in any joint. The following width-to-depth ratio table shall be adhered to, unless otherwise recommended by manufacturer.

| Joint Width               | Sealant Depth |                |
|---------------------------|---------------|----------------|
|                           | Minimum       | Maximum        |
| ¼ inch                    | 1/4 inch      | 1/4 inch       |
| Over 1/4 inch to 1/2 inch | 1/4 inch      | Equal to width |
| Over 1/2 inch to 1 inch   | 1/2 inch      | Equal to width |
| Over 1 inch to 2 inch     | 1/2 inch      | 1/2 of width   |

### 3.03 APPLICATION

- A. Exercise care before, during, and after installation so as not to damage any material by tearing or puncturing. All finished work shall be approved before covering with any other material or construction.
- B. Apply sealant by an approved type of gun except where the use of a gun is not practicable, suitable hand tools shall be used. Avoid applying the compound to any surface outside of the joints or spaces to be sealed. Mask areas where required to prevent overlapping of sealant.
- C. All joints shall be waterproof and weathertight.
- D. Point sealed joints to make a slightly concave joint, the edges of which are flush with the surrounding surfaces. Exposed joints in the interior side of the door and other frames shall be neatly pointed flush or to match adjacent jointing work.
- E. Adjacent materials which have been soiled shall be cleaned immediately and the work left in neat and clean condition.
- F. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

### 3.04 ADJUSTMENT AND CLEANING

- A. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.
- B. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Engineer.

### 3.05 SCHEDULE

### Schedule of Sealants

| Application                                                                                                                                                                        | Sealant                          | Color                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------|
| Vertical and horizontal expansion and construction joints in concrete structures unless noted otherwise herein or on Drawings.                                                     | Type 1                           | To closely match adjacent surfaces or mortar and as selected by the Owner. |
| Vertical and horizontal joints bordered on both sides by masonry, precast concrete, natural stone or other porous building material, unless noted otherwise herein or on Drawings. | Type 2                           | To closely match adjacent surfaces or mortar and as selected by the Owner. |
| Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.              | Type 3                           | To closely match adjacent surfaces and as selected by the Owner.           |
| Masonry expansion and control joints less than 1¼" wide.                                                                                                                           | Type 2                           | To closely match adjacent surfaces and as selected by the Owner.           |
| Masonry expansion and control joints equal or greater than 1¼ inches wide and not to exceed 2".                                                                                    | Type 1                           | To closely match adjacent surfaces and as selected by the Owner.           |
| Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit.                                                                                               | Type 2 OR Type 3                 | To closely match adjacent surfaces and as selected by the Owner.           |
| Below thresholds.                                                                                                                                                                  | Type 6                           | Manufacturer's standard                                                    |
| Submerged in liquids. See Note 2.                                                                                                                                                  | Type 1                           | Manufacturer's standard                                                    |
| Submerged in liquids with high concentration of chlorine (> 2 ppm).                                                                                                                | Type 7                           | Manufacturer's standard                                                    |
| Horizontal Joints exposed to vehicular or pedestrian traffic.                                                                                                                      | Type 8                           | To closely match adjacent surfaces.                                        |
| Other joints indicated on the drawings or customarily sealed but not listed.                                                                                                       | Type recommended by manufacturer | To closely match adjacent surfaces and as selected by the Owner.           |

Note 1. Sealants which will come in contact with potable water shall meet the requirements of NSF 61.

Note 2. Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

-END OF SECTION -

SECTION 08110  
STEEL DOORS AND FRAMES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, material, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04200 - Unit Masonry
- B. Section 08710 - Finish Hardware
- D. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications, the work shall conform to the applicable requirements of the following documents:
  - 1. ANSI/DHI A115                      Series Specifications for Steel Door and Frame Preparation for Hardware
  - 2. ANSI/SDI 100                      Recommended Specifications: Standard Steel Doors and Frames
  - 3. ASTM A153                      Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - 4. ASTM A366/A 366M                      Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality
  - 5. ASTM A525                      Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
  - 6. ASTM E152                      Standard Methods of Fire Tests of Door Assemblies
  - 7. NFPA 80                      Standard for Fire Doors and Windows

#### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:
  - 1. Manufacturer's product data.
  - 2. Complete layout and installation drawings and schedules with clearly marked dimensions. Indicate details of construction, profiles, gauges, reinforcing and location of doors and frames.
  - 3. Certify that shop applied primer is compatible with finish coats specified in Section 09900, Painting.

#### 1.05 QUALITY ASSURANCE

- A. Comply with ANSI/SDI 100.
- B. Locations where fire-rated door and frame assemblies are required, provide assemblies which comply with NFPA 80 and have been tested and labeled in accordance with ASTM E152 by agency acceptable to governing authorities.
- C. Provide certificate or label for fire-rated doors which exceed sizes tested from a independent testing and inspection agency. Certificate or label shall indicate that door and frame assembly conforms to the requirements of the design.
- D. Provide stairwell doors which have temperature rise rating of 450 degrees F maximum in 30 minutes of fire exposure.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver products boxed or crated suitable for storage.
- B. Store products under cover, raised above ground level, and stacked to prevent warping and damage.
- C. Replace items damaged during delivery, storage, or handling.

### PART 2 -- PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
  - 1. Curries Company
  - 2. Amweld Building Products, Inc.

### 3. Steelcraft

#### 2.02 MATERIALS

- A. Steel Sheets: Commercial quality hot or cold rolled. Galvanize sheet steel in accordance with ASTM A525, commercial quality, A60 zinc coating, mill phosphatized.
- B. Anchorages: Galvanized steel, minimum 18 gauge.
- C. Fasteners and Inserts: Galvanized units standard with manufacturer.
- D. Primer: Rust-inhibitive coating, suitable to receive finish coatings specified in Section 09900, Painting.

#### 2.03 FABRICATION, GENERAL

- A. Shop-fabricate assemblies to greatest extent possible.
- B. Fabricate exterior and interior doors, frames and louvers from hot-dip galvanized steel.
- C. Where exposed screws and fasteners are used, provide countersunk, flat Phillips-head fasteners.
- D. Fabricate exterior, vestibule and other doors indicated to be insulated in the schedule with foam in place insulation. Door and frame assembly shall have a maximum calculated core U-Value of 0.10 BTU per hour per square foot per degree F in accordance with ASTM C518.
- E. Comply with ANSI/DHI A115 series specifications for door and frame hardware preparation. Prepare door and frame using final hardware schedule and templates from hardware supplier.
- F. Shop Painting
  - 1. Clean surfaces thoroughly before beginning painting operations, removing rust, scale, oil, grease and other contaminants.
  - 2. Apply primer evenly to provide full protection of all exposed surfaces.

#### 2.04 STEEL DOORS

- A. Provide doors of size and style indicated.
  - 1. Exterior Doors: SDI-100, Grade III, extra heavy-duty, Model 4, seamless, 16 gauge for doors less than four feet wide and 14 gauge for doors greater than four feet wide.
  - 2. Interior Doors: SDI 100, Grade II, heavy-duty, Model 3, seamless, 18 gauge for doors less than four feet wide and 16 gauge for doors greater than four feet wide.



- B. Provide top and bottom closures on all doors, weather tight cap on all exterior doors.
- C. Where indicated, provide doors with sightproof and weatherproof louvers formed of 24 gauge galvanized steel.

#### 2.05 STEEL DOOR FRAMES

- A. Fabricate door frames with mitered and welded corners.
- B. Provide concealed fastenings, unless otherwise indicated.
- C. Provide galvanized plaster guards or mortar boxes at back of finish hardware cutouts.
- D. Drill frames to receive three silencers on strike jamb of side swinging doors, and two silencers on heads of double doors, unless doors are to receive weatherstripping.
- E. Provide a minimum of three jamb anchors per jamb for doors 96 inches or less in height and one additional anchor for each additional 24 inches of height.

#### 2.06 STEEL WINDOW FRAMES

- A. Fabricate window frames with mitered and welded corners.
- B. Provide concealed fastenings, unless otherwise indicated.
- C. Provide window with removable stop and resilient gaskets for an airtight installation.
- E. Provide a minimum of jamb anchors 24 inches on center vertically at each jamb. Provide a minimum of 2 anchors per jamb.

#### 2.07 Glass

- F. Provide 1" insulated glass with tempered glass panes. Glass shall meet code required safety requirements.

### PART 3 -- EXECUTION

#### 3.01 INSTALLATION

- A. All doors and frames specified herein shall be neatly installed in designated locations indicated on Drawings.
- B. Install frames in accordance with SDI-105 and as herein specified.
- C. Install doors in accordance with SDI-100 and as herein specified.
- D. Install fire-rated doors and frames in accordance with NFPA 80.

### 3.02 PROTECTION AND CLEANING

- A. Provide protection against stains, dirt or damage to the finished installation. Adjust doors for proper operation.
- B. Immediately after erection and prior to finish painting, remove rusted or damaged prime coat and apply touch-up primer compatible with original primer and final coats.

- END OF SECTION -

SECTION 08710  
FINISH HARDWARE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 08110 – Steel Doors and Frames

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:
  - 1. ANSI/BHMA 156

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturers data for each item of hardware. Include installation and maintenance instructions.
  - 2. Furnish templates to fabricators of other work which is to receive hardware.
  - 3. Hardware schedule organized into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with shop drawings for other work, delivery schedules and similar information has been completed and accepted.
  - 4. Prepare a keying schedule in consultation with the Owner.

1.05 QUALITY ASSURANCE

- A. Provide materials, assemblies, equipment and services from a single source for each category except that locksets, latchsets and cylinders must originate from the same manufacturer.

- B. Replace any item of finish hardware which cannot be installed or will not function properly.
- C. Provide hardware complying with NFPA 80 and UL labeled for fire rated openings.
- D. Furnish templates or information to door and frame manufacturer. Coordinate between the manufacturers where two or more articles of hardware are to be mounted on the same door. Verify all dimensions, new and existing.
- E. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Handle, store, distribute, protect and install hardware in accordance with manufacturer's instructions or recommendations. Deliver packaged materials in original containers with seals unbroken and labels intact.
- B. Properly mark or label, so each piece of hardware is readily identifiable with the approved hardware schedule. Tag each change key or otherwise identifying the door of which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and hardware schedule.
- C. Provide secure storage area for hardware.

### PART 2 -- PRODUCTS

#### 2.01 MATERIALS AND FABRICATION

- A. Hand of Door
  - 1. Drawings show swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish hardware for proper installation and operation of door.
- B. Manufacturer's Name Plate
  - 1. Do not use manufacturer's products which have name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.
- C. Base Metals
  - 1. Produce hardware units of the basic metal and forming method indicated, using manufacturer's non-corrosive metal alloy, composition, temper and hardness but in no case of lesser quality material than specified.
- D. Fasteners

1. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self tapping sheet metal screws, except as specifically indicated.
2. Furnish stainless steel fasteners for installation with each hardware item. Exposed finish (under any condition) to match hardware finish or surfaces of adjacent work. Match the finish of adjacent work as closely as possible, including surfaces to receive painted finish.
3. Provide fasteners which are compatible with unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.

E. Tools for Maintenance

1. Furnish a complete set of specialized tools as needed for Owner's continued adjustment, maintenance, removal and replacement of builder's hardware.

F. Hardware Finishes

1. Stainless steel, US32D unless otherwise noted.
2. Closers shall have a USP finish unless otherwise noted.

G. Field Checks

1. Make periodic checks during installation of finish hardware to ascertain the correctness of the installation. After completion of the work, certify in writing, that all items of finish hardware have been installed, adjusted and are functioning in accordance with Specification requirements.

## 2.02 DESCRIPTION OF PRODUCTS

A. Hinges

1. Stainless steel full mortise concealed oil impregnated ball bearing type, five knuckle with non-rising pins for interior doors, and non-removable and non-rising pins for exterior doors. Tips shall be flat.
2. Sizes and weights of hinges:
  - a. Doors up to 36 inches – 4-1/2 inches regular weight.
  - b. Doors 36 inches to 40 inches – 5 inches regular weight.
  - c. Doors 40 inches to 48 inches – 5 inches heavy weight.
  - d. Fire Rated Doors up to 36 inches – 5 inches regular weight.

3. Provide three hinges per door leaf up to and including 90 inches and one additional hinge for each 30 inches of additional height.
4. Acceptable Manufacturers: Stanley Hardware, Hager Hardware

B. Keys and Keying

1. Provide construction keyed, removable core master key system as directed by the Owner.
2. Furnish five core removal keys and five master keys as directed by the Owner. Furnish a minimum of 10 change keys per cylinder.
3. Furnish cylinders keyed to Owners master key system.
5. Acceptable Manufacturers: Yale, Corbin\Russwin, Schlage

C. Panic Hardware

1. Heavy duty push bar exit device, U.L. labeled, with corrosive resistant construction.
2. ANSI A156.3, Grade 1.
3. Exterior trim to be lever type with return.
4. Type: mortise.
5. ANSI Function 08.
6. Acceptable manufacturer's: Von-Duprin, Adams Rite Manufacturing Company, Corbin/Russwin

D. Closers

1. Cast iron case with seamless one-piece forged steel spring tub.
2. Heavy duty forged steel arm.
3. Non-sized fully adjustable from size 1-6.
4. Backcheck intensity and location valves.
5. Delayed action closing.
6. Full metal cover.
7. Mechanical hold open device, except at fire rated doors.
8. ANSI 156.4, Grade 1.

9. Conforms to ADA 5 lbf. maximum door opening force requirement for non-fire rated interior doors.
10. Provide mounting brackets, and fasteners required for proper attachment.
11. Provide closers at fire rated doors.
12. Acceptable manufacturers: Corbin/Russwin, LCN, Norton

E. Automatic Flush Bolts

1. U.L. listed.
2. Forged brass or stainless steel construction, 1/2" diameter flattened bolt tip, 12" long rod.
3. Fully automatic.
4. Operation shall incorporate an override function.
5. Tested for a minimum of 100,000 cycles.
6. Provide dust proof strikes.
7. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

F. Coordinator

1. U.L. labeled and tested for 100,000 cycles.
2. Stop mounted, provide filler strips to fully cover stop.
3. Adjustable holding power and override feature.
4. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

G. Kickplates

1. Stainless steel, 0.050" thick, beveled 3 sides, 8" high, width 2 inches less than door width.
2. Acceptable manufacturers: H.B. Ives, Hager Hardware, and Builders Brass Works.

H. Thresholds

1. Extruded aluminum saddle type and fiberglass for opening with fiberglass door and frames. Provide with stainless steel fasteners. Six inches wide or as shown on drawings.

2. Acceptable manufacturers: Pemko, National Guard Products, Incorporated, and Zero International. Fiberglass threshold by fiberglass door and frame manufacturer.
- I. Door Bottom Seal
1. Extruded aluminum with neoprene seal.
  2. Acceptable manufacturers and products: Pemko Model 57, Zero International Model 328 and National Guard Products, Inc. Model 96.
- J. Weatherstripping
1. Extruded aluminum with neoprene seal.
  2. U.L. Labeled.
  3. Acceptable manufacturers and products: Pemko Model 294, National Guard Products, Inc. Model 190, and Zero International Model 328.

### PART 3 -- EXECUTION

#### 3.01 GENERAL

##### A. Templates

1. After the hardware schedule is approved furnish to the various manufacturers, required blueprint templates for fabrication purposes. Templates shall be made available not more than ten (10) days after receipt of the approved hardware schedule.

##### B. Packaging and Marking

1. Ship hardware with proper non-corrosive fastenings for secure application. Each package of hardware shall be legibly marked indicating the part of the work for which it is intended. Markings shall correspond with the item numbers shown on the approved hardware schedule. Keys shall be tagged within each package set and plainly marked on the face of the envelope with the key control number, door designation and all identification as necessary.

#### 3.02 INSTALLATION

- A. Install hardware in a manner which will eliminate cracks on surfaces.
- B. Mount hardware units at heights recommended in "Recommended Locations for Builders Hardware" by BHMA, except as otherwise indicated or required to comply with governing regulations.
- C. Install each hardware item in compliance with the manufacturer's instructions and



recommendations. Do not install surface-mounted items until finishes have been completed on the substrate.

- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as is necessary for proper installation and operation.
- E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with factory standards.
- F. Cut and fit thresholds and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
- G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.
- H. Set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture. Do not plug drainage holes or block weeps. Remove excess sealant.

### 3.03 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function. Lubricate moving parts as recommended by manufacturer. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application.
- B. Final Adjustment
  - 1. One week prior to acceptance or occupancy make a final check and adjustment of all hardware items. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices and compensate for final operation of heating and ventilating equipment.
- C. Instruct Owner personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

### 3.04 HARDWARE SETS

- A. The door hardware sets on the Drawings indicates functional and general requirements. Items shall be quality and finish as specified. Hardware set identification refers to set numbers indicated on the Drawings. Provide hardware required to meet Code requirements. Consult Drawings for set number required. Security hardware shall be coordinated with Security System Installer. All security devices shall be compatible and capable of communicating with fire alarm and other systems shown on Contract Drawings and Specifications.
- B. Hardware shall be as follows:

### Hardware Sets

1. Hinges  
Panic Device  
Overhead Door Closer Holder (each leaf)  
Automatic Flush Bolts  
Coordinator  
Kickplate  
Threshold  
Door Bottom Seal  
Weatherstripping  
Astragal w/Weatherstripping
2. Hinges  
Panic Device  
Door Closer  
Kickplate  
Threshold  
Door Bottom Seal  
Weatherstripping
3. Hinges  
Bathroom Lockset  
Kickplate

- END OF SECTION -

## SECTION 09900

### PAINTING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.
- B. Section Includes:
  - 1. Paint Materials
  - 2. Shop Painting
  - 3. Field Painting
    - a. Surface Preparation
    - b. Piping and Equipment Identification
    - c. Schedule of Colors
    - d. Work in Confined Spaces
    - e. OSHA Safety Colors

##### 1.02 RELATED SECTIONS

- A. Section 15030 - Piping and Equipment Identification Systems

##### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications the Work shall conform to the applicable requirements of the following documents:
  - 1. SSPC – The Society for Protective Coatings Standards
    - a. SSPC-Vis 1 Pictorial Surface Preparation Standards for Painting Steel Structures
    - b. SSPC-SP2 Hand Tool Cleaning
    - c. SSPC-SP3 Power Tool Cleaning

- d. SSPC-SP5 White Metal Blast Cleaning
  - e. SSPC-SP6 Commercial Blast Cleaning
  - f. SSPC-SP10 Near-White Metal Blast
  - g. SSPC-SP13/NACE6 Surface Preparation of Concrete
2. NACE - National Association of Corrosion Engineers
  3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus
  4. ASTM B117 - Method of Salt Spray (Fog) Testing
  5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser
  6. ASTM D3359 - Method for Measuring Adhesion by Tape Test

#### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  1. Manufacturer's literature and Material Safety Data Sheets for each product.
  2. Painting schedule identifying surface preparation and paint systems proposed. Cross-reference with Tables 9-1 and 9-2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.
  3. Certifications that painting materials are in compliance with local and state VOC regulations.

#### 1.05 SYSTEM DESCRIPTION

- A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenance.
- B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.

- C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.
- D. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

#### 1.06 QUALITY ASSURANCE

- A. Painting operations shall be accomplished by skilled craftsman and licensed by the state to perform painting work.
- B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

#### 1.07 STORAGE AND DELIVERY

- A. Bring materials to the job site in the original sealed and labeled containers.
- B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

### PART 2 -- MATERIALS

#### 2.01 GENERAL INFORMATION

- A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.
- B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.
- C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.

- D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.
- E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.
- F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.
- G. Where existing surfaces are to be coated existing coating systems shall be tested for compatibility with specified top coat. If existing coating is intact provide top coat as indicated in Table 9-1. Where surface prep removes existing coating system provide complete system shown in Table 9-1. Where existing coating and specified coating are not compatible provide barrier coat recommended by manufacturer and approved by the Engineer or provide alternate top coat recommended by manufacturer and approved by the Engineer or totally remove existing coating and provide system as shown in Table 9-1.

## 2.02 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
  - 1. Tnemec Company Inc.
  - 2. PPG
  - 3. CARBOLINE
  - 4. Sherwin-Williams

## PART 3 -- EXECUTION

### 3.01 SHOP PAINTING

- A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during

handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.

- B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.

### 3.02 SURFACE PREPARATION

#### A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.
2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.
3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.
4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.
5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.
6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.
7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

#### B. Metal Surface Preparation

1. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or

NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.

2. Perform blast cleaning operations for metal when following conditions exist:
  - a. Moisture is not present on the surface.
  - b. Relative humidity is below 80%.
  - c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.
  - d. Painting or drying of paint is not being performed in the area.
  - e. Equipment is in good operating condition.
  - f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.
3. Sandblast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.
4. Sandblast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service.
5. Sandblast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment.
6. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system.
7. Prime cleaned metals immediately after cleaning to prevent rusting.
8. Clean rusted metals down to bright metal by sandblasting and immediately field primed.

#### C. Concrete Surface Preparation

1. Cure concrete a minimum of 30 days before surface preparation, and painting begins.
2. Test concrete for moisture content using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.



3. Prepare concrete surfaces to receive coatings in accordance with SSPC-13 – Concrete Surface Preparation. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall be similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.
4. Acid etch (Reference ASTM D 260) concrete floors to receive paint. Following method is a minimum requirement. Remove residual dust and dirt. Wet surface of concrete until surface is damp. Etch surface with 15% to 20% muriatic acid solution to produce a "medium sandpaper" texture. Do not allow acid solution to dry on concrete. Rinse concrete when bubbling action of the acid begins to subside. Continue rinsing process until pH is 7 or higher. Remove excess water and allow concrete to thoroughly dry before coating. Other methods may be used, if approved by Engineer.
5. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.
6. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.
7. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

#### D. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.
2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

#### E. Masonry

1. Cure for a minimum of 30 days prior to paint application.
2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.
3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

#### F. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.
2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.
3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.
4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.
5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

#### 3.03 APPLICATION OF PAINT

- A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.
- B. Apply paint without runs, sags, thin spots, or unacceptable marks.
- C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.
- D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.
- E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.
- F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.
- G. Suspend painting when any of the following conditions exist:
  1. Rainy or excessively damp weather.
  2. Relative humidity exceeds 85%.

3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.
4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.
5. Surface temperature of item is within 5 degrees of dewpoint.
6. Dew or moisture condensation are anticipated.
7. Surface temperature exceeds the manufacturer's recommendations.

### 3.04 INSPECTION

- A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.
- B. Use magnetic dry film thickness gauges and wet film thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.
- C. Coatings shall pass a holiday detector test.
- D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.
- E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.
  1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Razor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.

- F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

### 3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

- A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.
- B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

### 3.06 PIPING AND EQUIPMENT IDENTIFICATION

- A. Piping and equipment identification shall be in accordance with Section 15030, Piping and Equipment Identification Systems.

### 3.07 SCHEDULE OF COLORS

- A. Match colors indicated. Piping and equipment colors are indicated in Section 15030. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

### 3.08 WORK IN CONFINED SPACES

- A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state and local regulations at all times.

### 3.09 OSHA SAFETY COLORS

- A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not exceed 2-feet wide by 3-feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.
- B. Paint hazardous areas and objects in accordance with OSHA regulations.

**TABLE 9-1**  
**PAINTING SCHEDULE**

| SURFACE                                                                                      | APPLICATION                                                             | PAINTING SYSTEM &<br>NO. OF COATS                                                                  | PRODUCT<br>REFERENCE<br>(TABLE 9.2) | TOTAL MIN.<br>DRY FILM<br>THICKNESS<br>(MILS) |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------------|-----------------------------------------------|
| <u>Concrete and Masonry</u>                                                                  |                                                                         |                                                                                                    |                                     |                                               |
| Interior masonry and<br>concrete walls and ceilings                                          | All locations                                                           | 1 coat sealer<br>2 coats acrylic epoxy                                                             | 101<br>116                          | 75-85<br>sq.ft./gal.<br>4-6/coat              |
| <u>Metals</u>                                                                                |                                                                         |                                                                                                    |                                     |                                               |
| Interior and exterior<br>nonsubmerged (gloss)                                                | All blowers, pumps,<br>motors and mechanical<br>equipment, piping, etc. | 1 coat epoxy polyamide<br>primer<br><br>1 coat epoxy polyamide<br>1 coat aliphatic<br>polyurethane | 104<br><br>102<br>115               | 4-6<br><br>4-6<br>3-5                         |
| Submerged Wastewater                                                                         |                                                                         | 2 coats high solids epoxy                                                                          | 119                                 | 8-10/coat                                     |
| Steel doors, windows and<br>door frames, steel stairs,<br>monorails, misc. metals<br>(steel) | All locations                                                           | 1 coat epoxy polyamide<br><br>1 coat aliphatic<br>polyurethane                                     | 102<br><br>115                      | 5-8<br><br>3-4                                |
| Aluminum surfaces in<br>contact with concrete                                                | All locations                                                           | 2 coats coal tar                                                                                   | 107                                 | 26                                            |
| Structural Steel                                                                             | All locations including<br>trusses                                      | 2 coats epoxy polyamide                                                                            | 102                                 | 4-6/coat                                      |
| Other:<br>Gypsum Wall Board and<br>Cement Fiber Trim                                         | All locations                                                           | 2 coats acrylic                                                                                    | 108                                 | 2-3/coat                                      |

TABLE 9-2

PRODUCT LISTING

(Manufacturer shall substitute equal products where listed product does not meet local VOC limits.  
Equal products shall provide equal or better performance)

| REF. | SYSTEM                  | PURPOSE                         | PRODUCT              |                 |                     |                                                 |
|------|-------------------------|---------------------------------|----------------------|-----------------|---------------------|-------------------------------------------------|
|      |                         |                                 | <u>Tnemec Series</u> | <u>PPG</u>      | <u>CARBOLINE</u>    | <u>Sherwin-Williams</u>                         |
| 101  | Acrylic filler          | Primer-sealer                   | 54                   | BLOXFIL 4000    | Sanitile 100        | Cement-Plex 875                                 |
| 102  | Epoxy polyamide         | Finish coat semi-gloss or gloss | 49                   | AMERLOCK 2/400  | Carboguard 890      | Macropoxy 646 - 100                             |
| 103  | Acrylic                 | Sealer                          | 1026                 | PITT TECH PLUS  | Carbocrylic 3359DTM | Solo Acrylic                                    |
| 104  | Epoxy Polyamide – metal | Primer                          | L69                  | AMERCOAT 385    | Carboguard 893SG    | Macropoxy 646 – 100                             |
| 105  | Epoxy                   | Primer/Finish                   | L140                 | AMERLOCK 2      | Carboguard 561/56LT | Macropoxy 5500                                  |
| 106  | Elastomeric Acrylic     | Primer/Finish                   | 157                  | ---             | ---                 | ---                                             |
| 107  | Coal tar                | Sealer/Finish                   | 46-465               | AMERCOAT 78HB   | Bitumastic 300M     | Targuard Coal Tar Epoxy Low VOC                 |
| 108  | Acrylic                 | Finish coat                     | 1029                 | DEVGUARD 4308   | Carbocoat 8215      | Pro Industrial Acrylic                          |
| 109  | Acrylic                 | Finish coat                     | 1029                 | DEVGUARD 4308   | Carbocoat 8215      | Pro Industrial Acrylic                          |
| 110  | Epoxy polyamide         | Primer                          | L69                  | AMERCOAT 385    | Carboguard 893SG    | Macropoxy 646 - 100                             |
| 112  | Epoxy polyamide         | Sealer                          | L69                  | AMERCOAT 385    | Carboguard 893SG    | Macropoxy 646 - 100                             |
| 113  | Urethane                | Barrier coat                    | 135                  | AMERLOCK SEALER | Rustbond            | Macropoxy 5000                                  |
| 114  | Polyamine Epoxy         | Intermediate coat               | 104                  | AMERLOCK 385    | Carboguard 893SG    | Cor Cote HP                                     |
| 115  | Aliphatic Polyurethane  | Finish coat                     | 1095                 | AMERCOAT 450 HS | Carbothane 134HG    | Hi-Solids Polyurethane 100                      |
| 116  | Acrylic epoxy           | Finish coat                     | 280                  | AQUAPON WB      | Sanitile 255        | Pro Industrial Water-Based Catalyzed Epoxy, B73 |
| 117  | Epoxy block filler      | Sealer                          | 54-562               | AMERLOCK 400 BF | Sanitile 600        | Cement Plex 875                                 |
| 118  | Catalyzed epoxy         | Finish coat                     | 84                   | AMERLOCK 2/400  | Carboguard 890      | Macropoxy 646 -100                              |
| 119  | High solids epoxy       | Finish coat                     | 104                  | AMERLOCK 400    | Semstone 110        | Duraplate UHS                                   |
| 120  | Epoxy                   | Top coat                        | L69                  | AMERLOCK 2/400  | Carboguard 890      | Macropoxy 646-100                               |

- END OF SECTION -

SECTION 10400  
IDENTIFYING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.
- B. Principal items of work include:
  - 1. Plastic engraved door and informational signs as indicated on the Drawings.
  - 2. Safety signs

1.02 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Color and finish samples for all nameplates, signs and building name letters.
  - 2. Shop Drawings shall include, but not be limited to:
    - a. Complete details for all signs and building name letters giving sizes and styles of lettering and colors.
    - b. Complete schedules for all nameplates, signs, and building name letters giving location, message, letter, size, color, and method of attachment.
    - c. Details of fabrication and attachment of all items.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in unopened, unbroken and undamaged original packaging bearing the manufacturer's label and identification for installation.
- B. Handle all materials with care to prevent defacement of any nature.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Seton
2. Compliance Signs
3. Safety Signs

## 2.02 MATERIALS

### A. Signs

1. Interior signs shall be self extinguishing plastic or 0.040 aluminum
  2. Exterior signs shall be 0.040 aluminum with vinyl lettering and numbering.
- B. Character size and style shall be 3/4 inch high minimum upper case Helvetica. Spacing and proportions of letters shall be in strict accordance with the Americans with Disabilities Act of 1990.
- C. Colors shall be as selected by the Owner from the manufacturer standard colors.
- D. Materials shall be suitable for exterior or interior exposure as applicable.

## 2.03 ACCESSORIES

- A. Mounting Hardware: Stainless steel screws.

## 2.04 FABRICATION

- A. All items specified herein to be factory fabricated to the extent practicable.
- B. Provide all attachments and anchors necessary for concealed installments for door numbers, room name plates, and bulletin boards.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. All materials specified herein shall be installed in compliance with the approved manufacturer's printed specifications. Mounting devices, bolts, screws, nuts and the like shall be of high strength aluminum or stainless steel. The final location of each sign shall be as determined by the Engineer.
- B. Plastic door numbers and room name plates shall be attached stainless steel oval Phillips head screw at each corner.
1. Submit a schedule of door numbers and name plates to the Engineer for approval.



2. Install door and name plates after final field finish has been applied and thoroughly dried.

### 3.02 ADJUSTMENT AND CLEANING

- A. After completion of project, remove all protective devices, touch up as necessary and clean all exposed surfaces with a mild solution of detergent and warm water. Leave all surfaces in a neat and clean condition.

### 3.03 SCHEDULES

- A. FIRE RELATED SIGNS provide each sign with wording and pictogram. Signs shall have red background and white letters and pictogram.

| Wording           | Size | Quantity |
|-------------------|------|----------|
| FIRE EXTINGUISHER | 7x10 | 2        |

- B. CAUTION SIGNS shall have a yellow background with the word CAUTION 2 inches high with white letters and black background centered above wording below in black letters. Each sign shall be provided with pictogram showing figure in compliance with sign (i.e. a figure wearing glasses)

| Wording                                  | Size | Quantity |
|------------------------------------------|------|----------|
| EYE PROTECTION MUST BE WORN IN THIS AREA | 7x10 | 2        |

- C SAFETY SIGNS. Signs shall comply with ANSI Z S35 requirements.

| Wording                                                   | Size | Quantity |
|-----------------------------------------------------------|------|----------|
| NO ENTRY<br>AUTHORIZED PERSONNEL ONLY<br>(with pictogram) | 7x10 | 2        |

Note 1: Sign shall be 2½ inches high x length required. Sign shall be centered.

### D. EXTERIOR HAZARDOUS MATERIAL BUILDING SIGNAGE

1. The authority having jurisdiction shall be consulted regarding the quantity and placement of identification NFPA 704 placard to assist in response to incidents at locations.

| Wording                     | Size  | Quantity |
|-----------------------------|-------|----------|
| In accordance with NFPA 704 | 10X10 | 2        |

- END OF SECTION -

SECTION 10522  
FIRE EXTINGUISHERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish and install fire extinguishers as shown on the Drawings and specified herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these Specifications the Work shall conform to the applicable requirements of the following documents:
  - 1. NFPA 10 - Portable Fire Extinguishers

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:
  - 1. Complete detail and installation drawings for Fire Extinguisher Cabinets.
  - 2. Manufacturer's data sheets and verification of U.L. ratings.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products from one of the following manufacturers:
  - 1. Kidde Fire Extinguisher Company
  - 2. Ansul Fire Protection
  - 3. Potter - Roemer
  - 4. J. L. Industries

2.02 MATERIALS

- A. Dry Chemical (DC) Fire Extinguishers

1. Provide where indicated on drawings, 10 lb. capacity, hand portable, with wall mount, tri-class dry chemical type, with Underwriters' Laboratories rating of 4-A: 60 BC.

B. Carbon Dioxide (CO<sub>2</sub>) Fire Extinguishers

1. Provide 10 lb. capacity, portable carbon dioxide type with steel wall mounts, having Underwriters' Laboratories rating of 10-BC. Provide where shown in electrical room.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. Fire extinguishers shall be installed where directed by the Engineer.
- B. Wall mounts for extinguishers shall be securely mounted to masonry with lag bolts and shields.
- C. Fire extinguishers shall be installed so that the top of the fire extinguisher is not more than 5 feet above the floor.

- END OF SECTION -

SECTION 10523  
FIRST AID CABINETS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. Furnish and install first aid cabinets as shown on the Drawings and as specified herein. Coordinate work in this Section with painting and marking as specified in Section 09900, Painting. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

1.02 SUBMITTALS

- A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.03 MANUFACTURERS

- A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

PART 2 -- PRODUCTS

2.01 FIRST AID CABINET

- A. The first aid cabinet shall be manufactured by Northern Safety, Global Industrial, or equal. Provide 2 or 3 Shelf Steel Cabinet First Aid Kit, ANSI Compliant, and designed for up to 50 Persons. Provide one first aid cabinet. Mounting brackets for masonry mounting shall be provided. Cabinets shall be field located as directed by the Engineer.

PART 3 -- EXECUTION

3.01 INSTALLATION

- A. First aid cabinets shall be installed where shown on the Drawings or as directed by the Engineer. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.

- END OF SECTION -

## SECTION 10800

### TOILET AND BATH ACCESSORIES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish and install toilet and bath accessories as shown on the Drawings and specified herein.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04200 - Unit Masonry

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
  - 1. Manufacturer's data.

##### 1.04 QUALITY ASSURANCE

- A. Coordinate with other work to avoid interference and to assure proper operation and servicing of accessory units.

#### PART 2 -- PRODUCTS

##### 2.01 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are approved for use.
  - 1. American Specialties Inc.
  - 2. Bobrick Washroom Equipment, Inc.
  - 3. Bradley Corp.
  - 4. McKinney Parker

##### 2.02 MATERIALS

- A. Provide the following (Model numbers are Bobrick Washroom Equipment, Inc. numbers and are used for convenience only).
  - 1. Surface Mounted Toilet Tissue Dispenser for Two Rolls At each water closet - Model B-686, Type 304 -stainless, polished finish, concealed stainless steel wall plate.

2. Surface Mounted Paper Towel Dispenser and Disposal: Satin finish stainless steel, 12 gallon removable receptacle. Dispenses 600 C-fold, 800 multifold, or 1100 single fold towels. Model B-3949 with skirt.
3. Wall Mirrors: One (1) at each lavatory - stainless steel angle frame mirror, Model B-290. Corners shall heliarc welded, ground and polished smooth. No. 1 quality, 1/4" (6mm) select float glass mirror electrolytically copper-plated; guaranteed against silver spoilage for 15 years. Provide 1/8 inch (3mm) thick, water-resistant, shock-absorbing padding and 20 gauge galvanized steel back. Concealed mounting. Size as shown on Drawings.
4. Grab Bars: 1-1/2 inch diameter, 18 gauge, stain finish, Type 304 stainless steel, concealed mounting with set screws. Joints and supports shall be contour cut and heliarc welded. Length shall be as indicated on the Drawings, and shall comply with the requirements of the Americans with Disabilities Act.
5. Surface Mounted Soap Dispenser: 304 stainless steel back and body with satin finish. Capacity of 40 fluid ounces. Corrosion-resistant valve and dispenser. Unbreakable refill window. Vandal resistant. Large, locked, hinged, stainless steel filler top. Model B-2112.

### PART 3 -- EXECUTION

#### 3.01 INSPECTION

- A. Examine substrates, previously installed inserts and anchorages necessary for mounting of toilet accessories and other conditions under which installation is to occur, and notify the Contractor of conditions detrimental to proper completion of work. Do not proceed until unsatisfactory conditions have been corrected in a manner acceptable.

#### 3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions, using fasteners which are appropriate to substrate and recommended by the manufacturer of the unit. Install plumb and level, firmly anchored in locations indicated.
- B. Install mirrors with back frame concealed fasteners.
- C. Mounting heights shall comply with the American with Disabilities Act and the accessibility requirements of the California Building Code.

#### 3.03 ADJUST AND CLEAN

- A. Adjust for proper operation of that mechanisms function smoothly.
- B. Clean and polish exposed surfaces after removing protective coating.

- END OF SECTION -

## SECTION 11000

### EQUIPMENT GENERAL PROVISIONS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in acceptable operation all mechanical equipment and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.
- B. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.
- C. It is the intent of these Specifications that the Contractor shall provide the Owner complete and operational equipment/systems. To this end, it is the responsibility of the Contractor to coordinate all interfaces with related mechanical, structural, electrical, instrumentation and control work and to provide necessary ancillary items such as controls, wiring, etc., to make each piece of equipment operational as intended by the Specifications.
- D. The complete installation shall be free from excessive vibration, cavitation, noise, and oil or water leaks.
- E. The requirements of this section shall apply to equipment furnished under Divisions 11, 14, and 15.

##### 1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

##### 1.03 SHOP DRAWINGS

- A. Shop Drawings shall be submitted to the Engineer for all equipment in accordance with Section 01300, Submittals and shall include the following information in addition to the requirements of Section 01300, Submittals:
  - 1. Performance characteristics and descriptive data.
  - 2. Detailed equipment dimensional drawings and setting plans.
  - 3. General lifting, erection, installation, and adjustment instructions, and recommendations.

4. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.
5. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.
6. Details on materials of construction of all components including applicable ASTM designations.
7. Information on bearing types and bearing life.
8. Gear box design and performance criteria and AGMA service factor.
9. Piping schematics.
10. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.
11. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.
12. Equipment shop coating systems, interior and exterior.
13. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.
14. A list of spare parts and special tools to be provided.
15. Any additional information required to show conformance with the equipment specifications.
16. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

#### 1.04 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

- A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01300, Submittals.
- B. O&M manuals shall include instructions, equipment ratings, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full information required for the proper operation, maintenance, and repair of the equipment. Included in this submission shall be a spare parts diagram, complete spare



parts list, bill of materials, OEM part numbers and manufacturer's catalog information of all equipment components.

- C. Each set of instructions shall be bound together in appropriate three-ring binders with a detailed Table of Contents.
- D. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.
- E. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.
- F. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.
- G. Extensive pictorial cuts of equipment are required for operator reference in servicing.
- H. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

#### 1.05 GENERAL INFORMATION AND DESCRIPTION

- A. All parts of the equipment furnished shall, be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.
- B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.
- C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.
- D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.
- E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.
- F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.

- G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State in which the project is located.
- H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.
- I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.
- J. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products. .

#### 1.06 EQUIPMENT WARRANTIES

- A. Warranty requirements may be added to or modified in the individual equipment specifications.
- B. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified in the individual equipment specifications. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.
- C. The Contractor shall provide an equipment warranty log book prepared specifically for this project and submit two (2) copies of the document to the Engineer prior to final payment. The equipment warranty log book shall include a summary listing of all equipment warranties provided, date received, and start date and end date of warranty period. A copy of each equipment warranty and equipment start-up certification shall also be provided in the document.
- D. The Equipment Supplier shall guarantee to the Owner that all equipment offered under these specifications, or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation, and that he has not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which the Owner as user is likely to be made the defendant.

Where patent infringements are likely to occur, each Equipment Supplier shall submit, as a part of his bid, license arrangements between himself, or the manufacturer of the

equipment offered, and the patent owner or the controller of the patent, which will permit the use in the specified manner of such mechanical equipment as he may be bidding.

Each Equipment Supplier, by submitting his bid, agrees to hold and save the Owner and Engineer or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by the Owner.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. The materials covered by these Specifications are intended to be equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The Contractor shall, upon request of the Engineer, furnish the names of not less than 5 successful installations of the manufacturer's equipment of the same size and model of that offered under this contract. The equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

### 2.02 ANCHORS AND SUPPORTS

- A. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.
- B. Anchor bolts and fasteners shall be furnished in accordance with Section 05050, Metal Fastening, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.
- C. The Contractor shall provide all concrete pads or pedestals required for equipment furnished. All concrete equipment pads shall be a minimum of 6" high, unless otherwise shown on the Drawings and shall be doweled.
- D. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated or required. Equipment shall be leveled by first using sitting nuts on the anchor bolts, and then filling the space between the equipment base and concrete pedestal with non-shrink grout, unless alternate methods are recommended by the manufacturer and are acceptable to the Engineer (such as shim leveling pumps, or chemical grout). Non-shrink grout shall be as specified in Section 03600, Grout.

### 2.03 STRUCTURAL STEEL

- A. Structural steel used for fabricating equipment shall conform to the requirements of Section 05120, Structural Steel.
- B. All materials shall conform to applicable provisions of the AISC Specifications for the design and fabrication of structural steel, and to pertinent ASTM Standard Specifications.

#### 2.04 DISSIMILAR METALS

- A. All dissimilar metals shall be properly isolated to the satisfaction of the Engineer.

#### 2.05 GALVANIZING

- A. Where required by the equipment specifications, galvanizing shall be performed in accordance with Section 05035, Galvanizing.

#### 2.06 STANDARDIZATION OF GREASE FITTINGS

- A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be "Zerk" type.

#### 2.07 ELECTRICAL REQUIREMENTS

- A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 16 specifications and the latest National Electric Code.
- B. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor and shall upgrade the electrical service (conduit, wires, starters, etc.) at no additional cost to the Owner.
- C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

#### 2.08 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

- A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.
- B. Spare parts shall be identical and interchangeable with original parts.
- C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

- D. Painting requirements for spare parts shall be identical to those for original, installed parts. Where no painting or protective coating is specified, suitable provisions shall be made to protect against corrosion.
- E. Spare parts shall be delivered at the same time as the equipment to which they pertain. Spare parts shall be stored separately in a locked area, maintained by the Contractor, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Engineer.
- F. The Contractor shall furnish all special tools necessary to operate, disassemble, service, repair, and adjust the equipment in accordance with the manufacturers operation and maintenance manual.
- G. The Contractor shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of these materials shall be properly packed, labeled and stored where directed by the Engineer.

## 2.09 EQUIPMENT IDENTIFICATION

- A. All mechanical equipment shall be provided with a substantial stainless steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.
- B. Each pump and other piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or stainless steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump #1". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.
- C. Nameplates shall not be painted over.

## PART 3 -- EXECUTION

### 3.01 SHOP TESTING

- A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.
- B. No equipment shall be shipped to the project until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.

- C. Five (5) certified copies of the manufacturer's actual test data and interpreted results thereof shall be forwarded to the Engineer for review.
- D. If required by the individual equipment Specifications, arrangements shall be made for the Owner/Engineer to witness performance tests in the manufacturer's shop. The Engineer shall be notified ten working days before shop testing commences. Expenses are to be paid by Contractor.
- E. Shop testing of electric motors shall be in accordance with applicable requirements of Section 16000, Basic Electrical Requirements.

### 3.02 STORAGE OF EQUIPMENT AND MATERIALS

- A. Contractor shall store his equipment and materials at the job site in strict accordance with the manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations, and rulings of the public authority having jurisdiction. Equipment and materials shall not be delivered to the site prior to 90 days in advance of the scheduled installation. Partial payment requests will not be processed for materials delivered prior to 90 days before installation or for materials that are not properly stored.
- B. Material or equipment stored on the job site is stored at the Contractor's risk. Any damage sustained of whatever nature shall be repaired to the Engineer's satisfaction at no expense to the Owner. Stored electrical equipment is to be protected from the elements and shall have space heaters energized.
- C. Contractor shall not store unnecessary materials or equipment on the job site and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.
- D. Contractor shall observe all regulatory signs for loadings on structures, fire safety, and smoking areas.
- E. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

### 3.03 MANUFACTURER'S FIELD SERVICES

- A. The Contractor shall arrange for a qualified Technical Representative from each manufacturer or supplier of equipment who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of the specified equipment. Qualification of the Technical Representative shall be appropriate to the type of equipment furnished and subject to the approval of the Engineer and the Owner. Where equipment furnished has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment. When necessary, the Contractor shall schedule multiple Technical

Representatives to be present at the same time for the purpose of coordinating the operation of multiple pieces of related equipment.

- B. For each site visit, the Technical Representative shall submit jointly to the Owner, the Engineer, and the Contractor a complete signed report of the results of his inspection, operation, adjustments, and testing. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified.
- C. The manufacturer's Technical Representative shall provide the following services.
  - 1. Installation: The Technical Representative shall inspect the installed equipment to verify that installation is in accordance with the manufacturer's requirements. Where required by individual equipment specifications, the Technical Representative shall also supervise the installation of the equipment.
  - 2. Testing: After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Technical Representative shall inspect, operate, test, and adjust the equipment as required to prove that the equipment is in proper condition for satisfactory operation under the conditions specified. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for startup and that nothing in the installation will render the manufacturer's warranty null and void. The report shall include date of final acceptance field test, as well as a listing of all persons present during tests.
  - 3. Startup: The Technical Representative shall start up the equipment for actual service with the help of the Contractor. In the event that equipment or installation problems are experienced, the Contractor and the representative shall provide the necessary services until the equipment is operating satisfactorily and performing according to the specifications at no additional cost to the Owner. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.
  - 4. Training: The Technical Representative shall instruct the Owner's operating personnel in correct operation and maintenance procedures. The instruction shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. Such instruction shall be scheduled at a time arranged with the Owner at least 2 weeks in advance of the training and shall be provided while the respective Technical Representative's equipment is fully operational. The Contractor shall have submitted, and had accepted, the O&M Manuals prior to commencement of training.
  - 5. Services after Startup: Where required by the individual equipment specifications, the Technical Representative shall return to the project site thirty (30) days after the start up date to review the equipment performance, correct any equipment

problems, and conduct operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of Technical Representative prior to and during equipment startup. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that his equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the Technical Representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful thirty (30) days operating period.

- D. Services of the Technical Representative will require a minimum of two (2) site visits, one for installation and testing and one for startup and training, and will be for the minimum number of days recommended by the manufacturer and approved by the Engineer but will not be less than the number of days specified in individual equipment sections.
- E. The Contract amount shall include the cost of furnishing the Technical Representative for the minimum number of days specified, and any additional time required to achieve successful installation and operation. The times specified for services by the Technical Representative in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.
- F. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.
- G. The Technical Representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

### 3.04 INSTALLATION

- A. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished the Engineer's field representative one week prior to installation.
- B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.
- C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.
- D. All equipment sections and loose items shall be match-marked prior to shipping.
- E. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the pump and motor prior to making piping connections or anchoring the pump base. Alignment shall be as specified herein.



- F. The Contractor shall furnish oil and grease for initial operation and testing. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.

### 3.05 ALIGNMENT

- A. Set equipment to dimensions shown on drawings. Dimensions shall be accurate to  $\pm 1/16$  inch unless otherwise noted on the drawings. Wedges shall not be used for leveling, aligning, or supporting equipment.
- B. General Equipment Leveling: Non-rotating equipment shall be set level to  $\pm 1/16$  inch per 10 foot length (.005 inch per foot) unless otherwise noted on the drawings. Shims shall be used unless equipment is furnished with leveling feet. Set shims flush with equipment baseplate edges. When grouting is required, equipment shall be shimmed to allow a minimum of one inch grout thickness. Grout shall cover shims at least 3 inches. Final level check shall be held for inspection and approval by Engineer before proceeding.
- C. Grouting
  - 1. Fill anchor bolt holes or sleeves with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.
  - 2. Surface Preparation. Roughen surface by chipping, removing laitance, and unsound concrete. Clean area of all foreign material such as oil, grease, and scale. Saturate area with water at least 4 hours prior to grouting, removing excess water ponds.
  - 3. Application. Place grout after the equipment base has been set and its alignment and level have been approved. Form around the base, mix grout, and place in accordance with the grout manufacturers published instructions. Eliminate all air or water pockets beneath the base using a drag chain or rope.
  - 4. Finishing. Point the edges of the grout to form a smooth 45 degree slope.
  - 5. After grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.
  - 6. Level Verification. After grout has cured, and immediately prior to drive alignment, recheck equipment for level and plumb. Re-level and square as necessary. Hold final checks for inspection and approval by Engineer.
- D. Inspect for and remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet.
- E. Inspect and clean equipment mounting base pads, feet, and frames to remove all grease, rust, paint and dirt.

- F. Assembled equipment shafts shall be set level to .0015 inches per foot of shaft length (+/- .0005 inches) up to a maximum of 0.015 inches for any length shaft unless the manufacturers requirements are more stringent or unless otherwise noted in the equipment specifications. Use the machined surfaces on which the equipment sets for the base/mounting frame leveling plane. Use the machined shaft surface for equipment leveling plane.
- G. Sprocket and Sheave Alignment. Check shaft mounted components for face runout and eccentricity (outside diameter) runout by magnetically mounting a dial indicator on a stationary base and indicating over 360 degrees on a continuous machined surface at the outside diameter of the component. Maximum allowable total indicated face runout and eccentricity for sprockets and sheaves will be per ANSI Standard B29.1-1975.
- H. Belt tensioning. Set drive belt tension to manufacturer's specification for the belt type. Recheck alignment after drive tensioning.
- I. Thermal/Mechanical Growth. Thermal/mechanical growth corrections for driver and driven machines will be used in vertical and horizontal alignment where applicable. The equipment manufacturer will determine thermal/mechanical growth applicability for any machine and provide the correction offsets to be used.
- J. Rotating Shaft Alignment
  - 1. Fixtures will be set up on the driver and driven machine, machines shaft surfaces. Machined coupling hubs may be used only if there is no clearance to mount fixtures directly on the shafts.
  - 2. Primary alignment method for direct drive machines is when coupled. Uncoupled alignment will be used only when approved by the Engineer.
  - 3. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.
  - 4. Uncoupled machines must be connected so that both shafts turn together without relative motion during alignment.
  - 5. Indicator bar sag will be measured and included for each reverse indicator alignment setup.
  - 6. Reverse Dial Indicator. The final maximum allowable misalignment: vertical and horizontal from the desired targets of .000 inches (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) must meet BOTH of the following conditions simultaneously: 1/2 the final total indicator reading at each indicator will be no more than shown in the table below AND the final remaining correction at each machine foot be no more than .001 inches of required movement.

| Machine Speed (RPM) | Total Misalignment* (inches) |
|---------------------|------------------------------|
| Up to 1800          | .002                         |
| 1800 and greater    | .001                         |

\* 1/2 indicator reading

### 3.06 FIELD TESTING

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions. Provide all necessary calibrated instruments to execute performance tests. Submit report certified by the pump manufacturer's representative.

#### B. Preliminary Field Tests, Yellow Tag

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall:
  - a. Verify that the equipment is free from defects.
  - b. Check for alignment as specified herein.
  - c. Check for direction of rotation.
  - d. Check motor for no load current draw.
2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.
3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.
4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

#### C. Final Field Tests, Blue Tag

1. Upon completion of the above, and at a time approved by the Engineer, the equipment will be tested by operating it as a unit with all related piping, ducting, electrical and controls, and other ancillary facilities.
2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.

3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Operating field tests shall consist of the following:
  - a. Check equipment for excessive vibration and noise as specified herein.
  - b. Check motor current draw under load conditions. The rated motor nameplate current shall not be exceeded.
  - c. Recheck alignment with dial indicators where applicable, after unit has run under load for a minimum of 24 hours.
- D. In addition to the above described field tests, any other tests specifically required by Section 11100, Pumps-General, the individual equipment Specifications, or by the manufacturer shall be performed.
- E. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.
- F. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.
- G. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.
- H. All costs in connection with field testing of equipment such as lubricants, temporary instruments, labor, equipment, etc., shall be borne by the Contractor. Power, fuel, chemicals, water, etc. normally consumed by specific equipment shall be supplied by the Owner unless otherwise specified in the individual equipment specifications.
- I. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

### 3.07 VIBRATION TESTING

- A. Unless specified otherwise in the detailed equipment specifications, each pump, blower, compressor, motor or similar item of stationary rotating equipment having a rated power in excess of 15HP shall be tested after installation for acceptable vibration levels.
- B. Vibration testing shall be performed by an experienced factory-trained and authorized third-party analysis expert (not a sales representative) retained by the Contractor and approved by the Engineer. Each unit or pump system shall be tested separately without duplicate equipment running. All field testing shall be done in the presence of the

Engineer. The Engineer shall be furnished with four (4) certified copies of vibration test data for each test performed.

- C. For systems with variable speed drives, tests shall be conducted at various speeds between maximum and minimum. For systems with two-speed drives, tests shall be conducted at both speeds. For systems with constant-speed drive, tests shall be conducted under various loading conditions as determined by the Engineer.
- D. All field vibration tests shall be performed with the equipment operating on the product for which it is intended, or a substitute acceptable to the Engineer.
- E. The term displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity or speed of the vibration cycle, measured in G's. Displacement and velocity shall be measured by suitable equipment equal to IRD Mechanalysis, Bentley, Nevada.
- E. Frequency of vibration, in cycles per minute (cpm), shall be determined when vibration exceeds specified levels or as otherwise necessary. Vibration shall be measured on the bearing housing, unless other locations are deemed necessary by the vibration analysis expert and Engineer.
- F. For all equipment tested, vibration shall be checked in the radial and axial directions. Unless otherwise specified elsewhere, axial vibration shall not exceed 0.1 in/sec; and radial vibration shall not exceed 0.2 in/sec. For pumps radial vibration shall not exceed that permitted by the Hydraulic Institute Standards except that, at vibration frequencies in excess of 8,000 cpm, the velocity shall not exceed 0.2 in/sec.
- G. Copies of test results shall be submitted to the Engineer for review. Should the vibration field test results exceed shop test results, the manufacturer's recommendations, or the limits specified herein, the Contractor shall correct the deficiencies within thirty (30) days. After corrections have been completed, the vibration testing shall be re-run and the results re-submitted to the Engineer for review.
- H. Noise or vibration in any rotating equipment which the Engineer judges to be excessive or damaging, shall be cause for rejection.

### 3.08 FAILURE OF EQUIPMENT TO PERFORM

- A. Any defects in the equipment, or failure to meet the guarantees or performance requirements of the Specifications shall be promptly corrected by the Contractor by replacements or otherwise.
- B. If the Contractor fails to make these corrections, or if the improved equipment shall fail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.
- C. The Contractor shall then obtain specified equipment to meet the contract requirements or upon mutual agreement with the Owner, adjust the contract price to reflect not supplying the specific equipment item.

- D. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on progress certificates or otherwise on account of the lump sum prices herein specified.
- E. Upon receipt of said sums of money, the Owner will execute and deliver to the Contractor a bill of sale of all his rights, title, and interest in and to said rejected equipment; provided, however, that said equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected.
- F. Said bill of sale shall not abrogate Owner's right to recover damages for delays, losses, or other conditions arising out of the basic contract.

### 3.09 PAINTING

- A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting.
- B. All shop coatings shall be compatible with proposed field coatings.
- C. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.
- D. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

### 3.10 WELDING

- A. The Equipment Manufacturer's shop welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirement of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.
- B. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.
- C. The Contractor shall perform all field welding in conformance with the information shown on the Equipment Manufacturer's drawings regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society, and special conditions, as shown by notes and details.

- END OF SECTION -

SECTION 11100  
PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.
- B. All pumping equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.
- C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.
- D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.02 SHOP DRAWINGS

- A. Shop Drawings shall include the following information in addition to the requirements of Section 01300, Submittals and Section 11000, Equipment General Provisions.
  - 1. Details of shaft sealing system
  - 2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.
  - 3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.
  - 4. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A 532 (where required in the individual pump specifications).
  - 5. Submersible pump submittals shall also include:
    - a. Product data sheets for power and control cables and length of cables.
    - b. Details on pump guide rail system and mounting requirements.

## PART 2 -- PRODUCTS

### 2.01 MATERIALS

- A. All materials employed in the pumping equipment shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:
  - 1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.
  - 2. Bronze pump impellers shall conform to ASTM B 584, "G" bronze.
  - 3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.
- B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.
- C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

### 2.02 APPURTENANCES

- A. Pressure Gauges
  - 1. The Contractor shall furnish and install pressure gauges on the suction and discharge of each pump, except wet-pit submersible pumps and vertical turbine pumps.
  - 2. The Contractor shall furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Engineer.
  - 3. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.
  - 4. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.
  - 5. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650, Pressure Gauges.



6. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698, Instrumentation and Control Accessories.

## 2.03 ELECTRICAL REQUIREMENTS

- A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.
- B. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between pump supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished and specified under Division 16.
- C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

## 2.04 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of Section 11000, Equipment General Provisions, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

# PART 3 -- EXECUTION

## 3.01 INSTALLATION

- A. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with galvanized steel pipe or copper tube, properly supported with brackets.
- B. Solenoid Valves: Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

## 3.02 SHOP TESTING

- A. Shop tests shall be performed in accordance with Section 11000, Equipment General Provisions, and except where stated otherwise herein, shall be conducted in accordance with the latest version of Hydraulic Institute Standard 14.6, Hydraulic Performance Acceptance Tests.
- B. Pump testing shall be witnessed by the Owner/Engineer where specified in the individual pump specifications. The testing procedure shall be submitted to the Engineer for review before scheduling the testing. The Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.

- C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications. Certified tests will not be required for submersible sump pumps with motors less than 5 hp.
- D. Pumps shall be within the tolerances specified for Acceptance Grade 1U, in accordance with the latest version of Hydraulic Institute Standards 14.6. with the following exceptions:
  - 1. The required horsepower shall not exceed the rated motor horsepower.
- E. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.
- F. As a minimum, each finished pump shall be performance tested for total dynamic head, capacity, efficiency and power requirements at six operating points plus shut-off head for the selected impeller diameter, of which the design capacity operating point shall be included.
- G. In the event of failure of any pump to meet any of the design requirements or efficiencies, the Contractor shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional compensation, until found satisfactory.

### 3.03 FIELD TESTING

- A. Field tests shall be performed in accordance with Section 11000, Equipment General Provisions and additionally as specified below and in the individual pump specifications.
- B. Final acceptance tests shall demonstrate the following:
  - 1. The pumps have been properly installed and are in proper alignment.
  - 2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.
  - 3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of six points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

- END OF SECTION -

## SECTION 11130

### SUBMERSIBLE NON-CLOG PUMPS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install submersible non-clog pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.
- B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions and Section 11100, Pump - General.

##### 1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

| <b>Lift Station</b>                | <b>Skyfarm</b>     | <b>Hansford</b>     |
|------------------------------------|--------------------|---------------------|
| Number of Units                    | 6 (3x2 in series)  | 2                   |
| Pump Model                         | Flygt NP 3153      | Flygt NP 3153       |
| Pump Installation                  | Horizontal Dry-Pit | Submersible Wet-Pit |
| Design Capacity (gpm)              | 150                | 180                 |
| Total Dynamic Head (feet)          | 240                | 120                 |
| Maximum Brake Horsepower           | 17                 | 17                  |
| Maximum Pump Speed (rpm)           | 3,510              | 3,510               |
| Temperature of Liquid Pumped       | Ambient            | Ambient             |
| Suction Condition                  | Flooded            | Flooded             |
| Maximum Size of Solids (In.)       | 3                  | 3                   |
| Minimum Discharge Diameter (In.)   | 4                  | 4                   |
| Mix-Flush Valve                    | No                 | Yes (1)             |
| Service Cart                       | Yes                | No                  |
| Guiderail System                   | No                 | Yes                 |
| Closed Loop Cooling                | Yes                | Yes                 |
| Power Rating                       | 460V, 3 ph, 60 Hz  | 240V, 3 ph, 60 Hz   |
| Horsepower                         | 20                 | 20                  |
| Insulation                         | Class H            | Class H             |
| Explosion Proof                    | Yes                | Yes                 |
| Inverter Duty                      | No                 | No                  |
| Service Factor                     | 1.15               | 1.15                |
| Motor Winding Temperature Switches | Yes                | Yes                 |
| RTDs                               | No                 | No                  |

### 1.03 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:

- 1. Certified Performance Curve

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Each pump shall be a submersible, non-clog, centrifugal pump, as manufactured by Flygt, without exception.

### 2.02 MATERIALS

- A. The pump and all related equipment shall be designed for the wastewater applications specified herein and shall be suitable for continuous or intermittent operation. The pump shall be bottom suction, side discharge construction and shall be supplied with a foot mounted discharge connection elbow and integral sliding rail removal system of the pump manufacturer's design matched to the pumps being supplied.
- B. The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48-Class 30, 35, or 40. Ductile iron pump volute shall be furnished if recommended by pump manufacturer for specified pressure rating. All exposed nuts, bolts, washers, and other fastening devices shall be AISI type 316 stainless steel.
- C. Casing shall be a smooth surface devoid of blowholes, pits, burrs, or other irregularities. The casing shall have a suction cover, which can be easily removed for easy access to the impeller. All non-stainless steel metal surfaces coming in contact with the pumped media shall be protected by a factory applied spray coating of Supplier's modified acrylic primer and finish. The volute shall be single piece, non-concentric design and shall have smooth fluid passages large enough at all points to pass any size solids which can pass through the impeller. Pump volute shall be provided with a cleanout port to allow for removal of any foreign material blocking or impeding performance of the pump.
- D. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile or Viton rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without the requirement of a specific torque limit. Secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall not be acceptable.
- E. The impeller shall be hard alloy gray cast iron conforming to ASTM A-48 Class 30, 35, or 40. Impellers shall be dynamically balanced, closed non-clogging design with multiple vanes. The impeller shall be capable of handling solids of specified sphere size, fibrous

materials, heavy sludge, and other matter found in normal wastewater applications. The impeller shall be mechanically secured to the motor shaft per manufacturer's recommendations utilizing machined stainless steel components. Adhesive or friction-type fits are not acceptable. Impeller shall be coated with the same system applied to the interior of the casing.

- F. A wear ring system shall provide efficient sealing between the volute and impeller. Casing and impeller wear ring shall be of stainless steel construction. Supplier shall submit AISI grades of stainless steel proposed for the wear rings. Rings shall be drive fitted to the volute inlet and heat-shrink fitted to the impeller.
- G. Shafting shall be constructed of AISI 329 stainless steel or 416 stainless steel for the pump and motor, sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat-treated, turned, ground, and polished over its entire length.

#### H. Shaft Seals

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies of high-pressure design. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. Seal lubricant shall be FDA Approved, nontoxic.
2. The lower, primary seal unit, located between the pump and the lubricant chamber shall contain one stationary and one positively driven rotating, industrial duty, corrosion resistant, seal rings (Tungsten carbide/Tungsten carbide or Tungsten carbide/silicon carbide). The lower seal shall be independent of the impeller hub.
3. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, chamber shall contain one stationary and one positively driven rotating, industrial duty, corrosion resistant, seal rings (ceramic/carbon or carbo/Ni-resist).
4. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. The seal system shall not be damaged when run dry. No external source of seal cooling or lubrication water shall be required. All metal components of the upper and lower seals shall be AISI Type 316 stainless steel. All elastomers of shall be of Viton material.
5. Mechanical seals shall be readily and commercially available from third-party sources other than the pump and motor manufacturer, their agents, dealers and/or

distributors. Mechanical seals shall be John Crane Type 21 or approved equivalent.

6. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. Cartridge type systems will not be acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.
- I. The pump shaft shall rotate on at least two (2) heavy duty permanently lubricated bearings. Bearings shall be designed to carry all radial and axial thrust loads and shall have a minimum AFBMA B-10 life of 100,000 hours at all points along the usable portion of the pump curve at maximum pump speed.
- J. Each pump, as specified herein or as recommended by the manufacturer, shall be provided with an integral, closed-loop cooling system that is adequately designed to cool the motor without an external cooling source. The cooling jacket shall be of cast-iron construction and shall surround the stator housing. The cooling jacket shall provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. The impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pumpage, through the cooling system. The cooling liquid shall pass through a classifying labyrinth prior to entering the cooling jacket. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall direct the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4" diameter located 180° apart. The cooling system shall provide for completely unsubmerged pump operation in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.
- K. The Slide Rail Mounting System shall be as shown on the Contract Drawings and as specified herein.
  1. A rail system shall be provided and installed for each pump. The pump shall be easily removed from the wetpit for inspection or service without entering the pit or disconnecting piping.
  2. The pump shall be provided with a foot mounted discharge connection elbow constructed of cast iron conforming to ASTM A48-Class 30 or 35, permanently installed in the wet well along with the discharge piping. The discharge connection elbow shall be constructed with a 125 lb. ANSI standard flat faced flange. The pump shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service. Sealing

of the pumping unit to the discharge connection elbow shall be accomplished by a simple downward motion of the pump.

3. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by the guide bar(s) and pressed tightly against the discharge connection elbow to provide positive sealing under all conditions.
  4. The entire sliding rail system shall be designed to safely withstand all stresses imposed thereon by vibration, torque, shock and all possible direct and eccentric loads. No portion of the pump shall bear directly on the floor of the sump.
  5. Lower guide bar holders shall be integral with the discharge connection. Guide bars shall be of at least standard weight 316 stainless steel pipe of a conservative size adequate for its intended use. The guide bars shall not support any portion of the weight of the pump.
  6. All anchor bolts, lifting bolts, eye lugs and lifting cable, etc. necessary for a complete installation and maintenance of the pump shall be constructed of Type 316 stainless steel and shall be adequately designed for its intended use.
  7. All metal to metal interfaces where movement might occur shall be non-sparking. The slide mounting system for the influent pumps shall meet or exceed Underwriters Laboratory requirements for operation in a Class I, Division 1, Group D hazardous location.
- L. All anchor bolts, lifting bolts, eye lugs, etc. necessary for complete installation and maintenance of the pump shall be furnished by Supplier and constructed of Type 316 stainless steel and shall be adequately designed for its intended use.
- M. The Mix-Flush Valve shall automatically flush the wet well during initial operation of the pump. The valve shall be open when the pump starts with a ball closing the valve in a period of 20 to 50 seconds. A means of adjusting the desired flushing period shall be provided on the outside of the valve. The operation of the valve shall depend only on the pump flow and pressure. No electrical components or cables shall be used with the valve. The valve shall be Model 4901 Flush Valve manufactured by Flygt.

## 2.03 ELECTRICAL AND CONTROL REQUIREMENTS

- A. The pump manufacturer shall provide the power and control cables between the pump and the local disconnect switch, junction box, or control panel (see Drawings) and shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same pumping application shall be provided with the same length of cable. No splices shall be allowed unless specifically indicated on the Drawings. Cables shall be PVC or oil resistant chloroprene rubber jacketed type SPC cable suitable for submersible pump applications, shall be sized according to NEC and ICEA standards, and shall meet with MSHA approval. Stainless steel strain relief connectors shall be furnished for all cables.
- B. Cable Entry Water Seal

1. The cable entry water seal design shall insure a watertight and submersible seal without specific torque requirements. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate gaining access through the pump top. The junction chamber containing the terminal board shall be sealed from the motor by an elastomer compression seal O-ring. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to the terminal board and thus perfectly leak proof. Each pump shall be equipped with separate terminal board that totally isolates the incoming power supply from the pump motor.
  2. An acceptable alternate cable entry seal shall include cable leads shall enter at the top of the motor and shall allow the cable-to-motor connection to be accomplished in the field without soldering. All power and control lead wires shall be double sealed as they enter the motor in such a manner that cable-wicking will not occur. This sealing system shall consist of a rubber grommet followed by epoxy that is high in adhesive qualities and has a low coefficient of expansion. Each conductor shall have a small section of insulation removed to establish a window area of bare wire and each wire shall be untwisted and surrounded by epoxy potting material. A cable strain relief mechanism shall be an integral part of the sealing system. The cable sealing system shall be capable of withstanding an external pressure test of 1,200 psi as well as a cable assembly pull test as required by Underwriters Laboratories. Power and control leads shall be terminated on a sealed terminal board. The terminal board and its bronze lugs shall be O-ring sealed.
- C. The pump motor shall be a squirrel-cage induction type, housed in a watertight chamber. The stator winding and stator leads shall be moisture resistant. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.
  - D. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of fifteen (15) starts per hour without overheating.
  - E. Each pump motor stator must incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor must stop and activate an alarm. Moisture detector probes shall be provided in the oil-seal chamber. The thermal switches and moisture detector probe must be connected to a Mini CAS II control and status monitoring unit. The Mini CAS unit must be designed to be mounted in the pump control panel.

#### 2.04 CONTROL PANEL

- A. Motor starters and controls for each pump installation shall be provided in a NEMA 4X stainless steel control panel. Power cable between the pumps and the control panel shall



be furnished by the pump supplier. Each control panel shall include, but not be limited to, the following:

1. A single fused or circuit breaker type NEMA 4X lockable disconnect switch operable from outside the control panel or mounted in a separate NEMA 4X stainless steel enclosure.
2. A motor circuit protector and full voltage nonreversing magnetic starter for each pump. The motor starter shall be NEMA Size 1 (minimum) for each pump.
3. Each pump shall be provided with a Hand-Off-Auto (H-O-A) control switch on the front of the control panel with control in the automatic mode by the plant control system.
4. Control power shall be 120 VAC from an integral, fused control power transformer.
5. Each control panel shall include an individual alarm/indicating pilot light for: Pump Running, Seal Failure (Moisture Intrusion), Motor Winding High Temperature, and Power On. The panel shall also include a 24 VDC PLC interposing relay and an Elapsed Time Meter. Seal failure and motor over temperature alarms shall seal- in and stop the associated pump. A reset pushbutton shall be provided.

## 2.05 SPARE PARTS

- A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following for each series of pumps

One (1) - set of lower and upper wearing rings  
One (1) - set of motor and pump bearings  
One (1) - complete mechanical seal assembly (upper and lower)  
Two (2) - complete set of gaskets and O-ring seals

## PART 3 -- EXECUTION

### 3.01 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions. For each pump station or series of pumps, field services shall include the following site visits:

| Service                  | Number of Trips | Number of Days/Trip |
|--------------------------|-----------------|---------------------|
| Installation and Testing | 1               | 1                   |
| Startup and Training     | 1               | 1                   |
| Services after Startup   | 1               | 1                   |

### 3.02 SHOP TESTING

- A. Shop testing shall be in accordance with Section 11100, Pumps - General with the following additional requirements:
1. Impeller, motor rating and electrical connections shall be checked.
  2. A motor and cable insulation test for moisture content or defective insulation shall be made.
  3. Prior to submergence, the pump shall be bumped to establish correct rotation and mechanical integrity.
  4. The pump shall be run for 30 minutes submerged, a minimum of six (6) ft. under water.
  5. After the pump test, the insulation test shall be performed again.

- END OF SECTION -

## SECTION 14600

### CRANES AND HOISTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install and make fully operational the crane and hoist systems in the locations and conditions of service, as shown on the Drawings and as specified in the Crane and Hoist Schedule.
- B. These Specifications shall be considered as minimum requirements. The Contractor shall add such additional features as are necessary for satisfactory operation.
- C. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions.
- D. All equipment supplied under this Specification shall comply in all respects with the provisions of the Occupational Safety and Health Act of 1970, including all standards promulgated under the authority of such Act, and shall also meet all applicable industrial codes in the State in which the project is located.
- E. The manufacturer and ultimately the Contractor shall be totally responsible for structural design of the crane and hoist systems, for the compatibility of all equipment, and for verification of required operating clearances.
- F. All parts of the mechanism furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All equipment specified herein shall be designed for the Crane Manufacturer's Association of America Duty Classification as specified herein.
- G. If the Contractor elects to utilize the crane and hoist equipment in any way during the erection of piping and installation of equipment, he shall notify the Owner in writing and shall provide for an inspection by the equipment manufacturer and take any steps necessary to return the equipment to "as new" condition. He shall also obtain recertification by the manufacturer and reinstate all warranties and guarantees.

##### 1.02 CAPACITY AND DESIGN LOADS

- A. The crane shall be designed to withstand the dead load (caused by the weight of the crane and components themselves), the live load and hoist load, and the inertia forces caused by movement of the crane, components, and loads during standard operation.
- B. Standard capacity ratings shall represent the net rated load at the hook of any type of trolley hoist with the same load rating installed on the crane having a trolley hoist weight within the established limits.

- C. All design loads shall meet CMAA requirements. The design load for stress calculations shall be based upon the capacity plus 15% for the weight of the hoist and trolley and an additional 25% for impact (capacity x 1.4). Design load for deflection calculations shall be based upon the capacity plus 15% for the weight of the trolley hoist (capacity x 1.15).
- D. The rated load capacity of each crane shall be clearly labeled on each crane using a label size easily read from the floor level and/or loading position.

#### 1.03 CRANE AND HOIST SCHEDULE

| Location                  | Lift Station |
|---------------------------|--------------|
|                           |              |
| <b>General</b>            |              |
| Indoor / Outdoor          | Indoor       |
| Capacity, tons            | 1            |
| Operating Floor Elevation | 484          |
|                           |              |
| <b>Crane</b>              |              |
| Crane Type                | Monorail     |
| Mounting                  | N/A          |
| CMAA Duty Classification  | N/A          |
| Span, ft                  | 20           |
| Frame Spread, ft          | N/A          |
| Max Bridge Speed, fpm     | N/A          |
|                           |              |
| <b>Trolley Hoist</b>      |              |
| Trolley Type              | Electric     |
| Hoist Type                | Electric     |
| ASME Duty Classification  | Class H1     |
| Hook Elevation            |              |
| High Point                | 493          |
| Low Point                 | 485          |
| Hook End Approach, in     | 24           |
| Operating Speeds          |              |
| Trolley Speed, fpm        | 65           |
| Hoist Speed(s), fpm       | 22 and 7     |

All elevations and spans are approximate. All equipment shall be installed as shown on the Drawings.

#### 1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced

Specifications, codes and standards refer to the most current issue available at the time of the Bid.

- |    |               |                                                       |
|----|---------------|-------------------------------------------------------|
| 1. | CMAA          | Crane Manufacturers Association of America            |
| 2. | AISC          | "Manual of Steel Construction"                        |
| 3. | ASTM A48      | Standard Specifications for Gray Iron Castings        |
| 4. | ANSI B30.11   | Safety Code for Underhung Cranes and Monorail Systems |
| 5. | ANSI B30.16   | Safety Code for Overhead Hoists                       |
| 6. | MMA MH27.1    | Monorail Manufacturers Association                    |
| 7. | OSHA 1910-179 | Occupation Safety and Health Administration           |

#### 1.05 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:
  - 1. Certification that the systems have been designed to resist all loads implied herein and loadings stipulated in the applicable building codes of the State in which the project is located. The Certification shall also state that the design has been performed and signed and sealed by a Professional Engineer registered in the State in which the project is located.
  - 2. Performance Affidavit
- B. Certification that the equipment has been field tested and passed.
- C. Details and design calculations shall be submitted, signed, and sealed by a Professional Engineer registered in the State in which the project is located for any of the following components furnished by the Manufacturer:
  - 1. Runway beams.
  - 2. Monorail patented track.
  - 3. Monorail suspension systems.
  - 4. End stops and connections.

#### 1.06 WARRANTY AND GUARANTEE

- A. Warranty and Guarantee shall be as specified in Section 11000 with the exception that the warranty period shall be for two (2) years.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. The equipment covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment.

### 2.02 GENERAL

- A. The crane system shall be constructed of structural steel, in accordance with current AISC (American Institute of Steel Construction) and ASTM (American Society for Testing and Materials) A-36 specifications minimum.
- B. All crane components will have properly finished ends and surfaces.
- C. Welding shall follow the current recommended practices of the AWS (American Welding Society) D14.1 specifications.
- D. Moving members of the crane shall be separated by a clearance of at least 3 inches vertically from any overhead obstruction, and 2 inches horizontally from any lateral obstruction.

### 2.03 MONORAILS

- A. Unless otherwise indicated on the Drawings, monorail shall be patented track consisting of a top flange, web and hardened 3.25" or 3.33" bottom operation flange. All rails shall be furnished with splices and end stops and shall be designed for spans, thermal expansion and contraction and turning radii as shown on the Drawings. Unless otherwise shown on the Drawings provisions shall be made for connection of monorail suspension system to support locations designated on Drawings. The suspension system shall provide support and bracing of all live, dead, and impact loads. Monorail shall be manufactured by Loudon division of ACCO, TC/American Monorail, Cleveland Tramrail division of Gorbel, Tram Beam, or equal. Rated capacity of monorail shall be painted with stencil on both the hoist and the monorail beam.

### 2.04 TROLLEY HOISTS

- A. Trolley hoists shall be as manufactured by ACCO Industries, Electrolift, or Yale.
- B. All load carrying parts shall be of steel. The wheels shall have hardened treads. Wheels and axles shall be equipped with antifriction bearings which are permanently sealed and lubricated. The gear head of the motor shall have an alloy steel, heat-treated gear train operating in a fully enclosed oil bath. The gear shaft shall have precision, oil lubricated ball bearings. Where monorail track as specified or shown on the Drawings is curved, trolleys shall be the swivel-type to negotiate curved sections.

1. Electrically operated trolleys shall include variable frequency control with 2-step in, a gear-motor with solid-state soft start with adjustable time and torque, and electric brake.
  2. Manual trolleys shall be of hand-driven geared type.
- C. The hoist drive shall be of the close-headroom, double reeved, cross-mounted type and shall include a geared train with inherent or mechanical load brake, hook, wire rope, and drum. Rated capacity shall be stamped on the hoist frame. The frame shall be oil-tight, of cast steel construction, with no part of the load carried by assembly bolts. Gearing shall be machine cut and heat-treated, and shall operate in an oil bath. Except for the drum pinion, no gears shall be cantilever mounted. Shafting shall be ground and polished and all bearings shall be of the antifriction type. Grease fittings and oil reservoir shall be readily accessible. The drum shall be of the large diameter, guarded, flanged type with machine cut grooves to accommodate the hoist cable without overwrapping. Right- and left-hand drum grooving shall be utilized in close-headroom, double-reeved, cross-mounted hoist applications to provide a true vertical lift. The wire ropes shall be of the preformed extra flexible type, have a safety factor of at least five, and be anchored to the hoist drum. The load block shall be of the safety type with guarded sheaves and forged swiveled hooks. Hooks shall open slowly when subjected to heavy overloads.
1. Electrically driven hoists shall include variable frequency control with 2-step in, direct coupled motor, electrical controls, and solenoid brake. The solenoid brake shall be spring set with magnetic release operated by and interlocked with the electrical control equipment. Either a worm gear drive with an inherent load brake or a mechanical load brake designed in accordance with the Hoist Manufacturer's Institute standards shall be provided for controlling the speed when lowering, and for holding maximum hook load for any load up to capacity. Stressed parts shall be of cast or forged steel. In the event of a power failure the braking system shall automatically lock the piece of equipment being lifted to prevent further movement. Hoists shall also include either a clutch-type or electric-type overload cut-off device to protect hoist from an overload condition.
  2. Manual hoists shall include a handwheel and chain and a clutch-type overload cut-off device to protect hoist from an overload condition.
- D. Rated capacity of trolley hoists shall be painted with stencil on the trolley hoist.

## 2.08 ELECTRICAL AND CONTROL REQUIREMENTS

- A. Electrical power wiring and connection to the electrical system not integral to the equipment shall be provided under Division 16, Electrical. All other power wiring associated with and integral to the hoist systems shall be furnished and installed under Division 14.
- B. All electrical appurtenances furnished by the equipment manufacturer shall be rated for installation in classified areas where such areas are indicated on the Drawings or specified herein.

- C. All wiring between motor, limit switches and starters shall be short, compact and protected by rigid galvanized steel conduit or flexible steel neoprene jacketed cable. In corrosive areas, rigid galvanized steel conduit shall be PVC coated.
- D. The Electrical System providing power to the bridge crane drives, trolley drives, and hoists shall be either the insulated channel conductor type or the festoon type as specified herein.
1. Insulated Channel Conductor Type: An insulated channel conductor shall be supplied along the bridge crane rails and girder or monorail where specified herein. The conductor shall be capable of carrying 100 amperes per pole, 3-phase, 460V. The conductor shall be supported as recommended by the manufacturer. The conductor shall be "Saf-T-Bar" enclosed electrification as manufactured by Howell Corporation, Midland Ross, SAFPOWER as manufactured by Cleveland Tramrail, Duct-O-Bar, Magnetek, Conductix, or equal. The conductor channels shall be of stainless steel, flame retardant, amply double insulated. The system shall permit longitudinal movement of the housing and busways only to the extent to allow for expansion and contraction. An expansion joint section shall be provided as required for expansion and contraction and still maintain true alignment. Collectors shall be of the type required by the conductor manufacturer.
- E. Starting equipment shall be integral with the crane drives and/or trolley hoist unit with three overload elements. Equipment shall be housed in an enclosure suitable to the conditions of service and as specified herein.
- F. Hoisting motors shall be a two-speed motors. The trolley motors shall be a single speed squirrel cage induction motors NEMA Design "D". Motors shall be of the totally enclosed type designed for hoist service. The motor rating shall be on a 30-minute 55°C, duty cycle basis.
- G. Electrical/Control Requirements

|                           | <b>Lift Station</b>         |
|---------------------------|-----------------------------|
| Area Classification       | Unclassified                |
| NEMA Rating of Components | NEMA 4X                     |
| Electrical System         | Insulated Channel Conductor |
| Control System            | Pendent                     |
| <b>Motors</b>             |                             |
| Rating                    | 460V, 3 ph, 60 Hz           |
| Bridge Motor HP           | -                           |
| Trolley Motor HP          | -                           |
| Hoist Motor HP            | 5                           |
| Enclosure                 | TEFC                        |
| Insulation                | Class F                     |
| Inverter Duty             | No                          |
| Service Factor            | 1.15                        |
| Space Heater              | Yes                         |



|                                       |     |
|---------------------------------------|-----|
| Motor Winding<br>Temperature Switches | Yes |
|---------------------------------------|-----|

- H. Limit switches shall be approved geared typed, positive in action, compact, oil proof and readily accessible. Solenoid brakes shall be disk type, spring set with magnetic release. Solenoids shall be totally enclosed, protected from oil and moisture, readily accessible for adjustment and maintenance and shall develop the required forces without overheating.
- I. All electrical and control components shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

## 2.09 CONTROLS

- A. The Control System providing control of the bridge crane drives, trolley drives, and hoists shall be either through wired pendent controls or wireless radio controls as specified herein.
  - 1. Pendent controls for lift and travel shall be provided complete with heavy-duty push-button station of constant pressure type with silver-to-silver contact elements, and sufficient control cable and chain for support of the control station at a point 4 feet above the lowest operating floor where multiple levels are to be accessed. A balancer shall be provided which will allow the control pushbutton station to be retracted to a maximum of four feet above the upper operating level. Two speed control of the hoist drive shall be effected by a two-step pushbutton. Pendant controls shall be suspended from the hoist for monorail applications. Pendant controls shall be suspended independently from the hoist using a c- track festoon for bridge crane applications.]
- B. Control power shall be 120 volt, provided by a control power transformer within the starter units. One side of this transformer shall be grounded, the other side shall be connected via a fuse of adequate rating.

## PART 3 -- EXECUTION

### 3.01 MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for each crane and hoist system:

| Service                  | Number of Trips | Number of Days/Trip |
|--------------------------|-----------------|---------------------|
| Installation and Testing | 1               | 1                   |
| Startup and Training     | 1               | 1                   |
| Services after Startup   | 1               | 1                   |

### 3.02 INSTALLATION

- A. All crane equipment shall be installed in accordance with the applicable sections of Division 5 - Metals, Division 16 – Electrical, and the manufacturer's instructions and recommendations.

### 3.03 FIELD TESTS

- A. Field tests shall be conducted in accordance with Section 11000 and the manufacturer's instructions and recommendations. Prior to initial use, all cranes shall be proof-tested at 125% of their rated load in accordance with all OSHA requirements.

### 3.04 PAINTING

- A. The crane shall be painted OSHA safety yellow before shipment.
- B. A wire-brushing and/or solvent wipe shall be performed prior to painting to clean and remove debris, mill scale, dirt, and oils.
- C. At least one spray can of matching color paint shall be shipped with each crane for field touch-ups.
- D. The crane shall be properly banded and skidded prior to shipment. Any paint damage, scratches, blemishes to the finish of the crane, caused by shipping, transportation via common carrier, etc., shall be repaired by the Contractor.
- E. Rated capacity of crane system shall be painted with stencil on all components of crane system as specified herein.

- END OF SECTION -

## SECTION 15000

### BASIC MECHANICAL REQUIREMENTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.
- B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.
- C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.
- D. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.
- E. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.
- F. The work shall include, but not be limited to, the following:
  - 1. Connections to existing pipelines.
  - 2. Pothole as necessary to locate or verify existing pipe and appurtenances.
  - 3. Installation of all new pipe and materials required for a complete installation.
  - 4. Cleaning, testing and disinfecting as required.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 1, General Requirements
- B. Division 2, Sitework
- C. Division 5, Metals
- D. Division 9, Finishes
- E. Division 11, Equipment
- F. Division 16, Electrical

### 1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

- A. The Contractor shall furnish to the Owner (through the Engineer) a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.
- B. Shop Drawings for major piping (2-inches in diameter and greater) shall be prepared and submitted in accordance with Section 01300 – Submittals. In addition to the requirements of Section 01300 – Submittals, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.
- C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

## PART 2 -- PRODUCTS

### 2.01 GENERAL

- A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
- B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in Section 3.09.
- C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 15390, Schedules.

- D. ALL BURIED EXTERIOR PIPING SHALL HAVE RESTRAINED JOINTS FOR THRUST PROTECTION UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS. ALL EXPOSED EXTERIOR PIPING SHALL HAVE FLANGED JOINTS, UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS.
- E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

## 2.02 WALL PIPES

- A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

| <u>Pipe Size</u> | <u>Waterstop<br/>Flange Diameter</u> | <u>Waterstop<br/>Flange Thickness</u> |
|------------------|--------------------------------------|---------------------------------------|
| 4" - 12"         | OD + 3.10"                           | 0.50"                                 |
| 14" - 24"        | OD + 4.15"                           | 0.75"                                 |
| 30" - 36"        | OD + 4.50"                           | 1.00"                                 |
| 42" - 48"        | OD + 5.00"                           | 1.25"                                 |
| 54"              | OD + 5.90"                           | 1.50"                                 |

## 2.03 SLEEVES

- A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured, or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.
- B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer's approval is obtained. Steel sleeves shall be fabricated of structural steel plate in accordance with the standards and procedures of

AISC and AWS. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09900 – Painting.

- C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by Garlock Pipeline Technologies (GPT) or equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the manufacturer's recommendations. For non-fire rated walls and floors, pressure plate shall be glass reinforced nylon plastic with EPDM rubber seal and 316 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and low carbon steel, zinc galvanized bolts and nuts.
- D. Cast iron mechanical joint adapter sleeves shall be Clow # 1429, as manufactured by the Clow Corp., or equal. Mechanical joint adapter sleeves shall be provided with suitable gasket, follower ring, and bolts to effect a proper seal. In general, sleeves installed in walls, floors, or roofs against one side of which will develop a hydrostatic pressure, or through which leakage of liquid will occur, shall be so sealed. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange.

#### 2.04 SOLID SLEEVE COUPLINGS (FOR BURIED SERVICE THROUGH 54-INCH)

- A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal. Solid sleeve couplings shall be restrained with wedge-type restraining glands to meet the pressures specified in 15390.
- B. Alternatively, EBAA Iron 3800 Mega-Coupling is acceptable.

#### 2.05 NOT USED

#### 2.06 FLANGED COUPLING ADAPTERS

- A. Flanged coupling adapters shall be restrained, furnished as required and as shown on the Drawings, and suitable for use with steel, ductile iron, and PVC pipe.
- B. Flanged adapters shall be made of ductile iron conforming to ASTM A536, have flange bolt circles that are compatible with the mating flange, and shall be rated for the same pressure as the connected piping.
- C. Restraint for flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.

- D. The flange adapters shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6 inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
- E. The flange adapter shall be the Series 2100 Megaflange Restrained Flange Adapter as produced by EBAA Iron, Inc., or approved equal.  
Flanged coupling adapters shall be provided with manufacturer's fusion bonded epoxy painting system, and type 316 stainless steel nuts and bolts.

## 2.07 DISMANTLING JOINTS

- A. Dismantling joints shall be furnished at locations shown on the Drawings.
- B. Dismantling joints for sizes less than 12-inch shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping. Dismantling joints for sizes greater than 12-inches shall be of carbon steel construction and shall be rated for the same pressure as the connected piping.
- C. Flanges for dismantling joints shall match the bolt pattern and pressure rating of the flanges for the connected piping.
- D. All dismantling joints shall be restrained utilizing restraining rods provided by the manufacturer. Restraining rods, bolts, and nuts shall be constructed from type 316 stainless steel. Restraining rods and restraint system shall be installed in strict accordance with manufacturer's recommendations.
- E. Dismantling joints shall be provided with manufacturer's fusion bonded epoxy painting system.
- F. Dismantling joints shall be Viking Johnson Dismantling Joint , Smith Blair Model 975, Romac Industries Model DJ400, or equal.

## 2.08 NOT USED

## 2.09 TAPPING SLEEVES AND TAPPING SADDLES

- A. Tapping sleeves shall be similar to Mueller Outlet Seal, American Uniseal or Kennedy Square Seal. All sleeves shall have a minimum working pressure of 150 psi. All sleeves larger than twelve (12) inches shall be ductile iron. All taps shall be machine drilled; no burned taps will be allowed.
- B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall

be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or equal. All taps shall be machine cut, no burned taps will be allowed.

## 2.10 UNIONS

- A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.
- B. For copper piping, unions shall have ground joints and conform to ANSI B16.18.
- C. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

## 2.11 THERMOPLASTIC TUBING AND FITTINGS

- A. Thermoplastic tubing shall be manufactured from polyallomer tubing. Tubing shall be protected from ultraviolet radiation degradation with a black coating or integral color conforming to ASTM D-1248, Type 1, Class C, Category 3. Fittings and connectors used with thermoplastic tubing shall be the flareless tube type constructed of brass conforming to SAE CA377, SAE CA360 or equal. Brass sleeves shall be used.
- B. Assembly of the thermoplastic tubing shall consist of pushing the tubing into the fitting and hand tightening the nut with final tightening with a wrench. Care shall be taken not to overtighten the nut. Plastic tube racks and bend holders shall be provided for holding the tubing in position. Needle valves used with thermoplastic tubing shall be the globe type constructed with a brass body, stem and seat and Buna-N "O"-ring seals. Installation shall be in accordance with the manufacturer's recommendations. Thermoplastic tubing, shall be the Impolene (polyallomer) system and needle valves, fittings and connectors shall be the Poly-Flo with 261 UB Universal Nut and Sleeve system as manufactured by Imperial Eastman, or equal.

## 2.12 BOLTS AND NUTS FOR DUCTILE IRON OR STEEL FLANGES AND COUPLINGS

- A. Working Pressure  $\leq$  300 psi

Bolts, nuts, and washers for flanges and couplings shall be Type 316 stainless steel conforming to Heavy Hex Head ASTM A 193 (Grade B8M) for bolts, and Heavy Hex Head ASTM A 194 (Grade 8M) for nuts. Nuts and washers shall be coated using a three layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat. Coating shall be FluoroKote#1 by Metal Coatings Corp., Tripac 2000 Blue Coating System by Tripac Fasteners, or approved equal.

T-bolts and heavy hex nuts for mechanical joint pipe and fittings shall be High-Strength Low Allow steel. Nuts and t-bolts shall be coated using a three layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat.

- B. Working Pressure  $>$  300 psi



Bolts and nuts for flanges and couplings shall be AISI 4140/4142 alloy steel conforming to Heavy Hex Head ASTM A 193 (Grade B7) for bolts, and Heavy Hex Head ASTM A 194 (Grade 7) for nuts. Washers shall be provided for each nut and shall be ASTM F436 Type 3. Nuts, bolts, and washers shall be coated using a three layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat.

- C. Bolts shall extend through the nuts a minimum of 1/4-inch.

#### 2.13 BOLTS AND NUTS FOR FLANGES ON COPPER TUBING

- A. When both above ground adjoining flanges are bronze, use bronze bolts and nuts. Bolts shall conform to ASTM F 468, Grade C65100 or C63000. Nuts shall conform to ASTM F 467, Grade C65100 or C63000.
- B. When only one of the aboveground adjoining flanges is bronze, use Type 316 stainless-steel bolts and nuts conforming to ASTM A 193 (Grade B8M) for bolts and ASTM A 194 (Grade 8M) for nuts. Nuts and washers shall be coated using a three layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat.
- C. Connect to buried ferrous flanges with flange insulation kits. Bolts used in flange insulation kits shall conform to ASTM B 193, Grade B7. Nuts shall comply with ASTM A 194, Grade 2H. If the adjoining buried flange is bronze, use bronze bolts and nuts as described above, without a flange insulation kit.
- D. Provide washers for each nut. Washers shall be of the same material as the nuts.

#### 2.14 DIELECTRIC NIPPLES

- A. Dielectric nipples shall create a dielectric waterway to inhibit galvanic corrosion between two dissimilar metals. Dielectric nipples shall be Schedule 40 carbon steel with plastic lining conforming to the requirements of ASTM A53 and ASTM F1545, and shall be coated in accordance with Section 09900. Dielectric nipples shall be Victaulic Dielectric Waterway, or approved equal.

#### 2.15 THREADED INSULATING CONNECTIONS

- A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.
- C. Couplings shall be Lochinvar V-line or equal.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.
- B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.
- C. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.
- D. ALL EXCAVATION REQUIRED BY THIS CONTRACT SHALL BE UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION REQUIRED FOR THE INSTALLATION OF PIPE OR STRUCTURES SHOWN ON THE DRAWINGS.
- E. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work

within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

- F. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.
- G. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.
- H. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.
- I. JOINT DEFLECTION SHALL NOT EXCEED 75 PERCENT OF THE MANUFACTURERS RECOMMENDED DEFLECTION. Excavation and backfilling shall conform to the requirements of Section 02200 - Earthwork, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.
- J. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. UNDER NO CIRCUMSTANCES SHALL ANY OF THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCH.
- K. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.
- L. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.

- M. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.
- N. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.
- O. AT THE CLOSE OF EACH WORK DAY THE END OF THE PIPELINE SHALL BE TIGHTLY SEALED WITH A CAP OR PLUG SO THAT NO WATER, DIRT, OR OTHER FOREIGN SUBSTANCE MAY ENTER THE PIPELINE, AND THIS PLUG SHALL BE KEPT IN PLACE UNTIL PIPE LAYING IS RESUMED.
- P. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.
- Q. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used exceptions: closure pieces at manholes and areas where joint deflection is required.
- R. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.
- S. NOT USED.
- T. Detector tape shall be installed 12 inches below final grade and directly above all buried potable water and sewer force main piping. The tape shall be blue and silver and shall be clearly and permanently labeled "Water" or "Sewer". Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or equal.
- U. AT THE CLOSE OF WORK EACH DAY PIPELINE TRENCHES SHALL BE COMPLETELY BACKFILLED. IN PAVED AREAS THE SURFACE SHALL BE RESTORED AS SPECIFIED IN SECTION 02510, PAVING AND SURFACING, TO ALLOW FOR TRAFFIC OVER THE TRENCH DURING NON-WORKING HOURS. UNDER NO CONDITIONS SHALL ANY PIPELINE TRENCH BE LEFT OPEN DURING NON-WORKING HOURS.

### 3.02 REINFORCED CONCRETE PIPE, CONCRETE CULVERT, AND DRAIN PIPE

- A. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

### 3.03 PRESTRESSED CONCRETE PIPE

- A. The laying of prestressed concrete pipe shall be in accordance with the manufacturer's recommendations and shall conform to the applicable sections of AWWA Manual M-9. Prior to assembling the spigot end into the bell end, both ends shall be thoroughly cleaned and the rubber gasket and the bell end of the previously laid pipe shall be coated with vegetable soap furnished by the manufacturer.
- B. For each crew that is inexperienced in laying this type of pipe, one reliable man shall be furnished by the manufacturer's representative with and instructed in the use of a set of steel inserts and feeler gauge to be used in determining if the rubber gasket is in proper position prior to the joint being pushed or pulled home. An experienced crew may omit the use of a feeler gauge. In either method of operation, the Contractor shall be responsible for a good, proper and sound joint. Any joint found in later tests to be faulty shall be repaired to the satisfaction of the Engineer.
- C. After the pipe is "home" a cloth diaper (minimum 7-inches wide) supplied by the pipe manufacturer shall be placed and wired around the outside of the pipe at the joint. This diaper shall serve as a form for pouring a 1:2 cement-sand grout in the external recess.
- D. Great care shall be taken to prevent the concrete core or jacket or the steel bell and spigot rings from being damaged, and any core, jacket or ring damaged in any way shall be repaired or replaced by the Contractor to the satisfaction of the Engineer.

#### 3.04 DUCTILE IRON PIPE

- A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600.
- B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat workmanlike manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.
- C. UNLESS OTHERWISE APPROVED BY THE ENGINEER, FIELD WELDING OF DUCTILE IRON WILL NOT BE PERMITTED.

#### 3.05 PVC/CPVC AND HDPE PIPE

- A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.
- B. Plastic piping shall not be installed when the temperature is less than 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

#### 3.06 CARBON AND STAINLESS STEEL PIPE

- A. Installation of steel pipe shall be by skilled workmen and shall conform to the applicable sections of AWWA Manual M-11. Joints for steel piping shall be either screwed, welded, or flanged as shown on the Drawings or as specified.
- B. Welding in the field shall be performed only when requested on the shop drawings and permitted by the Engineer for carbon steel pipe. No welding of stainless steel pipe shall be allowed in the field. All field welds shall be radiographically inspected.
- C. Installation of the steel casing pipe shall be by skilled workmen and in accordance with the best standard practice for steel pipe installation. Joints for steel casing pipe shall be butt welded.
  - 1. The boring equipment to be used for installing the jacked casing shall be of such size and capacity to allow the boring to proceed in a safe and expeditious manner. The installation of the casing and boring of the hole shall be done simultaneously to avoid cave-ins or settlement and for safety of traffic above.
  - 2. The Contractor shall check the vertical and horizontal alignment of the casing by survey instrument at least once during each four feet of advance, or as directed by the Engineer. Pits shall be well sheeted and braced as necessary for safe and adequate access for workmen, inspectors and materials and shall be of a size suitable to equipment and material handling requirements.
  - 3. Under no conditions shall jetting or wet boring of encasement under pavement be allowed.
  - 4. After installation of the carrier pipe, each end of the casing pipe shall be made watertight with a brick masonry bulkhead. In addition, a Class B concrete cradle shall be provided from each end of the bulkhead to the first pipe joint outside of the bulkhead.

### 3.07 COPPER PIPE

- A. Installation of copper pipe shall be by skilled workman in accordance with the manufacturer's recommendations. Use teflon tape at all fittings unless otherwise required for intended service. Install unions at the connections to each piece of equipment to allow removal of equipment without dismantling connecting piping.
- B. Wall sleeves shall be provided for all piping passing through exterior walls and shall be of the same material as the piping to which it is joined. All wall sleeves shall be provided with an acceptable waterstop.
- C. The Contractor shall provide hot and cold water mains with branches and risers complete from point indicated on the Drawings running to all fixtures and other outlets indicated. Mains and branches shall be run generally as shown on the Drawings. The Contractor shall provide all interior water piping, branches, and risers as shown on the Drawing and

shall make connections to all plumbing fixtures, hose bibs, wall hydrants, and other points requiring water under this and other Divisions of the Specifications.

- D. All water mains and branches shall be pitched at least one (1) inch in twenty-five (25) feet toward fixtures. The piping installation shall be arranged so that the entire system can be drained through fixture supply connections. Pipe installed on inside walls shall be horizontally level.
- E. Unions shall be installed at the connections to each piece of equipment to allow for removal of equipment without dismantling connecting piping.
- F. Joints 1-1/4 inches and larger shall be made with silver solder. For joints less than 1-1/4 inches and all valves (regardless of size) use 95/5 solder. Soldered joints shall be prepared with a non-corrosive paste flux in accordance with manufacturer's instructions. All joints shall be thoroughly cleaned with emery cloth and reamed out before assembly. Acid core solder will not be permitted.

### 3.08 NOT USED

### 3.09 JOINTS IN PIPING

- A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.
- B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed, and the condition corrected.
- C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints. Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.
- D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution of mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be

inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

- E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.
- F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.
- G. Welded joints shall be made by competent operators in a first class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A251. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.
- H. Copper joints shall be thoroughly cleaned and the end of pipes uniformly flared by a suitable tool to the bevels of the fittings used. Wrenches shall be applied to the bodies of fittings where the joint is being made and in no case to a joint previously made. Dimensions of tubing and copper piping shall be in complete accordance with the fittings used. No flare joints shall be made on piping not suited for flare joints. Installations for propane gas shall be in accordance with NFPA 54 and/or 58.
- I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product



approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.

- J. Dielectric isolation such as flange isolation kits, dielectric unions, or similar, shall be installed wherever dissimilar metals are connected according to the following table.

|                                                                                                                                                                                                                                                                                                                                                                  | Zinc | Galvanized Steel | Aluminum | Cast Iron | Ductile Iron | Mild Steel/<br>Carbon Steel | Copper | Brass | Stainless Steel |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------|----------|-----------|--------------|-----------------------------|--------|-------|-----------------|
| Zinc                                                                                                                                                                                                                                                                                                                                                             |      |                  | •        | •         | •            | •                           | •      | •     | •               |
| Galvanized Steel                                                                                                                                                                                                                                                                                                                                                 |      |                  | •        | •         | •            | •                           | •      | •     | •               |
| Aluminum                                                                                                                                                                                                                                                                                                                                                         | •    | •                |          | •         | •            | •                           | •      | •     | •               |
| Cast Iron                                                                                                                                                                                                                                                                                                                                                        | •    | •                | •        |           |              |                             | •      | •     | •               |
| Ductile Iron                                                                                                                                                                                                                                                                                                                                                     | •    | •                | •        |           |              |                             | •      | •     | •               |
| Mild Steel/<br>Carbon Steel                                                                                                                                                                                                                                                                                                                                      | •    | •                | •        |           |              |                             | •      | •     | •               |
| Copper                                                                                                                                                                                                                                                                                                                                                           | •    | •                | •        | •         | •            | •                           |        |       | •               |
| Brass                                                                                                                                                                                                                                                                                                                                                            | •    | •                | •        | •         | •            | •                           |        |       | •               |
| Stainless Steel                                                                                                                                                                                                                                                                                                                                                  | •    | •                | •        | •         | •            | •                           | •      | •     |                 |
| 1. "•" signifies dielectric isolation is required between the two materials noted.<br>2. Consult Engineer for items not listed in table.<br>3. Provide flange isolation kits for all flanged connections of dissimilar metals and hardware including connections to equipment.<br>4. Contractor shall include all isolation descriptions with piping submittals. |      |                  |          |           |              |                             |        |       |                 |

- K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.
- L. Joints in polypropylene and polyvinylidene fluoride pipe shall be butt fusion weld. All butt welding shall follow the requirements of ASTM D-2657 and the manufacturer's recommendations.

### 3.10 FLUSHING AND TESTING

- A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. Air and gas pipelines shall be flushed and tested with compressed air. Gravity sewer piping shall be flushed and tested as specified in Section 02604 - Utility Structures. All other liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and

apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 15390 – Schedules, and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer reasonable notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right, within reason, to request flushing and testing of any section or portion of a pipeline.

- B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.
- C. Air and gas piping shall be completely and thoroughly cleaned of all foreign matter, scale, and dirt prior to start-up of the air or gas system.
- D. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.
- E. Compressed/service air and gas piping shall be flushed by removing end caps from the distribution lines and operating one (1) compressor, in accordance with the manufacturer's instructions.
- F. After flushing, all air piping shall be pressure and leak tested prior to coating and wrapping of welded joints. Immediately upon successful completion of the pressure and leak test, welded joints shall be thoroughly cleaned of all foreign matter, scale, rust, and discoloration and coated in accordance with the Specifications.
- G. All process air piping shall be leak tested by applying a soap solution to each joint. Leak tests shall be conducted with one (1) blower in service at normal operating pressure.
- H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.
- I. All buried process air piping shall be pressurized to 25 psig and tested for leaks by applying a soap solution to each joint. The air supply shall be stopped and the pipe pressure monitored. System pressure shall not fall by more than 0.5% of the 25 psig test pressure over a one-hour test period. Should the system fail to hold the required pressure for one hour, the cause shall be determined and corrected and the test repeated until a successful test of the entire system is obtained.

- J. Field leakage tests shall be performed for all submerged process air piping. The procedure shall consist of operating the system under clear nonpotable water for visual identification of all leaks. All field leakage tests shall be witnessed by the Engineer. All submerged piping shall be installed free of any leaks.
- K. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 15390 – Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600.
- L. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.
- M. After flushing, all gas piping shall be leak tested in accordance with all local codes and regulations and in conformance with the recommendations or requirements of any National Institute or Association for the specific service application.

### 3.11 DISINFECTION

- A. Following acceptable pressure testing, flush and disinfect all sections of the water distribution system and receive approval thereof from the appropriate agencies, prior to placing in service. Advance notice of 24 hours shall be provided to the Owner before disinfecting procedures start. The flushing and disinfection shall be accomplished in accordance with the applicable provisions of AWWA Standard C651, "Disinfecting Water Mains" and all appropriate approval agencies.
- B. Administration shall be by any of the several methods described in AWWA Standard C651 as proposed by the CONTRACTOR and approved by the ENGINEER. Proposals as to method must be approved prior to commencement of the disinfection process.
- C. The concentration of the dosage applied to the water within the pipeline shall be at least 50 ppm and shall not exceed 100 ppm. Chlorinated water must be retained in the pipeline long enough to destroy all non spore forming bacteria, and not less than 24 hours. After the chlorine treated water has been retained for the required time, the chlorine residual at the pipe extremities and at other representative locations shall be at least 25 ppm.
- D. During the period that the chlorine solution or slug is in the section of pipeline, valves shall be opened and closed to obtain a chlorine residual at hydrants and other pipeline appurtenances. Care shall be taken to ensure that no chlorinated water enters any active pipeline.
- E. Following contact with chlorine solution, the system shall be thoroughly flushed out per Section 6 of AWWA C651. Samples shall then be taken using sterile containers obtained

from the County Health Department. Samples shall be taken by the Contractor and delivered to the County Health Department or approved laboratory for analysis.

- F. If samples test positive for coliform organisms, the disinfection procedure shall be repeated until two series of satisfactory samples are obtained, the period between such series of samples to be a minimum of 24 hours. Contractor is responsible for all costs associated with repeat tests.
- G. Following disinfection, pipelines and appurtenances shall remain isolated from any operational water system facilities until evidence has been submitted to Owner demonstrating that the pipelines and appurtenances have been adequately and properly disinfected. Normally, pipelines and appurtenances shall be isolated for at least 48 hours, longer if so determined by the Owner.
- H. Sanitary construction methods must be followed during installation of the final connections so no contamination of the new or existing water main with foreign material or groundwater occurs. Materials used for final connections shall be disinfected in accordance with Section 9 of AWWA C651.
- I. All water used in testing and disinfecting the portions of pipeline, including that used for retesting, shall be disposed of following such testing, retesting, and disinfecting, by the Contractor at its own expense. Water may be discharged into storm drains where written permission is given by the governmental agency having jurisdiction over storm drainage facilities. If required by any agency having jurisdiction, the Contractor shall apply a reducing agent to the solution to neutralize residual chlorine or chloramines remaining in the water. The disposal of water shall, in all cases, be carried out in strict observance of the water pollution control requirements of the State Regional Water Quality Control Board and the State Water Resources Control Board. The flow of water from the portions of the pipeline shall be controlled to prevent erosion of surrounding soil, damage to vegetation, and altering of ecological conditions in the area.

### 3.12 PAINTING AND COLOR CODING SYSTEM

- A. All exposed piping specified shall be color coded in accordance with the Owner's standard color designation system for pipe recognition and in accordance with Section 15030 – Piping and Equipment Identification Systems. In the absence of a standard color designation system, the Engineer will establish a standard color designation for each piping service category from color charts submitted by the Contractor in compliance with Section 09900 – Painting.
- B. All piping specified in this Section shall be painted in accordance with Section 09900 – Painting, except as follows:
  - 1. Copper pipe
  - 2. Stainless steel pipe. Flanges and supports or hangers shall be painted.

- END OF SECTION –

## SECTION 15006

### DUCTILE IRON PIPE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. This section describes materials for ductile iron pipe and fittings. All ductile iron pipe and fittings for this project shall have restrained joints and be thickness class 52 minimum.
- D. Reference Section 15000, Basic Mechanical Requirements
- E. Reference Section 15390, Schedules, for pressure rating requirements for specific applications.

#### PART 2 -- PRODUCT

##### 2.01 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe (DIP) of the sizes shown or specified shall conform to ANSI A21.51 (AWWA C151), Grade 60-42-10 for ductile iron pipe centrifugally cast in metal molds or sand-lined molds. All ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) Thickness Class 52 minimum and shall be supplied in 18 or 20 foot nominal lengths or as required to meet the requirements of the Drawings. The minimum wall thickness for flanged or grooved end spools shall be thickness Class 53.
- B. Joints in above ground piping or piping located in vaults and structures shall be flanged, unless flange adapters are shown on the Drawings. Joints shall conform to the "American National Standard for Flanged Iron and Ductile Iron Pipe with Threaded Flanges," ANSI A21.15/AWWA C115. All flanges shall be flat faced and conform to the requirements of ANSI B16.1. Flanged pipe shall conform to the requirements of ANSI Specification A21.15, (AWWA C115). Pipe lengths shall be fabricated to meet the requirements of the Drawings. Blind flanges shall be fusion epoxy lined and coated.
- C. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of ANSI A21.11 (AWWA C111). Fittings and specials shall be supplied with mechanical joints as specified for mechanical joint pipe. If required by installation conditions, pipe shall have cast-on lugs for adequately tying it together.
- D. Mechanical joints fittings shall conform to the requirements of ANSI A21.11, (AWWA C111). Joints shall be made employing a tapered rubber gasket forced into a tapered groove with a ductile iron follower ring. If required by installation conditions, pipe and fittings shall have cast-on lugs for adequately tying the pipe and fittings together.

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These shall be in conformance with standard practice and as outlined under the appropriate AWWA Specifications.

- E. Restrained joint pipe shall consist of factory manufactured bolted retainer rings, ductile iron locking segments held in place by rubber retainers, or ductile iron retaining rings that lock over the bell of the joint and are secured to prevent rotation, and factory welded retainer beads or rings on the spigot of the pipe. All components of the bolted or snap ring assemblies shall be constructed of corrosion-resistant, high strength, low-alloy steel coated using a three layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat. Restrained joint pipe shall be Flex-Ring or Lock-Ring type joints as manufactured by American Cast Iron Pipe Company, HP LOK or TR Flex as manufactured by US Pipe, Bolt-Lok or Snap-Lok as manufactured by Griffin Pipe Products, TR Flex or Super Lock as manufactured by Clow Water Systems Co., or approved equal.
- F. Restrained fittings for piping systems 16-inches in diameter and greater shall have factory restraint systems identical to the factory restrained joint pipe specified above. All fittings shall be minimum Thickness Class 52 unless otherwise specified.
- M. Restrained fittings for pipe systems 14-inches in diameter and smaller shall be Mechanical Joint fittings with restraint assemblies such as Stargrip by Star Pipe Systems, Mega Lug by EBAA Iron, ONE LOK by Sigma, Grip Ring by Romac, or approved equal. Where threaded-rods are allowed, the rods and tabs shall be designed for the specified restraint system design pressure, shall have lengths less than 10 feet between fittings, and shall be painted with two heavy coats of coal tar epoxy after installation.
- N. The manufactured systems for thrust restraint indicated above shall be used where restrained joint ductile iron pipe and fittings are specified or indicated on the drawings. Gripping gaskets are not an acceptable form of restraint. Thrust restraint and harnessing systems such as threaded-rods, friction clamps, retainer glands shall be used only where specifically specified herein, indicated on the drawings or if allowed by the Engineer in isolated applications where conditions warrant and necessitate their use. Concrete thrust blocks may be used in accordance with the schedule indicated on the drawings, if applicable.

## 2.02 PIPE LINING

- A. Unless called out otherwise in the plans, all pipe and fittings used for conveying potable or raw water shall be cement mortar lined. Linings shall conform to American Standard Specifications for Cement Mortar Lining for Cast Iron Pipe and Ductile Iron Pipe and Fittings, ANSI A21.4 (AWWA C104) and shall be double thickness. The mortar lining shall be protected with the bituminous seal coat.
- B. The interior of pipe and fittings used for conveying sewer shall be lined with an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment, applied to 40 mils minimum dry film thickness. Lining shall be Protecto 401®, or approved equal. Gasket area and spigot end of pipe shall be coated using Protecto Joint Compound, 6 mils nominal thickness. Lining shall be installed and tested in strict accordance with lining manufacturer's specifications.

- C. Where called for in the plans, pipe and fittings shall be fusion-bonded epoxy lined and coated (FBEL&C) in accordance with ANSI/AWWA C116. The lining and coating material shall be 100 percent powder epoxy, certified as compliant with NSF Standard 61. Coating and lining shall be Scotchkote 134, 206N, or approved equal, applied to a minimum dry film thickness of 14 mils.

## 2.03 PIPE COATINGS

- A. The exterior surfaces of pipe and fittings located indoors, in vaults and structures, and above ground shall be coated per Section 09900. Prime coat shall be factory applied; finish coats shall be applied in field.
- B. The exterior surfaces of all buried pipe and fittings shall be factory coated with a petroleum asphaltic material, 1 mil minimum thickness, per AWWA C110 and C151.

## 2.04 FLANGE GASKETS

- A. Flange Gaskets: All gaskets shall be full-face gaskets with a thickness of 1/8-inch, with a bolt hole pattern matching the flange drilling pattern. The use of jointing compounds, release agents, lubricants, grease, or adhesives on either the gasket or flange faces is not allowed unless specifically recommended by the Manufacturer. Manufacturer shall provide bolt torques required for each pipe diameter and working pressure. Gaskets shall meet the following requirements:

- 1. Working Pressure  $\leq$  150 psi

Gasket shall be full face, NSF-61 certified EPDM or Viton (fluoroelastomer), and shall be in accordance with ANSI/AWWA C111/A21.11. Flanged gaskets shall have a rated working pressure of at least 150 psi, a rated maximum pressure of at least 200 psi, and shall have at least three (3) bulb type rings molded into both faces of the gasket to reduce bolting torque. Flanged gaskets shall be U.S. Pipe Full-Face Flange-Tyte Gasket, Garlock Stress Saver XP, or approved equal.

- 2. Working Pressure  $>$  150 psi up to 350 psi

Gasket shall be full-face type, NSF-61 certified, compressed non-asbestos synthetic fibers with an elastomeric binder, a rated working pressure of at least 350 psi, and shall swell when contacted with water to enhance sealing properties. Gasket shall be Garlock Multi-Swell Style 3760-U, or approved equal.

## 2.05 OUTLETS

- A. For outlets 3 inches and smaller, use a ductile iron tapping saddle.
- B. For outlets 4 inches and larger, use a tee with a flanged outlet.

## 2.06 POLYETHYLENE ENCASEMENT

- A. Wrap all buried ductile iron pipes, valves and fittings with 8 mil polyethylene film per ANSI A21.5/AWWA C-105. Use only tube type for pipe. Complete the wrap prior to placing concrete anchors, collars, supports or thrust blocks. Repair polyethylene if damaged during installation.

## 2.07 CAST IRON SOIL PIPE

- A. Cast Iron Soil Pipe shall conform to the standards of the Cast Iron Soil Pipe Institute (CISPI) Specification HS-67, and also ANSI Specification A-112.5.2 for Hub & Spigot pipe or A.112.5.1 for Hub & Spigot pipe or A.112.5.1 for No-Hub Pipe. Pipe class shall be "Extra Heavy: (XH).

- END OF SECTION -



## SECTION 15020

### PIPE SUPPORTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and design calculations required to provide pipe supports in accordance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01350 – Seismic Anchorage and Bracing
- B. Division 3, Concrete – Appropriate and Related Sections
- C. Section 05010 – Metal Materials
- D. Section 05035 – Galvanizing
- E. Section 05050 – Metal Fastening
- F. Section 05120 – Structural Steel
- G. Section 15000 – Basic Mechanical Requirements

##### 1.03 SUBMITTALS

- A. Applicable and associated cut sheets and drawings for materials and support components shall be submitted with the Shop Drawings in accordance with or in addition to the submittal requirements specified in Section 01300 – Submittals, Section 15000 – Basic Mechanical Requirements, and other referenced Sections above.
  - 1. Catalog cut information on all system components such as pipe supports, hangers, guides, anchors, and channel -type supports.
  - 2. Drawings of the piping support systems, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide and anchor type by catalog number and Shop Drawing detail number.
  - 3. With each piping support system Shop Drawing, the Contractor shall attach calculations prepared and sealed by a Professional Engineer licensed in the State of California showing that the piping support system complies with the specified requirements, including all building code and seismic code requirements pertaining to support of piping and other non-structural components. See Section 01350 – Seismic Anchorage and Bracing.

4. Table showing the manufacturer's recommended hanger support spacing for PVC, CPVC and FRP pipe for the services listed in Section 15390 - Schedules.

#### 1.04 QUALITY ASSURANCE

- A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Professional Engineer licensed in the State of California.

### PART 2 – PRODUCTS

#### 2.01 GENERAL

- A. The Contractor shall be responsible for the design of all piping support systems not specifically designed by the Engineer and detailed on the Drawings. The supports typically detailed on the Drawings, not included on Standard Detail Drawings, are designed to resist resulting external thrust forces in addition to gravity, seismic and other applicable loads required by the governing building code.
- B. No attempt has been made to show all of the required pipe supports either on the main Drawings or on the standard detail drawings. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility of providing them throughout the project at no additional cost to the Owner.
- C. Where special pipe support fabrications are required, products and execution shall be as specified in Section 05500 - Metal Fabrications and other related and referenced Sections of the Specifications.
- D. Existing piping support systems to support new piping shall only be used if the Contractor can show and demonstrate by submitting supporting calculations that they are adequate for the additional load imposed by the new piping, or if they are strengthened to support the additional load.
- E. Design Criteria for Piping Support Systems:
  1. Design pipe supports for dead loads imposed by the weight of the pipes filled with water, except for air and gas pipelines, plus the weight of insulation. If applicable by location, ice loads per code shall be applied as indicated in the governing building code.
  2. Design for the thermal expansion and contraction of the piping and its associated pipe support and pipe expansion systems and couplers.
  3. Design the pipe supports for all seismic loading requirements and conditions as specified in the governing building code and referenced seismic design codes. Refer to Section 01350 - Seismic Anchorage and Bracing and the structural code drawing for seismic design criteria to be used for this particular project.

4. A minimum safety factor of 2 or as approved by the Engineer, based upon the yield strength of the support material, shall be used for pipe supports, braces, hangers, and guides as well as for beam and column members used in channel-type support systems.
5. The horizontal pipe hanger and/or floor support spacing shall be as recommended by the pipe and/or hanger manufacturer, but shall not exceed 10 feet on center unless indicated otherwise herein or on the Drawings.
6. Seismic and sway bracing shall be provided at maximum 10-foot centers.
7. The design, sizing and spacing of anchor bolts, including concrete anchors, shall be based on withstanding shear and pullout loads imposed by loading at each particular support. The minimum anchor bolt size shall be ½ inches in diameter. Refer to Section 05830 – Bearing Devices and Anchoring.
8. Pipe support design shall not utilize process equipment for thrust restraint or support of piping loads.

## 2.02 HANGERS AND SUPPORTS

- A. All piping shall be adequately supported and braced by means of steel hangers and/or supports, concrete piers, supplemental lateral bracing components, pre-fabricated brackets, or otherwise as may be required by the location and forces applied per governing code, including gravity and lateral forces from earthquake and/or wind (if exterior). Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure. Refer to Standard Detail Drawings.
  1. Metal pipe support materials, where stainless steel pipe is supported, shall be Type 304 stainless steel meeting the requirements of Section 05061 - Stainless Steel.
  2. Metal pipe support materials, where carbon steel, ductile or other ferrous pipe is supported, shall be galvanized carbon steel meeting Section 05120 - Structural Steel and Section 05035 - Galvanizing unless indicated otherwise on the Drawings or in the specifications or by the Engineer.
  3. Metal pipe supports indicated as standard type pipe hangers are designed and detailed for gravity loading only. Resulting lateral loads from wind, earthquake, or other lateral loads per code, or special loading conditions during construction, shall be applied to the pipe in accordance with the governing building code. Supplemental lateral stiffening members (when necessary) shall be provided along pipe or at gravity supports using appropriate supplemental members and connections when required by calculations. The Contractor shall include design calculations and details with all pipe hanger and support submissions for review by the Engineer. The main structure and structural components that will support

the pipe hangers and other appurtenant components of the facility have been designed to resist all resulting secondary lateral loading from pipe hangers and other non-structural members for gravity and resulting lateral loads.

B. Hangers and supports shall conform to the following requirements:

1. All fabricated metal hangers and supports shall be capable of adjustment after installation. Different types of hangers and supports along a pipe length, including bends, shall be kept to a minimum.
2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.
3. Vertical piping shall be properly supported at each floor and between floors by stays or braces to prevent rattling and vibration.
4. Supports and hangers for plastic and FRP piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.
5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless-steel hangers.
6. Ferrous pipes to be painted shall be painted in accordance with Section 09900 - Painting. Ferrous pipes that require painting or galvanizing shall be supported by galvanized hangers and supports. Stainless steel piping shall be supported by stainless steel saddles and straps (if required).
7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.
8. Plastic piping shall be supported by plastic coated steel hangers and supports.
9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.
10. Expansion and adhesive type anchors used for pipe hangers and supports shall be Type 304 stainless steel.

C. Metallic hangers and supports may be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction. All gravity type hangers and supports shall be restrained laterally to resist seismic loading and other loading as required by the governing code.

D. Non-metallic support system shall be a heavy-duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping

accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Contractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Contractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

### PART 3 -- EXECUTION

#### 3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Support piping connections to equipment by pipe support and not by the equipment.
- B. Support large or heavy valves, fittings, flow meters and appurtenances independently of the connected piping.
- C. Support no pipe from the pipe above it.
- D. Support piping at changes in direction or in elevation, adjacent to flexible joints, expansion joints, and couplings, and where shown.
- E. The Contractor shall not install piping supports and hangers in equipment access areas or bridge crane runs.
- F. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
- G. Install pipe anchors (fixed supports and/or guides) where shown and/or as may otherwise be required to withstand expansion thrust loads and to direct and control thermal expansion. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that complete details describing location, pipe supports and hydraulic thrust protection are submitted.

- END OF SECTION -

## SECTION 15030

### PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping. The Contractor shall paint the equipment and piping of all Contracts in the colors herein specified, and in accordance with the requirements of Section 09900, Painting.
- B. In addition to the legends specified herein the Engineer may order the Contractor to furnish and install additional identification legends and arrows at no additional cost to the Owner. Such additional signs may be requested near completion of the work and shall be limited to no more than five (5) signs for each type specified herein. The legends and color combinations for additional signs shall conform to the requirements specified herein.
- C. The Contractor shall submit a schedule of the colors and designations proposed in accordance with Section 01300, Submittals, and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.
- D. Reference Section 15000, Basic Mechanical Requirements.

#### PART 2 -- PRODUCTS

##### 2.01 PIPING BAND

- A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on centers regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefabricated metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer.

##### 2.02 PIPING IDENTIFICATION LEGEND

- A. The Contractor shall apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Engineer. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form, and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type, Seton nameplate "setmarks", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

Diameter of Pipe or Pipe CoveringHeight of Lettering

3/4 to 1-1/4 inches  
 1-1/2 to 2-inches  
 2-1/2 to 6-inches  
 8 to 10-inches  
 Over 10-inches

1/2-inches  
 3/4-inches  
 1-1/4-inches  
 2-1/2-inches  
 3-1/2-inches

- B. Identification lettering shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading. In the event lettering and arrow identifications are required for piping less than 3/4-inch in diameter, the Contractor shall furnish and attach approved color coded tags where instructed.
- C. The colors referenced in the legend are as manufactured by KOP-COAT. They are used for convenience only.
- D. Piping and Equipment Identification

| Service                         | Legend            | Base                               |
|---------------------------------|-------------------|------------------------------------|
| Sanitary and Process Drains     | Drain             | Grey                               |
| Filtrate                        | Filtrate Drain    | Grey                               |
| Sludge Digested Primary         | DPS               | Medium Brown                       |
| Supernatant                     | Supernatant       | Light Brown                        |
| Digested Waste Activated Sludge | DWAS              | Medium Brown                       |
| Process Air                     | Process Air       | Dark Green                         |
| Chlorine Solution               | Chlorine Solution | Not Painted                        |
| Potable Cold Water              | Potable Water     | Light Blue                         |
| Potable Hot Water               | Potable Water-Hot | Light Blue                         |
| Nonpotable Water                | Nonpotable Water  | Light Green                        |
| Seal Water Piping               | Seal Water        | Light Green                        |
| Natural Gas Piping              | Natural Gas       | Safety Orange                      |
| Caustic Solution                | Caustic Solution  | Alternating Orange and Yellow Tape |
| Hydrants                        | -                 | Red                                |
| Alum                            | Alum              | Not Painted                        |

## Piping and Equipment Identification

| Service                                                                 | Legend             | Base              | Band              |
|-------------------------------------------------------------------------|--------------------|-------------------|-------------------|
| Sanitary and Process Drains                                             | Drain              | 356 Dune Brown    | -                 |
| Filtrate Drains                                                         | Filtrate Drain     | 356 Dune Brown    | -                 |
| Primary Sludge                                                          | Primary Sludge     | 334 Light Brown   | 306 Light Grey    |
| Return Activated Sludge                                                 | Return Act. Sludge | 334 Light Brown   | 303 Dark Blue     |
| Waste Activated Sludge                                                  | Waste Act. Sludge  | 334 Light Brown   | 300 Aqua          |
| Thickened Sludge                                                        | Thickened Sludge   | 334 Light Brown   | 339 Medium Yellow |
| Scum Piping                                                             | Scum               | 334 Light Brown   | 305 Olive Green   |
| Service Air                                                             | -                  | 365 Vista Green   | -                 |
| Process Air                                                             | Process Air        | 365 Vista Green   | -                 |
| Chlorine Gas                                                            | Chlorine Gas       | 319 Light Yellow  | -                 |
| Chlorine Solution                                                       | Chlorine Solution  | 339 Medium Yellow | -                 |
| Spray Piping                                                            | -                  | 307 Medium Green  | 303 Dark Blue     |
| Potable Cold Water                                                      | Potable Water      | 301 Light Blue    | -                 |
| Potable Hot Water                                                       | Potable Water-Hot  | 303 Dark Blue     | -                 |
| Nonpotable Water                                                        | Nonpotable Water   | 300 Aqua Green    | 315 Tile Red      |
| Heating (HVAC) Piping                                                   | HVAC               | 324 Orange        | -                 |
| Seal Water Piping                                                       | Seal Water         | 336 Jade Green    | -                 |
| Natural Gas Piping                                                      | Natural Gas        | 315 Tile Red      | -                 |
| Sump Discharge Piping                                                   | Sump Pump Disch.   | 332 French Grey   | -                 |
| Dewatering Pump Piping                                                  | -                  | 300 Aqua Green    | -                 |
| Grit Pumping                                                            | Grit               | 300 Aqua Green    | 315 Tile Red      |
| Caustic Solution                                                        | Caustic Solution   | -                 | -                 |
| All valves, pumps, motors,<br>hoist and monorails                       | -                  | 324 Orange        | -                 |
| Scum Operators, Scum<br>Collectors, Slide Gate<br>Frames and Hose Lines | -                  | 305 Olive Green   | -                 |
| Hydrants                                                                | -                  | 319 Light Yellow  | -                 |



## SECTION 15095

### VALVES, GENERAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.
- B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM Designation A-126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B."
- C. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.
- D. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Contractor shall verify valve flange drilling is compatible with pipeline flanges prior to ordering flanged valves. All bolt heads and nuts shall be per Section 15000. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.
- E. Provide valves complete with operating hand wheels, levers, chain wheels, extension stems, floor stands, worm gear operators, operating nuts, chains, and wrenches required for operation.
- F. Valve Lining and Coating: Unless specified otherwise below, all cast or ductile iron surfaces shall be lined and coated with a fusion bonded thermosetting powdered epoxy, 12 mil minimum thickness.
- G. All products in contact with potable water shall be certified to NSF-61 and, where applicable, NSF-372 standards, per California Health and Safety Code Section 116875 (California AB-1953).
- H. Valves installed above ground shall be painted after installation per Section 09900 to match adjacent piping.

## 1.02 SUBMITTALS

- A. The Contractor shall furnish to the Owner, through the Engineer, a Performance Affidavit where required in individual valve specifications, utilizing the format specified in Section 11000, Equipment General Provisions. Performance tests shall be conducted in accordance with the latest revision of AWWA C500 and affidavits shall conform to the requirements of the Specifications
- B. Shop Drawings conforming to the requirements of Section 01300, Submittals, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.
- C. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

## PART 2 -- PRODUCTS

### 2.01 FLOW INDICATORS

- A. Flow indicators shall be the Akron ball-type as manufactured by Brooks Instrument Co., Fischer and Porter, or equal, and shall have bronze bodies, glass dome, and plastic ball.

### 2.02 NOT USED

### 2.03 FLOOR BOXES

- A. Floor boxes shall be provided for all nut operated or floor accessed valves. Floor boxes shall be of the adjustable, sliding type, cast iron, suitable to withstand heavy traffic, as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., or equal. The covers shall be marked with appropriate designations of piping contents (i.e.: water, sewer) and bases shall be the round type. All nut operated valves in this Section shall be clearly identified by stainless steel or laminated plastic identification tags. The tags shall be permanently affixed to the inside of the floor boxes, under grating, etc. and shall bear the embossed letters which clearly identify each valve by its appropriate designation.
- B. Two (2) valve operating wrenches shall be supplied in 4 foot lengths with tee handles for each size nut supplied. Valve wrenches shall be Model No. F-2520 as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Figure No. 122, or equal.

## 2.04 VALVE BOXES

- A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.
- B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.
- C. All valve boxes shall be per City Standards unless otherwise specified due to a non-city standard installation.

## 2.05 STRAINERS

- A. Y-Strainers shall be Y-pattern cast iron body, flanged or screwed ends with stainless steel or Monel, 20 mesh strainers. Strainers shall be 200 psi, cold-water service strainers, as manufactured by WATTS, Crane Co., Zurn, or equal.
- B. Caustic service Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.
- C. Stainless steel Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.
- D. PVC and CPVC y-strainers shall be provided in PVC and CPVC piping and as shown on the Drawings. Strainer shall be provided with PVC or CPVC body and end cap, EPDM or Viton seal as required for the chemical service, and 20 mesh screen. Temperature rating shall be 30°F to 140°F, and pressure rating shall be 150 psi @ 70°F, non-shock. PVC and CPVC y-Strainers shall be as manufactured by Asahi/America, Hayward, or equal.
- E. Manually cleaned strainers shall be the duplex basket tapered plug type.
  - 1. Strainers 3-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard.
  - 2. Strainers less than 3-inches in diameter shall have screwed end connectors, unless otherwise shown on the Drawings.
  - 3. Strainers shall be constructed with an ASTM A48, Class 30 cast iron body, ductile iron trim, removable 0.045 inch staggered hole perforation, 304 stainless steel filter baskets and gauges on the inlet and outlet.

4. All strainers shall be suitable for 125 psi service.
  5. Switching flow from one basket to the other shall be accomplished by moving the handle through a 180° arc. The switching operation shall not stop flow through the strainer and shall provide for on-line removal of either basket with the other basket functional. The plug shall be automatically positioned with integral stops and shall be easily lifted and reseated under pressure.
  6. The strainer shall be designed to minimize the possibility of material bypassing the plug while being rotated and to prevent debris from building up under the plug. The strainer covers shall be designed for quick opening with swing away yoke.
  7. Each basket compartment shall have a side drain outlet.
  8. All strainers shall be provided with support legs.
  9. Duplex basket strainers shall be similar to the Model 53BTX as manufactured by Hayward, or equal.
- F. PVC and CPVC simplex basket strainers shall be provided in PVC and CPVC piping as shown on the Drawings. 1/2"-4" strainers shall be one-piece molded body with (3) ports to facilitate straight-thru flow pattern or u-shape flow pattern as required. Connections shall be true union type to ease installation/future maintenance. The cover, vent plug, and drain plug shall all be hand-removable, requiring no tools. EPDM or Viton seals shall be used as required for chemical service, and internal baskets shall be 1/32" perforation (20- mesh) for 1/2"-1" sizes, and 1/8" perforation for 1-1/2"-8" sizes. 6" and 8" strainers shall be fabricated construction and shall contain flanged connections as standard. The pressure rating for 1/2"-8" sizes shall be 150 psi @ 70°F, non-shock. Strainers shall be manufactured by Hayward Industrial Products, or equal.

## 2.06 QUICK DISCONNECT COUPLINGS

- A. Quick disconnect type coupling for compressed/service air shall be provided where indicated on the Drawings. Coupling shall provide for instantaneous shutoff in socket end when lines are disconnected. Couplings shall be constructed of 316 stainless steel with a BUNA-N O-ring and integral safety lock. Couplings shall comply with Military Specification 4109 (interchangeable with standard plug of the same size).

## 2.07 BRASS BALL VALVES (4-INCH AND SMALLER)

- A. Ball valves shall be 2-piece full port design constructed using lead-free (less than one quarter of one percent (0.25%) of lead by weight) brass body and end adapter, and chrome plated lead-free brass ball. Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded, blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks, and have an adjustable packing gland. Valves shall be rated for a minimum 400 psi WOG non-shock, and have female NPT ends. Valves shall be provided with a zinc- plated steel or bronze lever (vinyl coated), lock washer, and nut. Valve shall be a Watts

Series LFFBV-3C, Smith-Cooper Series 8145L, Apollo 77CLF-100 Series or approved equal.

## 2.08 STAINLESS STEEL BALL VALVES (4-INCH AND SMALLER)

- A. Where called for in the Plans or when connecting to stainless steel piping, ball valves shall be full-ported two-piece design, 300-psi maximum working pressure, with female NPT ends, or flanged ends where needed; have Type 316 stainless steel bodies, stems, trim, and balls, with PTFE seals, packing, and seat; and be provided with a pad-lockable Type 304 stainless steel handle, with PVC handle sleeve. Valves shall be model 266FTS or 266F-150 by Ohio Valve Company, Apollo 76F-100-A Series or approved equal.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes, and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.
- B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Engineer.
- C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.
- D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.
- E. Valve boxes shall be set plumb, and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

### 3.02 SHOP AND FIELD TESTING

A. Shop and field testing of valves shall be as follows:

1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.
2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.
3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.
4. Preliminary and final field tests shall be conducted at a time approved by the Engineer. The Engineer shall witness all field testing.
5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.
6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer.
7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the pumps, air compressors, process air blowers, etc. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at

minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing. Performance of pneumatic valves and compressed air system under normal operating conditions and during simulated power failures shall be checked.

8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

- END OF SECTION -

## SECTION 15100

### VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

#### PART 1 - GENERAL

##### 1.01 THE REQUIREMENT

- A. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions and Section 15000 – Basic Mechanical Requirements.
- B. Reference Section 15390 – Schedules for additional information on valves and operators/actuators.
- C. The electric valve actuators shall meet the signal requirements described in Section 17060 – Signal Coordination Requirements, Section 17920 – Control System Input/Output Schedule, and Section 17950 – Functional Control Descriptions.
- D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.
- E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve actuator.
- F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility.

##### 1.02 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:
  - 1. A Performance Affidavit shall be submitted for electric actuators in accordance with Section 11000, Equipment General Provisions.
  - 2. Certification that the force required to operate all valves is as specified herein.

#### PART 2 -- PRODUCTS



## 2.01 GENERAL

- A. Electric actuators shall be provided where specified in the Valve Schedule in Section 15390 – Schedules.
- B. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.
- C. Quarter turn valves 8" and greater in size shall have geared operators. Gate valves 14" and greater in size shall have geared operators.
- D. Operators/actuators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes.

## 2.02 MANUAL OPERATORS

- A. Unless otherwise specified or shown on the Drawings, manual operator type shall be as follows:
  - 1. Buried valves shall be equipped with nut operators, extended stems, and valve boxes. Where the depth of the operating nut is more than 4 feet below finish grade, a valve operator extension shall be provided to bring the operating nut to within 18-24 inches of the surface.
  - 2. Exposed valves up to 6-inch shall be lever operated (except gate valves).
  - 3. Exposed valves 8-inches and larger shall be handwheel operated.
  - 4. Exposed gate valves shall be handwheel operated.
  - 5. Valves with centerline of operator located more than 6-feet above the floor or platform from which it is to be operated shall have a chainwheel operator unless otherwise indicated on the Drawings.
- B. Manual operators shall be rigidly attached to the valve body unless otherwise specified or shown on the Drawings.
- C. All operators shall turn counter-clockwise to open and shall have the open direction clearly and permanently marked.
- D. Valve operators shall be designed so that the force required to operate the handwheel, lever, or chain (including breakaway torque requirements) does not exceed 80 pounds applied at the extremity of handwheel or chainwheel operator. Design pressures for sizing of valve operators shall be the piping test pressure for the piping in which the valve is to be installed as shown in the Piping Schedule in Section 15390 – Schedules.

- E. Handwheels for valves operators shall not be less than 12 inches in diameter. The maximum diameter of any handwheel shall not exceed 24".
- F. Nut operators shall have standard 2-inch square AWWA operating nuts designed in accordance with AWWA C504-94.
- G. Geared manual operators shall be of the worm gear, traveling nut or scotch yolk type except manual operators for butterfly valves 18-inch in diameter or larger which shall be worm gear, unless otherwise indicated in the individual valve specification. Gear operators shall be of the worm gear or bevel gear type. Gear box designs incorporating end of travel stops in the housing shall be equipped with AWWA input stops. Each gearbox shall require a minimum of 10 turns for 90 degree rotation or full valve stem travel and shall be equipped with a mechanical valve position indicator.
- H. Manual operators on below grade (and vault installed) valves shall be permanently lubricated and watertight under an external water pressure of 10 psi.

## 2.03 ELECTRIC VALVE ACTUATORS

- A. Electric Actuators shall be open/close service or modulating service as specified in the Valve Schedule in Section 15390 – Schedules.
  - 1. Open/Close (non-modulating) valve actuators shall be IQ series as manufactured by Rotork, SA series as manufactured by AUMA, or Series 2000 as manufactured by EIM Controls.
  - 2. Modulating valve actuators shall be Type IQM as manufactured by Rotork, Type SAR as manufactured by AUMA, or Series 2000 Futronic as manufactured by EIM Controls.
- B. Performance Requirements
  - 1. The actuators shall be designed for indoor and outdoor service and shall be capable of mounting in any position.
  - 2. Torque capacity of the actuators shall be sufficient to operate the valves with the maximum pressure differential, as indicated in the Valve Schedule in Section 15390, with a safety factor of 1.5. Actuators in modulating service will be selected such that the required dynamic valve torque is no more than 60% of the electric actuator's maximum rated breakaway of torque.
  - 3. Operating time for full limits of travel shall be not more than 2 seconds per inch diameter of the valve, +/- 50 percent through 20 inches; +/- 30 percent for valves 24 inches and larger. Operating time shall not be less than 60 seconds for all modulating valves.
  - 4. Actuators shall be capable of operating in ambient temperatures ranging from 0 degrees F – 160 degrees F.

5. For open/close (non-modulating) actuators, the gearing, motor and contactor shall be capable of 60 starts per hour without overheating.
  6. For modulating actuators, the gearing, motor and contactor shall be capable of 1200 starts per hour without overheating.
- C. The actuators shall include, in one integral housing, individual compartments for the motor, gearing, wiring terminals, and control circuits. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall protect the motor and all other internal electrical elements of the actuator from entrance of moisture and dust when the terminal cover is removed. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be stainless steel. Compartments shall be provided with moisture and dust-proof rigid cast covers meeting NEMA 6, certified to submergence in 6 ft of water for 30 minutes. Actuators located in classified areas shall be suitable for use in Class 1, Division 1, Group D environments.
  - D. The actuators shall be provided with externally operable and lockable 480VAC circuit breakers integral to the control housing.
  - E. All gearing shall be hardened alloy steel or bronze and shall be rated at twice the output torque of the operator and shall be designed to withstand the stall torque of the motor without failure. Output drive gearing shall consist of a worm shaft and worm gear pinion operating in an oil bath. The worm gear pinion shall be alloy bronze. Worm gear drive shall be self-locking to prevent creeping of the valve disc in an intermediate position. Heavy-duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. Motor reduction gearing shall be spur or planetary gearing and shall allow for field repair and change in gear ratio. For quarter turn applications, overtravel of the operator shall be prevented by internal mechanical stops cast into the actuator.
  - F. A mechanical dial position indicator shall be furnished to continuously indicate the position of the valve at and between the fully open and fully closed positions. The indicator shall be driven by gearing driven off of the main worm gear pinion and shall operate when the actuator is in either the electrical mode or manual mode.
  - G. A handwheel shall be permanently attached for manual operation. A gear assembly shall be provided between the handwheel and the worm shaft if required to reduce the force necessary to operate the handwheel to less than 40 pounds. A positive declutch mechanism shall engage the handwheel when required. When the actuator is set in the declutched position for handwheel operation, it shall return automatically to electric operation when actuator motor is energized. The handwheel shall not rotate during electric operation nor shall a fused motor prevent handwheel operation.
  - H. The drive motor shall be specifically designed for actuator service and shall be characterized by high starting torque and low inertia. Motors shall be 460 volts, three phase, 60 Hz AC reversible squirrel cage induction type motors and shall be specifically designed for modulating service where indicated on the Valve Schedule in Section 15390.

Motors shall be totally enclosed, non-ventilated, with NEMA Class F insulation minimum (Class H for modulating actuators) and a maximum continuous temperature rating of 120 degree C (rise plus ambient). A 120 VAC space heater shall be provided in the motor compartment. The electric motor shall have a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. Motor bearings shall be permanently lubricated by premium lubricant. The motor shall have plug and socket electrical connection to facilitate easy removal and replacement. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. The motor shall include single phase protection. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components. The motor shall be capable of starting against the rated load in either the open or close direction when voltage to the motor terminals is plus or minus ten (10) percent of nameplate rating.

1. Open/Close actuators shall be furnished with electro-mechanical reversing starters.
  2. Modulating actuators shall be furnished with solid state reversing starters utilizing thyristors.
- I. Leads from the motor shall be brought to the control circuit (limit switch) compartment without external piping or conduit box. An adequately sized space heater shall be installed in the control circuit compartment to aid in the prevention of damage resulting in from condensation. The following items shall be located in the control circuit compartment.
1. Torque limit switches shall be provided to de-energize the motor control circuit in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Each actuator shall have an open direction torque switch and a close direction torque switch. The torque switches shall be mechanically operated and able to be set in torque units. Torque switches shall be calibrated prior to the actuator's assembly to the valve.
  2. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions. The limit switch drive shall be of the counter gear type and "in step" with the actuator output drive at all times in either the electrical or manual mode of operation. A minimum of six (6) contacts, three (3) normally open and three (3) normally closed, shall be supplied at each end of valve travel. Four (4) additional contacts shall be provided to report end of travel or any desired position between ends of travel.
- J. Modulating actuators shall have a position feedback potentiometer mounted directly to the valve actuator gearing inside the gearing compartment. The potentiometer shall provide a 4-20 mA signal corresponding to valve position. Modulating valve actuators shall be designed to respond to either a 4-20mADC analog signal or a digital pulse signal as specified herein or as required to coordinate with the requirements of Division 17.

1. Modulating valve actuators designed to respond to a 4-20mADC signal shall be provided with a valve positioner which shall position the valve proportional to an externally generated 4-20mADC signal. The valve positioning control circuitry shall position the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the "open," "closed," or "last" position on loss of 4-20 mADC command signal.
  2. Modulating valve actuators designed to respond to "pulse" open/close signals shall operate the valve during the time the open or close pulse signal is high. Modulating actuators designed to respond to "pulse" open/close signals shall have the latching circuitry described above for open/close actuators disabled.
- K. The electrical terminals shall be housed in a double sealed terminal compartment isolated from the rest of the actuator components. The actuators shall be designed to operate from a single 480VAC, 3-phase source. The actuators shall be furnished with fuses inside of the terminal compartment. A quantity of two – ¾ inch NPT conduit entries shall be furnished.
- L. Actuators shall contain wiring and terminals for the following control functions. All dry contacts shall be rated for 5A at 250VAC.
1. Open, Close, and Stop commands from external dry contacts (utilizing internal 24VDC power supply) and/or from an external signal of 12V to 120V. The inputs for the open, close, stop signals shall be field selectable to be respond to either maintained or momentary remote signals. In momentary mode, the actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact signal unless a stop signal is received.
  2. Emergency override input from a normally closed or normally open contact. The actuator shall either open or close (field selectable) upon receiving the emergency override input.
  3. Remote Local-Off-Remote selector switch, Open/Close pushbuttons, and Open/Closed pilot lights for a remote manual control station (see below). The remote Local-Off-Remote selector switch and Open/Close pushbuttons shall be a dry contact input to the actuator control circuitry. The Open/Closed pilot lights shall be powered from the valve actuator control power.
  4. Four (4) unpowered contacts shall be provided which can be selected to indicate valve "Opened" and "Closed" position, "Remote" status of the actuator, and fail status of the actuator. The fail status contacts shall activate upon motor overtemperature and actuator overtorque as a minimum.
  5. Terminals for 4-20mADC position command and 4-20mADC position feedback as described above for modulating actuators.

M. Local Controls

1. Actuators shall be furnished with a Local-Off-Remote selector switch; Open, Close, and Stop pushbuttons for local control; a red lamp indicating closed and a green lamp indicating open. L-O-R switch shall be padlockable in any of the three positions.
  - a. When the LOR is in the "Local" position, open/close control shall be by the open and close pushbuttons on the actuator. The stop push button shall stop the actuator travel.
  - b. When the LOR is in the "Off" position, the actuator shall not operate.
  - c. When the LOR is in the "Remote" position, the actuator shall be controlled by remote inputs from the PLC or from the remote manual controls station.
2. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.

#### N. Remote Manual Control Station

1. Where indicated in the Valve Schedule in Section 15390 – Schedules, manual actuator controls shall be furnished in a separate NEMA 4X stainless steel enclosure (NEMA 7 if located in a classified area). Manual control station controls shall include Hand–Off-Auto Selector switch; Open, Stop, and Close pushbuttons; a red lamp indicating closed and a green lamp indicating open.
  - a. When the HOA is in the "Hand" position, open/close control shall be by the open and close pushbuttons on the remote manual control station. The stop push button shall stop actuator travel.
  - b. When the HOA is in the "Off" position, the actuator shall not operate.
  - c. When the HOA is in the "Auto" position, the actuator shall be controlled by remote inputs to the valve actuator from the PLC.

## 2.04 ELECTRIC OPERATORS FOR PVC/CPVC VALVES

- A. Automatic electric operators shall be provided for PVC/CPVC valves where specified and/or as shown on the Drawings. Operators shall operate on 120 volt AC, single phase, 60 hertz power and be equipped with solid state electronic internal controls. Motors shall be brushless, capacitor-run, reversing type, suitable for high duty cycle applications and shall be specifically designed for open/close service. Motors shall be provided with integral thermal overload protection with auto-reset. Operator gears and shafts shall be constructed of heat treated high-alloy steel. Operator output shaft shall be electro-less nickel plated. Operator gear trains shall be permanently lubricated. The gear train shall

withstand operator stall torque. Operator enclosures shall be NEMA 4. Operators shall be provided with internally wired, thermostatically controlled enclosure heaters to maintain an enclosure temperature of at least 40 degrees F. Operators shall be provided with positive visual position indication markings permanently affixed to the operator body and final output shaft. Operator drive output shall be provided with a declutchable manual override. A manual lever shall be provided for manual valve positioning. Operators shall be failsafe, utilizing a mechanical spring with a clutch mechanism to uncouple the motor during spring return operation, allowing the spring to relax and either open or close the valve. Selection of either fail-opened or fail-closed shall be made by selection of field wiring terminals.

- B. Independently adjustable cam-operated position limit switches shall be provided with dry contacts for remote fully opened and fully closed valve position indication. Operators shall respond to external dry contact open/close controls. The actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact open or close signal unless a stop signal is received. The all actuator control circuitry, including latching circuitry, shall be internal to the valve actuator. Valve control circuits and components mounted in a separate enclosure external to the valve actuator assembly will not be permitted. Connections for external remote controls shall be powered from an internal 24VDC or 120VAC power supply. Limit switches shall be rated for 15 amps at 120 VAC. Valve remote status shall also be provided as specified in Section 17950. The Contractor shall coordinate operator controls with the functional requirements specified in Section 17950 – Functional Control Descriptions.

## **PART 3 -- EXECUTION**

### **3.01 MANUFACTURER'S FIELD SERVICES**

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for electric actuators:

| <b>Service</b>           | <b>Number of Trips</b> | <b>Number of Days/Trip</b> |
|--------------------------|------------------------|----------------------------|
| Installation and Testing | 1                      | 1                          |
| Startup and Training     | 1                      | 1                          |
| Services after Startup   | 1                      | 1                          |

### **3.02 INSTALLATION**

- A. All valve actuators shall be installed in accordance with the manufacturer's published recommendations and the applicable specification sections for valves, and motor controls.
- B. Valve actuators shall be factory coated in accordance with the manufacturer's standard paint system.

### **3.03 SHOP TESTING**

- A. Shop testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:
1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.
  2. Submit written certification that:
    - a. Shop tests for the electrical system and all controls were successfully conducted;
    - b. Electrical system and all controls provide the functions specified and required for proper operation of the valve operator system.
  3. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load and the following parameters should be recorded:
    - a. Current at maximum torque setting
    - b. Torque at maximum torque setting
    - c. Flash Test Voltage
    - d. Actuator Output Speed or Operating Time
    - e. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.
    - f. Verification of actuator torque rating with valve.

#### 3.04 FIELD TESTS

- A. Field testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:
1. Valve actuators shall be field-tested together with the associated valves.
  2. Test all valves at the operating pressures at which the particular line will be used.
  3. Test all valves for control operation as directed.
  4. Field testing shall include optimization of opening and closing times of the valves. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.



## B. Preliminary Field Tests

1. General: Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components.
2. Scope: Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly.
3. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation, as specified or otherwise directed.

## C. Final Field Tests

1. Final field tests shall be conducted in accordance with the latest revision of AWWA C500.
2. Final field tests shall be conducted simultaneously with the start-up and field testing of the pumps.
3. Final field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing.
4. Certification of Equipment Compliance: After the final field tests are completed and passed, submit affidavit according to Section 11000.

- END OF SECTION -

## SECTION 15105

### CHECK VALVES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Reference Section 15000, Basic Mechanical Requirements.
- B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

#### PART 2 -- PRODUCTS

##### 2.01 RESILIENT DISC CHECK VALVE (SEWER SERVICE)

- A. The check valves shall be Resilient Disc Check Valves of the full body type, with a domed access cover, a flexible disc, disc accelerator, mechanical indicator, and limit switch, suitable for cold working pressures of 150 psig. The valves shall be designed, manufactured and tested in accordance with ANSI/AWWA C508.
- B. Design
  - 1. The valve body shall be cast with integral flanges meeting ANSI B16.1, Class 125 requirements. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. valve shall be capable of passing a 3 in. sphere. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, without special tools or removing the valve from the line.
  - 2. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover for installation of a mechanical, disc position indicator.
  - 3. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action to provide a cracking pressure of 0.25 psig.
  - 4. The disc accelerator shall be of one-piece construction and provide rapid closure

of the valve upon pump shutoff. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place captured between the cover and disc, and shall not be attached to the disc. It shall be formed with a large radius to allow smooth movement over the disc surface.

5. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.
6. A mechanical indicator shall be provided to indicate disc position indication on valves 4" and larger. The indicator shall have continuous contact with the disc under all operating conditions to assure accurate disc position indication.
7. A pre-wired limit switch shall be provided to indicate open/closed position to a remote location. The mechanical type limit switch shall be activated by the external position indicator. The switch shall be rated for NEMA 4 and shall have U.L. rated 5 amp, 120 VAC contacts.

#### C. Materials

1. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B for 30 in. and larger.
2. The disc shall be precision molded Buna-N.
3. The disc accelerator shall be Type 302 stainless steel.
4. The exterior and interior of the valve shall be coated with a fusion bonded epoxy coating, 12 mil minimum thickness.

#### D. Manufacture

1. The manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of resilient, flexible disc check valves.
2. Check Valves shall be Series 7200 by Val-Matic, or approved equal.

- END OF SECTION -

## SECTION 15109

### PLUG VALVES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment, and incidentals required, and install complete and ready for operation all valves and appurtenances as shown on the Drawings and specified herein.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15000 - Basic Mechanical Requirements.
- B. Section 15095 - Valves, General

#### PART 2 -- PRODUCTS

##### 2.01 PLUG VALVES

- A. Plug valves shall be of the non-lubricated, eccentric seating plug type with synthetic rubber-faced plugs as manufactured by DeZurik Company, Pratt, Milliken, or equal. All valves shall be provided with limit stops and rotate 90° from fully open to fully shut. The minimum working pressure for all valves shall be 150 psi, and the test pressure shall be at least 270 psi for valves up through 12-inch and at least 230 psi for valves 14-inch and larger. The port area of valves shall be at least 80 percent of full pipe area for valves less than 24-inches and 70 percent for valves 24-inches and larger, unless otherwise specified herein. The body materials shall be of epoxy coated cast iron or semi-steel, unless specified otherwise. Seats shall have a welded overlay of 90 percent pure nickel and machined to a finish containing no stress cracks. Plug facings shall be of Hycar, or equal and completely suitable for use with domestic sewage.
- B. The shaft seal shall be either the bronze cartridge type with at least two O-Rings, monolithic V-Type, U-Cup Type, or pull down packing type. If monolithic V-Type, U-Cup Type, or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Plug valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator.
- C. All buried valves shall have mechanical joint ends (unless otherwise shown), conforming to ANSI A21.11 (AWWA C 111), and shall be operated with a standard AWWA 2-inch square nut through a totally enclosed worm gear actuator. Valve boxes shall be installed with all buried plug valves and shall be as specified herein.

- D. Unless otherwise shown, all exposed valves 4-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard with face-to-face dimensions of standard plug valves. Valves smaller than 4-inches in diameter shall have screwed ends, unless otherwise noted.
- E. Valves 8-inches in diameter and larger shall be handwheel or floorstand operated where required or indicated on the Drawings through totally enclosed worm gear actuators, unless otherwise specified or shown on the Drawings. Valves 6-inches in diameter and smaller shall have lever operators, unless otherwise specified or noted on the Drawings. Manual operators for plug valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators.
- F. The manufacturer shall certify that the plug valves are capable of operating in continuous duty service under these pressures and flow conditions.
- G. Each valve shall be hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.
- H. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be coated with a fusion bonded thermosetting powdered epoxy, 12 mil minimum thickness. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

- END OF SECTION -

## SECTION 15390

### SCHEDULES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. Reference Section 15000, Basin Mechanical Requirements.

##### 1.02 PIPING SCHEDULES

- A. Piping requirements for this Section are outlined on the Drawings. In the absence of a specified test pressure, pipe shall be tested at the greater of: 1) 150 percent of working pressure as determined by the Engineer or 2) 10 psig, unless the Schedule indicates no test is required.
- B. If the pipe material is not otherwise specified, the following materials shall be used.

| <u>Pipe Size</u>                                                                                                                                                                                                                               | <u>Material</u> | <u>Type of Joint</u>                       | <u>Class/Design</u> | <u>Test Pressure</u> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------|---------------------|----------------------|
| 4-in and larger                                                                                                                                                                                                                                | DIP             | Flanged<br>(Exposed)                       | Class 53            | (1)                  |
|                                                                                                                                                                                                                                                |                 | Restrained<br>Mechanical Joint<br>(Buried) | Class 52            |                      |
| Less than 4-in                                                                                                                                                                                                                                 | PVC/CPVC (2)    | Socket                                     | Sch 80              | (1)                  |
| (1) Test at 150 percent of working pressure or 10 psi, whichever is greater.<br>(2) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used. |                 |                                            |                     |                      |

- C. All piping shall be restrained at all joints.

- END OF SECTION -

SECTION 15400  
OVERALL PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the plumbing system as indicated on the Drawings and specified herein.
- B. Plumbing systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.
- C. Provide the following Plumbing Equipment.
  - 1. Potable water piping systems.
  - 2. Water Hammer Arresters.
  - 3. Thermometers.
  - 4. Pressure Gauges.
  - 5. Pipe supports, hangers, escutcheon plates, and sleeves.
  - 6. Plumbing pipe insulation.
  - 7. Pipe ID markers and equipment identification tags.
  - 8. Plumbing Fixtures
  - 9. Water Heaters.
  - 10. Expansion Tank.
  - 11. Reduced Pressure Zone Backflow Preventer (RPZ).
  - 12. Wall Hydrants (Non-Freeze).
  - 13. Shut-off valves

14. Sanitary sewer (DWV) piping systems, floor drains and cleanouts.

### 1.03 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Division 1, Submittals.
- B. Data to be submitted shall include but not be limited to:
  - 1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
  - 2. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
  - 3. Weight of all component parts and assembled weight.
  - 4. Electrical characteristics, wiring, diagrams, etc.
  - 5. Sample data sheet of equipment nameplate(s) including information contained thereon.
  - 6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.
  - 7. Details of special fasteners and accessories.
  - 8. Type of adhesives, binders, joint cement, mastics.
  - 9. Proposed insulation procedures and installation methods.
  - 10. Spreadsheet or chart identifying piping systems type and pipe size, model numbers of hangers to be used, special coatings for pipe supports etc.
  - 11. Sample data sheet of piping and valves including information contained thereon.
  - 12. Spare parts list
  - 13. Special tools list
- C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.
- D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.
- E. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.



#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the Project Site under provisions of Division 1.
- B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.
- D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

#### 1.05 SCHEDULES ON DRAWINGS

- A. In general, all capacities of equipment and fixtures characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. Variations of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

#### 1.06 MANUFACTURER'S INSTRUCTIONS

- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Submit all instruction books and manuals in accordance with Division 1.

#### 1.07 CODES, PERMITS AND STANDARDS

- A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.
- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, Plumbing and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

- D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:
1. American National Standards Institute (ANSI).
  2. American Society for Testing and Materials (ASTM).
  3. American Society of Mechanical Engineers (ASME).
  4. Factory Mutual (FM).
  5. National Electric Code (NEC).
  6. Occupational Safety and Health Standards (OSHA).
  7. State and local codes, ordinances and statutes.
  8. Underwriters Laboratories (UL).
  9. Others as designated in the specifications.

#### 1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience, who issues complete catalog data on total product.
- B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- E. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.
- F. Plumbing fixtures shall be set and connected to soil, waste, and vent and cold and hot water supplies in a neat, finished and uniform manner. Fixtures of each class and the connection to same shall be of equal height, level and at right angles to the wall unless otherwise directed by the Architect/Engineer.
- G. Each plumbing fixture shall be provided with an approved P-trap, which shall be set as close to the outlet as practicable, all water supply connections shall be provided with loose key stops.
- H. Vitreous china fixtures shall be carefully selected, free from spots, grazing or chips.

- I. Fixture trim, traps, faucets, escutcheons, and waste pipes that are exposed to view shall be brass with polished chromium plating over nickel finish. Exposed supplies shall be brass pipe plated in the same manner.
- J. All fixtures designated for use by the disabled shall fully conform and shall be installed per the requirements of the American Disabilities Act.
- K. All iron and steel piping, and pipe fittings shall be manufactured domestically within the United States of America.
- L. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- M. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, piping, electrical work, insulation and appurtenances ready for operation.
- B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.
- C. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.
- D. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

### 2.02 MATERIALS

- A. Underground cold water piping shall be copper tubing, Type "K", 2-1/2-inch and smaller with wrought copper solder joint fittings; 3-inch and larger shall be ductile iron pipe, bell and spigot, Class 52. Fittings shall be bell and spigot, Class 250.
- B. Aboveground tempered, hot and cold water piping shall be copper tubing, Type "L", 3- 1/2-inch and smaller with wrought copper solder joint fittings; 4-inch and larger shall be ductile iron pipe, AWWA C151, grooved or flanged ends.
- C. Underground soil, waste, and drainage pipe inside building and to a point 5'-0" (five feet) outside the building shall be standard weight cast iron soil pipe and fittings conforming to ASTM A74. Joints shall be hub and spigot, caulk joint, or installed with compression gaskets conforming to ASTM C-564. No-hub is not permitted underground.
- D. Aboveground soil, waste, and vent piping shall be Schedule 40 PVC pipe with PVC

Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns fittings and solvent-cemented joints.

## 2.03 PIPING

- A. Contractor shall form all holes; furnish and install all concrete inserts, flashings and sleeves in existing floors, walls, equipment foundations, ceilings, and roofs as required for the erection, installation, and support of all pipe and tubing.
  - 1. Provide sleeves and flashings for all pipes and tubing, etc., furnished which passes through existing walls, intermediate floors, partition walls and roofs. Caulk wall opening with fire retardant sealant.
  - 2. Provide fire stopping materials which consist of commercially manufactured products capable of passing ASTM E-814 (UL 1479) Standard Method of Fire Test for Through Penetration Fire Stops wherever piping penetrates a fire rated roof, wall or floor assembly.
  - 3. Install concrete inserts, sleeves and flashings required, as indicated, or in a manner acceptable to the Engineer.
  - 4. All holes missed by the Contractor, but required for the installation of the piping systems, shall be made in the walls, floors, roof and by the Contractor at no additional expense to the Owner by core drilling or saw cutting methods only.
  - 5. Provide escutcheons around pipes in all areas. Use chromium plated escutcheons on pipe penetrations exposed in finished rooms or areas. Use stainless steel escutcheons in all process areas.
  - 6. Install water hammer arrestors on all hot and cold water branch lines to fixtures and equipment.
- B. Copper Water Tube:
  - 1. Tube:
    - a. Reference: ASTM B88.
    - b. Type: K.
    - c. Temper: Hard drawn above grade, and soft annealed below grade. All below ground vertical sections shall be hard drawn or threaded brass.
  - 2. Joints:
    - a. General: Connect pipe with solder joints except where threaded or flanged fittings are required at valves, equipment connections or otherwise shown or directed.
    - b. Solder Joints: ASTM B32, Sb5 (95 5 tin antimony).
    - c. Threaded Joints:

- 1) Taper Pipe Threads: ANSI B2.1.
    - 2) Joint Preparation: Teflon Tape.
  - d. Flanged Joints:
  - e. Flanges: ANSI B16.24, 150 lb. class.
    - 1) Gaskets: Red rubber, ASTM D1330, Grade 1, 1/8 inch thick.
  - f. Bolts and Nuts:
    - 1) Standard: ANSI B18.21 and ANSI B18.2.2, respectively.
    - 2) Material: ASTM A307, Grade B.
- 3. Fittings:
  - a. Type: Wrought Copper.
  - b. Reference: ANSI B16.22.
- 4. Unions:
  - a. Reference: FS WW U 516.
  - b. Material: Bronze.
  - c. Rating: 250 pound W.O.G.
- 5. All copper piping 2 1/2 inches and smaller, run within the interior of a building, shall be hard drawn copper Type "K".
- 6. All buried copper piping 2 1/2 inches and smaller shall be soft temper copper Type "K" with polyethylene coating.
- C. Drain, waste and vent piping and fittings shall be manufactured by Tyler Pipe, Charlotte Pipe and Foundry, A.B. and I. Foundry, or equal.
  - 1. The piping shall be installed complete, of the size and arrangement shown on the drawings. All piping shall be installed to allow for expansion, and parallel or perpendicular to the building construction. When pipe is installed underground, the ground shall be excavated to a minimum depth to accomplish the grade shown or required by code. The pipe shall have bearing along its entire length and if installed on fill, shall be supported by concrete cradles to firm earth.
  - 2. All pipe shall be supported from the building structure in a neat manner, in compliance with current trade practices and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze hangers. Single runs of horizontal piping shall be supported with clevis type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipe will not be permitted. In concrete construction, approved inserts will be carefully set to support the piping. Soil and waste pipe

shall be supported at intervals of not more than five feet on horizontal runs and at the base of every stack.

3. Sealing Coupling Sleeve for No-hub joints: The coupling shall be made of stainless steel, ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 EPDM rubber sleeve with integral, center pipe stop. All surfaces of the sleeve shall be smooth except for the specified marking. The sleeves shall be free from dirt and foreign materials.
4. All pipes extending through the roof shall be a minimum of 3-inch diameter and shall be flashed with black EPDM rubber flashing boots. Vents shall extend 12-inches above finished roof and in conformity with NRCA details.

D. Pipe sleeves and escutcheons:

1. Sleeves shall be provided for all piping passing through masonry or concrete walls and floors. Sleeves for walls and floors shall be indicated, made watertight and extend above floor lines. Sleeves shall conform to the requirements of Division 15.
2. Escutcheon plates shall be polished chrome. Provide for all wall penetrations in finished areas.

E. Hangers and Supports shall be epoxy-coated Dura-Green by Cooper B-Line, Inc., Perma-Green III by Unistrut, Inc. or Approved Equal.

## 2.04 WATER SERVICE BALL VALVES

A. Products and Manufacturers: Provide ball valves as made by one of the following:

1. Watts, Series FBV-3C or FBVS-3C.
2. Nibco.
3. Or Approved Equal.

B. 2-piece full port brass ball valve.

C. NSF/ANSI Standard 61, for potable water use.

D. Sizes: 1/4" – 3".

## 2.05 FIXTURE WATER STOPS

A. Products and Manufacturers: Provide stops as made by one of the following:

1. Zurn, Model Z8800 to Z8845.
2. Watts.
3. Or Approved Equal.

B. Chrome plated, solid brass with round wheelhandle.

## 2.06 PIPE HANGERS AND SUPPORTS

- A. Hangers and supports shall conform to recommendation of Standard Practice No. 58 and 69 of Manufacturer's Standardization Society of the Valve and Fitting Industry.
- B. Hangers for pipes shall be clevis and adjustable rod hangers for single pipes or trapeze hangers for supporting more than one pipe on the same hanger. Trapeze hangers shall be made of 2-inch by 2-inch by 1/4-inch thick structural steel channels with legs down, and steel blocking of varying thickness welded to the channel under each pipe shall be used to obtain proper pitch.
- C. Pipe covering protection saddles shall be the weld on type, and protection shields shall be half round heavy gage galvanized sheet metal with heavy density weight bearing insulation where required.
- D. Hanger rods shall be 3/8-inch for pipe 2-inch and smaller, 1/2-inch for pipe 2-1/2-inch and larger. Acceptable manufacturers: Crawford, B-Line, Elcen Metal Products Co., or Fee & Mason.
- E. Nickel plated spring ceiling plates shall be provided for all hanger rods in all exposed areas. Acceptable manufacturers: Grinnell, Crawford, B-Line or Elcen.
- F. Electrolysis: Prevent electrolysis to copper tubing with rubber or neoprene lined pipe ring isolators and copper plated hanger and supports or other recognized industry methods.
- G. Corrosion protection: Hangers located in chemical storage room areas of the Treatment Facility shall be hot dipped galvanized. Threaded rod shall be electroplate galvanized or be manufactured of stainless steel.

## 2.07 PIPE INSULATION

- A. Products and Manufacturers: Provide insulation as made by one of the following:
  - 1. Armstrong: AP Armaflex
  - 2. Schuller: Aerotube II
  - 3. Rubatex Corp.: R-180-FS
  - 4. IMCOA: Imcolock
- B. Pipe Insulation:
  - 1. Type: Elastomeric Closed Cell.
  - 2. FM Approved.
  - 3. Unit slit tubing and miter cut fittings.
  - 4. Thickness and Application: 1/2" to 1-1/4" pipe – 3/4 inch insulation and 1-1/2" to 4" pipe – 1-inch of insulation on all water piping above slab/grade.

5. Average thermal conductivity not to exceed 0.27 (Btu-in)/(hr-FT<sup>2</sup>-°F) at mean temperature of 75° F, temperature range -40° to 220° F; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by ASTM D1056 and ozone resistant.

## 2.08 PIPE IDENTIFICATION

- A. Piping shall be identified by means of card mounted, self-bonding pipe markers. Markers shall be made of nonporous, color fast, nonabsorbent vinyl plastic. Letters shall be black or white for easy readability.
- B. Markers for pipe having an outside diameter of 3-inches or more (including insulation) shall have 2-inch high letters. Markers for pipe having an outside diameter of less than 3-inches (including insulation) shall have 1-inch high letters.
- C. Provide matching 3/4-inch wide banding tape.
- D. Acceptable Manufacturers: Seton Name Plate Corporation, W. H. Brady Company, or Westline Products Company.

## 2.09 VALVE TAGS AND NUMBERING

- A. All valves shall be tagged with 1-1/4-inch diameter, 0.040-inch thick brass or laminated plastic tags with numbers and letters. A complete directory of valves, pump motors, controls, devices, and other equipment, giving use, location, size, and manufacturer's number of each shall be prepared with permanent ink, framed under glass, and hung in the mechanical equipment room where directed by Using Agency/Owner.
- B. All valves above ceilings or access panels shall be identified by color-coded, self-adhesive "dots" affixed to the ceiling grid or the access panel frame. Dots shall be visible from a standing position on the floor immediately below the marker.

## 2.10 PLUMBING FIXTURES

- A. Provide and install plumbing fixtures and equipment specified and scheduled on Drawings. Fixtures shall bear the manufacturer's name and trademark and quality or class of fixture. All exposed piping, etc., shall be chromium plated brass. The Contractor shall check the Architectural and Plumbing Drawings for details and dimensions prior to roughing in for fixtures.
- B. WC: Water Closet (ADA): Vitreous china floor outlet, elongated siphon jet bowl with 1- 1/2 inch top spud, 1.3-1.5 gallons per flush. Seat shall be antimicrobial, white, open front, solid plastic with check hinge. Refer to fixture schedule for basis of design model numbers. Flush valve shall be 1.28 gallon flush valve with battery DC powered automatic proximity sensor touch less actuation, and chrome plated flush connection, American Standard 6065.121 or approved equal.
- C. Acceptable Products:
  1. American Standard



2. Kohler
  3. Toto
  4. Acceptable seats:
    - a. Church
    - b. Olsonite
    - c. Beneke
- D. LAV: Wall Hung, Lavatory (ADA): Wall hung, vitreous china, with wall hangers and punched for 4" center set fitting. Provide open grid strainer with tailpiece, 17 gauge chrome plated brass offset trap assembly (ADA compliant), p-trap and supplies with loose key stops. Provide floor mounted concealed arm chair carrier with cast iron block base feet, Schedule 40 pipe uprights, header, couplings, cast iron hanger. Anchor carrier securely to floor. Provide closed cell insulation, or Truebro Lavguard with vinyl cover on waste, stop valves and supply piping. Cover shall be antimicrobial.
1. Acceptable products:
    - a. American Standard #0355.012 (*Lucerne*), 20" x 18" (ADA)
    - b. Eljer #051-2104 (*Signature24*), 20" x 18" (ADA)
    - c. Kohler #K-2005 (*Kingston*), 21" x 18" (ADA)
  2. Acceptable trim:
    - a. American Standard
    - b. Eljer
    - c. Kohler
    - d. Chicago Faucets Model #3400-TCP, with integral perforated drain, 1-1/4" tail piece.
  3. Acceptable P-Traps:
    - a. American Standard #4401.014
    - b. Eljer #804-1180
    - c. Kohler #K-9000
  4. Acceptable carriers:
    - a. Zurn
    - b. Wade

- c. Josam
- 5. Acceptable faucet:
  - a. American Standard Model 6055.205
  - b. Kohler
  - c. Moen Commercial Line

E. Water Hammer Arrestor

Shock control device shall be tested and certified in accordance with Plumbing and Drainage Institute Standard PDI-WH201. Device shall be of all stainless steel construction with nitrogen gas cushion with welded nested bellows.

- 1. Acceptable Products:
  - a. Wade #W-5
  - b. J.R. Smith 5000 series
  - c. Zurn #Z-1700-100

2.11 INSTANTANUOUS WATER HEATER (IWH)

- A. Electric, Tankless, domestic water heaters shall be constructed with copper piping or tubing complying with NSF 61 and NSF 372 for barrier materials for potable water heaters without storage capacity.
- B. The pressure rating shall be 150 psig.
- C. The heating element shall be resistance heating system type.
- D. Temperature control shall be made with //flow control fittings// //thermostat//.
- E. The safety control shall be a high temperature limit cutoff device or system.
- F. The heater shall have an enameled jacket with an aluminum or steel floor stand or wall bracket for off-floor mounting.
- G. Heater capacities and electrical characteristics are scheduled on the drawings.

2.13 WALL HYDRANTS (HOSE BIBBS, HB)

- H. Exposed "anti-siphon" automatic draining wall hydrant. Complete with integral backflow preventer, copper casing, all bronze interior parts with 1/2 turn ceramic disk cartridge and combination 3/4 female solder and 3/4 male pipe thread inlet. Stainless steel face with operating key lock. All solder connections are lead free.

2.14 STAINLESS STEEL HOSE REEL:

- A. Manual crank rewind with cam-lock brake and spring actuated pin lock.

- B. 90 degree inlet with stainless steel ball bearing swivel joint and 1-inch female NPT threads.
- C. Heavy duty stainless steel angle mounting bracket for column or wall mounting.
- D. Storage for up to 75 feet of 5/8" or 3/4" I.D. hose.
- E. Pressure rated for up to 4000 psi.
- F. Unit shall be Steel Eagle, Hannay Reels, Inc., Reelcraft, or approved equal.

#### 2.15 FLOOR DRAINS

- A. Floor drains shall be located as shown on the drawings. They shall have seepage flanges and nickel brass tops.
- B. Refer to plumbing fixture schedule for floor drain variations, basis of design manufacturer and type.
- C. Verify floor finish and type of proper top configuration.
- D. Acceptable manufacturers: Zurn, Wade, or J.R. Smith.

#### 2.16 CLEANOUTS

- A. Cleanouts shall be flush with floor with adjustable round or square nickel brass top, and shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required.
- B. Adjustable Top Assemblies: Top assemblies shall vary with the floor finish where it is applied. Verify floor finishes for proper top configuration with General Contractor.
- C. Yard cleanouts shall be flush with grade with poured concrete anchoring/encasement, troweled smooth all around
- D. Acceptable products:
  - 1. Floor cleanout: Zurn #ZN-1400-K-BP, J.R. Smith 4020, or Wade.
  - 2. Wall Cleanout: Zurn #Z-1446, J.R. Smith 4530, or Wade.
  - 3. Yard cleanout: Zurn #Z-1449, J.R. Smith 4280, or Wade.

#### 2.17 GASKETS AND CONNECTORS

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.
- C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment

and replace any of these items damaged in storage, shipment or moving.

### PART 3 - EXECUTION

#### 3.01 POTABLE WATER SYSTEMS

- A. Provide cold and hot water supply systems in the buildings as indicated, making connections to all fixtures and equipment requiring hot and/or cold water.
- B. The Contractor shall provide swing or swivel joints on connections from mains to risers and from risers to branches. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- C. Install gages and thermometers in straight runs of piping so they may be read from the floor or operating platform. Install all gages with gage cocks.
- D. Underground Pipe
  - 1. The piping shown on the drawings shall be installed complete and shall be of the size shown. All pipe shall be installed in such a manner that it does not bear directly on rocks or debris in ground. Where pipe passes close to or through walls or footings, it shall be protected from contact with concrete or cinder block. All pipe passing through building walls shall be protected by a cast iron sleeve large enough to permit free movement of pipe. All turns shall be made with a gradual curve so there is no chance of kinking or collapsing the pipe. Where pipe passes through a building wall from underground to inside building, the sleeve shall be packed with oakum and made watertight.
  - 2. Pipe Joints
    - a. Solder Joints for copper pipe: All pipe shall be reamed to full diameter before joining. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-1/2-inch and larger, flux shall be applied to pipe and fittings. Joints shall be made with silver solder and a torch using a mixture of oxygen and acetylene.
    - b. Install underground ductile-iron piping according to AWWA C600, and AWWA M41. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets
  - 3. Pipe Supports: Earth shall be excavated to a minimum depth with an even surface to insure solid bearing of pipe for its entire length. Where water lines cross deeper excavations, these shall be filled and tamped to the proper level before copper pipe is installed.
  - 4. Pipe Depth
    - a. Interior: Water pipe shall NOT be permitted inside concrete slabs.

- b. Exterior: the water pipe shall have a minimum of 4 feet of cover and shall comply with state and local codes.
- 5. Under floor water piping shall be insulated with closed cell elastomeric foam insulation (reference Section 15290).

E. Aboveground Pipe:

- 1. The piping shown on the drawings shall be installed complete and shall be of the size shown. All piping shall be installed to allow for expansion, either parallel or perpendicular to the building construction. On individual fixtures, water hammer arrestors shall be installed at each fixture sized per PDI recommended sizes. On groups of fixtures, one water hammer arrestor (shock absorber) shall be installed for each group.
- 2. Pipe Joints: All pipe shall be reamed to full diameter before joining. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-1/2-inch and larger, flux shall be applied to pipe and fittings.
- 3. Solder Joints: Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 "Solder Metal" Grade 95TA. Solder and flux used for piping material providing water for human consumption shall be lead free. Flux shall be non-acid, non-lead type. Remove composition discs from solder end valves during soldering. Wipe excess solder, leaving a uniform fillet around cup of fitting.
- 4. Copper pipe shall be supported not to exceed 8 feet on center. Plastic pipe shall be supported in accordance with manufacturer's instructions, but in no case shall exceed 3 feet on center.
- 5. Use bracket type hanger fastened to walls to support piping running adjacent to walls and not supported from ceilings. Valves 3 inches and over in horizontal lines shall be supported independent of the pipelines.
- 6. Perforated strap iron hangers or wire are prohibited.
- 7. Pipe hangers shall be cleaned and painted with rust resistant paint before installation.
- 8. Hanger supports shall be securely fastened to structural members by beam clamps and clips, concrete inserts, or anchors.
- 9. Where pipes pass through walls and suspended ceilings, provide pipe sleeves of No. 20 gage galvanized iron, 1/2 inch larger than insulated pipe or bare pipe outside diameter.
- 10. Pipe passing through floors and foundation shall be provided with sleeves of standard weight galvanized steel pipe. Sleeves shall be at least 1 inch larger than bare pipe and 1/2 inch larger than insulated pipe outside diameter. Ends shall be cut square and smooth and finish flush with surface of building

construction. Where specifically noted, ends shall extend 1 inch above floor and edges chamfered.

11. Pipe sleeves shall be securely bedded in the building construction. Sleeves shall finish flush with finished wall and ceiling lines. Note that where covering is provided, it shall extend continuously through sleeves.
12. Sleeves installed in vertical positions shall be perfectly plumb and sleeves in horizontal positions shall be level. They shall be located, set, and maintained in position while surrounding construction work is being installed so that the center of each pipe shall be accurately installed in the center of the sleeve. The space between the pipe or the insulation and the sleeve shall be caulked to prevent light or air transfer. Where vertical sleeves occur, such as in floors or ceilings, special collars secured to the pipes or to the ceiling construction shall be provided to prevent the packing from falling out. The standard floor and ceiling plates herein specified for finished areas may be used for this purpose provided they are firmly secured to the pipes.
13. Pipe Insulation: Continuous through inside walls and at all hangers; pack insulation around pipes with fireproof self-supporting mineral wool insulation material, fully sealed.
14. Insulation for cold piping: Insulate all fittings, including flanges, all valve bodies and devices associated with cold surfaces. Maintain vapor barrier integrity.
15. Insulation for hot and tempered water piping: Insulate all fittings. Do not insulate unions, flanges, strainers, valves, flexible connections, or expansion joints.
16. Finish insulation neatly at hangers, supports and other protrusions or interruptions.
17. Ensure hangers and cradles are properly installed to avoid crushing insulation.
18. Install protective metal saddles and insulated inserts to prevent insulation compression.
19. Insulate all exposed piping below fixtures scheduled for use by the disabled in accordance with ADA with pre-formed insulation kits.
  - a. Truebro Lavguard 2E-Z, or equal.

### 3.02 ROOF VENTS

- A. Roof stack terminals shall be flashed using 16 ounce sheet copper.

### 3.03 WASTE SYSTEMS

- A. Horizontal piping shall be installed as high as possible without sags. Install 3 inches and larger horizontal drain and waste piping to 1/8 inch per foot slope. Piping 2-1/2 inches and smaller shall be installed at a slope of 1/4 inch per foot.

- B. Concealed piping shall be installed in time so as not to delay work of other trades and to allow ample time for tests and inspection.
  - C. Before beginning installation work, check plumbing Drawings with architectural, structural, mechanical, civil, air conditioning and electrical Drawings and make accurate layouts of plumbing piping. Coordinate with other trades and report all interferences, discrepancies, or proposed changes to the Engineer for approval prior to beginning installation work.
  - D. Underground piping shall be firmly bedded on solid ground as specified in Division 2. Soil and vent stacks shall be supported at the base by means of piers or hangers close to the bottom of the riser and at the floor by means of riser clamps.
    - 1. Each horizontal length of cast or ductile iron pipe and PVC DWV pipe shall be firmly fastened to wall, or otherwise suitably supported.
    - 2. All water risers shall be properly anchored with allowance made for expansion.
    - 3. Hangers, support and anchors shall be installed as required to adequately support the lines without interfering with their inherent flexibility. Pipes, pipe installation, hangers, supports, and anchors shall conform to the requirements of Section 15020.
  - E. Should the Contractor fail to accurately locate and lay out all necessary openings in new construction in sufficient time to incorporate same in the structure, then the Contractor shall, at no extra cost to the Owner, cut such holes as may be required and replace at his own expense all completed work which may have been damaged or destroyed by the cutting of the holes. All such cutting shall be done under the direction and with the permission of the Engineer.
  - F. Provide sleeves as described under potable water systems of this specification section.
- 3.04 FLOOR DRAIN AND CLEANOUT INSTALLATION
- A. Floor drains shall be installed perfectly plumb and level with elevation to provide for proper floor pitch.
  - B. Verify that the floor drains are not disturbed during floor or concrete installation.
  - C. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep 1/4 bend or one or two 1/8 bends extended to place of access or as shown on the drawings. An extra heavy cast brass ferrule with countersunk head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe shall be tee pattern, 90-degree branch drainage fittings with screw cast brass plugs of the same size as the pipe up to and including 4-inches.
  - D. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks and on each building drain outside the building. Cleanouts on pipe concealed in partitions and walls shall be provided with chromium plated cast brass covers secured to plugs.

- E. The access covers shall be installed to provide easy and complete access to the cleanout plug. Due consideration of wall construction must be given to allow for proper installation of frame and the installation shall be coordinated with the GC.
- F. Each cleanout, unless installed under an approved cover plate, shall be above grade, readily accessible, and so located as to serve the purpose for which it is intended. Cleanouts located under cover plates shall be so installed as to provide the clearances and accessibility required by the local plumbing code.
- G. Each cleanout in piping 2- inches or less in size shall be so installed that there is a clearance of not less than 12-inches in front of the cleanout. Cleanouts in piping larger than 2-inches shall have a clearance of not less than 18-inches in front of the cleanout.

### 3.05 PLUMBING FIXTURES

- A. After plumbing fixtures have been installed, fixtures and trim shall be thoroughly cleaned of all grease, oil, dirt, labels, stickers, and other foreign matter, and all packing materials shall be promptly removed from the premises. All valves and faucets shall be adjusted to suit the operating water pressure and all work maintained in clean and proper operating condition until accepted by the Engineer.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- F. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals.
- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- H. Installation of the plumbing fixtures and accessories shall meet the applicable requirements of the Accommodations for the Physically Handicapped Federal Regulation (36 CFR 910.34) and shall be located as shown on the Architectural Drawings.
- I. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- J. Install toilet seats on water closets.
- K. Install faucet, flow-control fittings with specified flow rates and patterns.



- L. Install traps on fixture outlets.
- M. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 for sealant and installation requirements.

### 3.06 TESTING

- A. Notify Owner and Engineer one week in advance that the items are ready for testing.
  - 1. Perform testing before work is concealed with construction or insulation, or before backfilling if piping is to be buried.
    - a. Concealed piping shall be installed in time so as not to delay work of other trades and to allow ample time for tests and inspection.
- B. Test pressures shall be in accordance with ANSI B31.1 Code for Pressure Piping, Paragraphs 121(a), (b), and (c).
  - 1. Test pressures shall be as follows:
    - a. Cold Water System - 100 psig hydrostatic.
    - b. Drainage, Waste, and Vent - 15 psig hydrostatic.
  - 2. All tests other than natural gas shall be held for at least 4 hours and until each joint has been inspected.
  - 3. At conclusion of testing remove special test fittings, caps, blanking plates, etc. and replace damaged gaskets and place systems in operation.
- C. If inspection or tests show defects or failure, such defective work, materials or failure shall be replaced without delay and inspection and tests repeated. Repairs to piping and equipment shall be repaired or replaced with new material or equipment. Caulking of screw joints or plugging leaks shall not be permitted.
- D. All water piping shall be hydraulically tested at 100 psig and proven tight for a period of not less than 4 hours with no loss of pressure. Tests for each section shall be repeated at no additional cost to the Owner until the piping is proven tight at the specified test pressure. Upon completion of work, inspection shall be made by the Engineer. All corrections, changes or removal of defective work shall be made by the Contractor at no cost to the Owner prior to approval of installation.
- E. Water and DWV Pipe Testing: Shall be hydrostatic tested as follows, except where more stringent tests are required by the codes.
  - 1. Slowly fill with water each valved section in pipe, and apply the specified test pressure by means of a portable positive displacement pump connected to the piping in an acceptable manner.
  - 2. Make taps if necessary, at points of highest elevation, and plug tightly afterwards.

3. Carefully examine all exposed pipe, fittings, valves and joints during the tests.
  4. Where joints show seepage or slight leaks repair as requested.
  5. Remove and replace any cracked or damaged pipe, fittings, valves, or other defective materials discovered during the test.
  6. After replacements and repairs have been made, repeat tests until work is satisfactory and approved.
- F. All drainage and vent piping shall be tested before fixtures are installed, by capping or plugging the openings and filling the entire system with water and allowing it to stand thus filled for three hours.
- G. All natural gas systems shall be inspected, tested, purged and placed into operation in accordance with NFPA 54 and as required herein.
- H. All water supply piping shall be tested before fixtures or faucets are connected.
- I. Each fixture shall be tested for soundness, stability of support and satisfactory operation of all its parts.
- J. Disinfection of potable water systems shall be performed in accordance with the procedures described in AWWA C651 or AWWA C652.

### 3.07 PIPE IDENTIFICATION

- A. Pipe markers shall be located as follows:
1. On straight runs of pipe at intervals not exceeding 100 feet.
  2. At every sectionalizing or main shut off valve.
  3. On each riser at a point 5 feet above floor or platform.
  4. On both sides of a wall or partition through which pipe passes.
- B. Markers shall be applied so they can be read from the floor.
- C. Markers shall be applied only after all insulating and painting has been completed.
- D. Surfaces shall be clean and free of dust, oil, or loose paint before applying markers.
- E. Before applying markers on insulated surfaces, smooth the surface with sandpaper. Clean surface of all dust after sanding.
- F. After applying each marker, wrap one turn of pipe banding tape completely around the circumference of the pipe at each end of the marker. Overlap ends of marker with the tape and overlap the tape upon itself a minimum of 1-inch. The pipe banding tape shall match the background color of the marker.
- G. Where a service is indicated on the drawings as a circulating system, the pipe marker legend for the particular service shall be followed by either the word "supply" or "return"

to clarify the line function. An arrow designating direction of flow shall follow the legend on each marker.

### 3.08 CLEANING

- A. Clean dirt and marks and other debris from exterior of equipment weekly.
- B. Remove debris and waste material resulting from installation weekly.
- C. Properly protect all plumbing fixtures and trim at all times and temporarily close all openings to prevent obstruction and damage.
- D. Maintain protective covers on all units until final clean-up time and, at that time, remove covers, clean and polish all fixture and trim surfaces.

- END OF SECTION -

SECTION 15500  
BASIC HVAC REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning, piping, etc. as indicated on the drawings and specified herein.
- B. Air conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

1.02 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.
- B. Data to be submitted shall include but not be limited to:
  - 1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
  - 2. Complete assembly, and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.
  - 3. Weight of all component parts and assembled weight.
  - 4. Electrical characteristics, wiring, diagrams, etc.
  - 5. Sample data sheet of equipment nameplate(s) including information contained thereon.
  - 6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.
  - 7. Details of special fasteners and accessories.
  - 8. Type of adhesives, binders, joint cement, mastics.

- 9. Proposed insulation procedures and installation methods.
  - 10. Spare parts list
  - 11. Special tools list
- C. The Contractor shall obtain from the manufacturer and submit to the engineer copies of the results of all certified shop tests.
- D. The Contractor shall obtain from the manufacturer and submit to the engineer copies of certified letters of compliance in accordance with the Specifications.
- 1.03 OPERATION AND MAINTENANCE MANUALS
- A. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1.
- B. Operation and Maintenance Manuals shall be submitted for all equipment.
- 1.04 MANUFACTURER'S INSTRUCTIONS
- A. Installation of all equipment shall be in accordance with manufacturer's data.
- B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.
- C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.
- D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.
- E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.
- F. Furnish Owner, indexed and bound in loose leaf binders, three (3) complete sets of Operating and Maintenance Instructions and pertinent manufacturers' literature and information on all of the apparatus and equipment under this Division of the Specifications.
- G. Submit all instruction books and manuals in accordance with Division 1.
- 1.05 CODES, PERMITS AND STANDARDS
- A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.
- B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

- C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Uniform Plumbing Code, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.
- D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

Air Conditioning and Refrigeration Institute (ARI)  
Air Diffusion Council (ADC)  
Air Moving and Conditioning Association (AMCA)  
American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)  
American National Standards Institute (ANSI)  
American Society for Testing and Materials (ASTM)  
American Society of Mechanical Engineers (ASME)  
Factory Mutual (FM)  
National Electric Code (NEC)  
NFPA 90A - Air Conditioning and Ventilation Systems  
Occupational Safety and Health Standards (OSHA)  
Sheet Metal & Air Conditioning Contractors National Association (SMACNA)  
Standard Building Code  
Standard Mechanical Code  
Standard Plumbing Code  
State and local codes, ordinances and statutes  
Underwriters Laboratories (UL)

Others as designated in the specifications.

#### 1.06 QUALITY ASSURANCE

- A. All material and equipment shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.
- B. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.
- C. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
- D. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

#### 1.07 IDENTIFICATION MARKERS

- A. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:

|                      |                                                                                                  |
|----------------------|--------------------------------------------------------------------------------------------------|
| <u>Yellow/Green:</u> | Supply air                                                                                       |
| <u>Blue:</u>         | Exhaust, outside, return and mixed air                                                           |
| <u>Nomenclature:</u> | Include the following:<br>Direction of air flow.<br>Duct service (supply, return, exhaust, etc.) |

#### 1.08 GASKETS AND CONNECTORS

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.
- C. Furnish all bolts, studs, nuts and fasteners for make-up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

### PART 2 -- PRODUCTS

#### 2.01 GENERAL

- A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.
- B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.
- C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial-commercial grade.
- D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located, otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.
- E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

- F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.
- G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring-type vibration isolators.

### PART 3 – EXECUTION

(NOT USED)

- END OF SECTION -



## SECTION 15590

### FANS

#### PART 1 -- GENERAL

##### 1.01 GENERAL REQUIREMENTS

- A. All parts of the equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the unit is to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these specifications.
- B. All anchor bolts, washers, clips, clamps and fasteners of any type shall be constructed of 316 stainless steel.
- C. All fan motors shall be provided with high premium energy efficient totally enclosed fan cooled type, unless otherwise noted.
- D. Provide exhaust fans which have been tested and rated in accordance with AMCA standard, and bear AMCA Certified Ratings Seal.
- E. Provide motors and electrical accessories complying with NEMA standards.
- F. Fans shall be standard prefabricated units of the type, size and arrangement indicated on the Drawings. All fans shall be rated and constructed in accordance with the Air Moving and Conditioning Association. Special construction materials, coatings and multi-speed fan motors shall be provided as indicated on the Drawings.
- G. Impellers shall be rigidly constructed, accurately balanced dynamically and statically at the speed at which it is scheduled to operate and free from objectionable vibration or noise. Fans with corrosion resistant coatings shall be balanced after being coated.
- H. Fans shall have no overloading characteristics for the horsepower indicated. All points on the fan brake horsepower curve shall not exceed the motor horsepower rating
- I. V-belt drives shall be rated at least 50 percent greater than the rated motor horsepower, and shall have sheaves which can vary the fan speed by 10 percent above or below the rating point. The fan motor shall be mounted on an adjustable heavy mounting plate.
- J. The operating fan speed shall be no greater than 85% of the maximum allowable fan speed for the selected model.
- K. Unless otherwise noted on the Fan Schedule fans shall be manufactured to meet the

balance quality and vibration limits of Fan Application Category BV-3 per AMCA Standard 204.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01350 - Seismic Anchorage and Bracing
- B. Section 15500 - Basic HVAC Requirements
- C. Section 15598 – Metallic Ductwork and Duct Accessories
- D. Section 15980 – HVAC Commissioning
- E. Section 15990 – HVAC Testing, Adjustment, and Balancing

#### 1.03 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01300, Submittals.
- B. The Contractor shall submit shop drawings for fan supports, locating and identifying each support, brace, hanger, guide, component and anchor. Fan support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer of California and shall comply with Section 01350 Seismic Anchorage and Bracing.
- C. Required information shall include:
  - 1. Horsepower, voltage, and rotating speed of motors.
  - 2. Total weight of the equipment plus the approximate weight of the shipped materials.
  - 3. Complete erection, installation, and adjustment instructions and recommendations.
  - 4. Fan performance curve at the operating speed, minimum, and maximum speeds. Provide brake horsepower curve for the operating speed.
  - 5. Details of corrosion resistance coating.
  - 6. Detailed construction information and data sheets for all accessories such as roof curbs, dampers, damper operators disconnect switches, vibration isolators etc.
  - 7. Example equipment nameplate data sheet.
  - 8. Interconnecting wiring diagrams.
  - 9. List of recommended lubricants.

10. Special Tools List
11. Reports of Certified Shop Tests
12. AMCA Approval for Fan Ratings
13. Sound data
14. Manufacturer's Installation Certification
15. Manufacturer's Field Test Results Certification

- D. The Contractor shall submit to the Owner a color chart of available colors for the corrosion coating to be applied to fans as indicated in the Contract Documents. The Owner shall select the final color choice.

#### 1.04 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit complete operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01300, Submittals.

#### 1.05 MANUFACTURERS

- A. The materials covered by these specifications are intended to be equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturer's recommendations.

#### 1.06 CONTRACTOR'S RESPONSIBILITY AND MANUFACTURER'S FIELD SERVICES

- A. The services of a qualified manufacturer's Technical Representative shall be provided. The manufacturer Technical Representative's services shall include the following site visits:

| Service               | Total Days | No. of Trips |
|-----------------------|------------|--------------|
| Installation Checkout | 1          | 1            |
| Startup and Testing   | 3          | 3            |
| Training              | 1          | 1            |

- B. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.
- C. The times specified are exclusive of travel time to and from the facility and shall not be

construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

#### 1.07 SPECIAL TOOLS

- A. Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

### PART 2 -- PRODUCT

#### 2.01 SIDEWALL PROPELLER FANS

- A. Propeller fans shall be of the heavy-duty industrial type designed for wall mounting. Fans shall be directly or indirectly driven by an electric motor, as indicated on the Drawings.
- B. Direct-driven fans shall have the fan wheel mounted on the extension of the motor shaft. The motor shall be mounted in a rigid, stream-lined frame designed to provide vibration isolation for the motor and protection for the wiring run to the motor.
- C. The fan shall be mounted on a steel frame and shall have aluminum or steel blades with heavy hubs. Bearings shall be of the permanently lubricated type.
- D. The motor enclosure shall be of the totally enclosed type. Motor speed shall not exceed 1,800 rpm.
- E. The fan shall be provided with a heavy gauge wire personnel guard which can be readily removed for servicing the fan.
- F. Propeller fans shall be as manufactured by Greenheck Fan Corp., Loren Cook Co., Penn Ventilators Co., or equal.

#### 2.01 WALL MOUNTED CENTRIFUGAL FANS

- A. Centrifugal fans shall be airfoil, non-overloading blades of aluminum construction continuously welded. Wheel inlets shall overlap an aerodynamic aluminum inlet cone.
- B. Wheel shall be balanced in accordance with AMCA Standard 204-05.
- C. Provide fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- D. Fans shall be direct driven as indicated on the Contract Drawings or as contained herein.
- E. The fan shall utilize all aluminum construction.
- F. The aluminum base shall have continuously welded curb cap corners.
- G. Fans shall have internal terminal box mounted on the exterior for ready wiring.

- H. The motor shall be separated from the exhaust air stream.
- I. Bearings shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
- J. Belts shall be oil and heat resistant, static conducting.
- K. Drives shall be keyed and securely attached to the wheel and motor shafts.
- L. All drives shall be variable pitched type and shall be sized for 150 percent of the installed motor horsepower.
- M. Centrifugal fans shall be as manufactured by Greenheck Fan Corp, Loren Cook Co., PennBarry, Hartzell, or approved equal.

## 2.02 ADDITIONAL REQUIREMENTS FOR ALL FANS

- A. The following additional requirements shall apply to all fans.
  - 1. Backdraft or motor-operated dampers shall be provided and installed in the openings as indicated on the Contract Drawings.
  - 2. All fans shall be provided with either integral or supplementary spring vibration or sound-absorbing mountings.
  - 3. Where indicated, wall mounted exhaust fans shall be mounted on a prefabricated curb.
  - 4. All motors unless indicated otherwise in this Specification or the Contract Drawings shall be TEFC. The break horsepower at any point on the fan curve for the design speed shall not exceed the motor nameplate horsepower. The break horse power shall include all applicable belt drive losses. Using the motor service factor shall be prohibited.
  - 5. All equipment shall be seismically secured and restrained in accordance with the Seismic Restraint Manual, Guidelines for Mechanical Systems, latest edition, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) and designed in accordance with the seismic provisions of ASCE-7 and the current Building Code to the extent that the most stringent provisions are utilized in developing the design seismic forces. See section 01350 for additional details and requirements.
  - 6. All non-fiberglass fans shall receive a corrosion resistant coating. The coating shall be an epoxy coating suitable for protecting the equipment from continuous exposure to air containing hydrogen sulfide 3ppm. The fans in the Supplemental Carbon Facility shall be suitable for exposure to methanol in addition to hydrogen sulfide. The coating shall be applied to all surfaces of the fans including but not

limited to fan wheels, propellers, hubs, structural components, housings (interior and exterior), inlet boxes, dampers, screens, lube lines, curb boxes, and curb box adapters. A UV resistant top coat shall be applied to all coating systems that are not rated for UV exposure. The Contractor shall submit and coordinate the available color choices to the Owner for final color selection.

7. Where indicated in the design documents, fans shall exceed the uncertainty requirements of AMCA standard 203 and shall perform within +/- 3% of the flowrate with respect to the static pressure of the fan curve.

## 2.03 DAMPERS

- A. See the respective sections in Sections 15598 for construction requirements.
- B. Dampers shall be coordinated to operate and interface with the fan being furnished.
- C. Dampers shall be sized to fit the specified openings.

## 2.04 THERMOSTATS

- A. Thermostats for exhaust fans shall be heavy-duty, low voltage type, arranged to open and close the circuit as required by a control point.
- B. Unless otherwise specified or indicated, the range of adjustment shall be 40°F–100°F.
- C. Enclosures for thermostats located in corrosive atmospheres or facilities shall be waterproof NEMA 4X stainless steel type.

## 2.05 PREFABRICATED WALL CURBS

- A. Prefabricated wall curbs shall be installed where indicated on the Drawings or as specified herein. The curbs shall be fabricated of .064 inch sheet aluminum with all joints heliarc welded. Cants and roof flanges shall be an integral part of the curb. The inside of the curb shall be insulated with rigid glass-fiber thermal and acoustical liner of approximately 3-lb. density and 1-1/2 inch minimum thickness with a neoprene or equal coating for protection from erosion. The lining shall conform to NFPA 90A Standards with a flame spread and fuel contributed rating not exceeding 50. Pressure-treated wood nailers shall be provided at the tops of the curbs. The curbs shall be sized to suit equipment. The curbs shall receive an epoxy corrosion resistant coating on the interior and exterior surfaces that is suitable for the conditions indicated in the Additional Requirements for All Fans section above.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. Contractor shall install fans in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.

- B. Contractor shall coordinate fan work with work of walls, and ceilings, as necessary for proper interfacing.
- C. Connect ducts to fans in accordance with manufacturer's installation instructions.
- D. The Contractor shall have the Manufacturer's Technical Representative provide in writing that the equipment is installed per the manufacturer's requirements and operates as required by the Contract. The Contractor shall submit the written confirmation to the Engineer for information only.

### 3.02 FIELD QUALITY CONTROL

- A. Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements as specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. See Section 15990, HVAC Testing, Adjusting and Balancing for testing requirements.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched coatings with a coating specified by the equipment manufacturer for repairs.

- END OF SECTION -

## SECTION 15980

### COMMISSIONING OF HVAC SYSTEMS

#### PART 1 - GENERAL

##### 1.01 SCOPE

- A. Perform Commissioning in accordance with the requirements of the standard under which the Commissioning Firm's qualifications are approved, i.e., ACG Commissioning Guideline, NEBB Commissioning Standard, or SMACNA 1429 unless otherwise stated herein. Consider mandatory all recommendations and suggested practices contained in the Commissioning Standard. Use the Commissioning Standard for all aspects of Commissioning, including qualifications for the Commissioning Firm and Specialist and calibration of Commissioning instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the Commissioning Standard, such as performance guarantees shall be part of this contract. For systems or system components not covered in the Commissioning Standard, Commissioning procedures shall be developed by the Commissioning Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements shall be considered
- B. This section covers commissioning after construction of the system(s). This shall include all HVAC systems as shown and/or specified.

##### 1.02 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
  - 1. ASSOCIATED AIR BALANCE COUNCIL (AABC) COMMISSIONING GROUP (ACG)
    - a. ACG Commissioning Guideline (2005) Commissioning Guideline
  - 2. NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
    - a. NEBB Commissioning Standard (1999) Procedural Standards for Building Systems Commissioning
  - 3. SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)
  - 4. SMACNA 1429 (1994, 1st Ed) HVAC Systems Commissioning Manual
  - 5. U.S. GREEN BUILDING COUNCIL (USGBC)



- a. LEED (2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED- NC)

### 1.03 ENERGY

- A. Formal LEED certification is not required; however, the Contractor is required to provide documentation that meets the LEED Energy & Atmosphere (EA) Prerequisite 1, Fundamental Commissioning.

### 1.04 SUBMITTALS

- A. Submittals shall be made under the provisions of Division 1, General Requirements.
- B. Certification of the proposed Commissioning Firm's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail.
- C. Certification of the proposed Commissioning Specialist's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections. The documentation shall include the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Specialist or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Specialist shall be described in detail.
- D. Commissioning Plan prepared in accordance with Commissioning Standard.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.01 TESTS

- A. Perform the pre-functional performance test checklists and functional performance tests in a manner that essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, establish methods which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. Provide all materials, services, and labor required to perform the pre- functional performance tests checks and functional performance tests. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if Owner's representative participating commissioning team member is not present for the test.

1. Perform Pre-Functional Performance Test Checklists for the items indicated below. Correct and re-inspect deficiencies discovered during these checks in accordance with the applicable contract requirements.
2. Perform Functional Performance Tests for the items indicated below. Begin Functional Performance Tests only after all Pre-Functional Performance Test Checklists have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Begin Tests with equipment or components and progress through subsystems to complete systems. Upon failure of any Functional Performance Test item, correct all deficiencies in accordance with the applicable contract requirements. The item shall then be retested until it has been completed with no errors.

### 3.02 PRE-FUNCTIONAL PERFORMANCE TEST CHECKLIST

#### A. For Fans:

1. Installation:
  - a. Fan belt adjusted
2. Electrical:
  - a. Power available to fan disconnect
  - b. Proper motor rotation verified
  - c. Verify that power disconnect is located within sight of the unit it controls
3. Controls:
  - a. Control interlocks properly installed
  - b. Control interlocks operable
  - c. Dampers/actuators operable
  - d. Verify proper location and installation of thermostat or switching controls
4. Testing, Adjusting, and Balancing (TAB):
  - a. TAB report approved

#### B. For HVAC System Controls:

1. Installation:
  - a. Layout of control panel matches drawings
  - b. Framed instructions mounted in or near control panel
  - c. Components properly labeled (on inside and outside of panel)
  - d. Control components piped and/or wired to each labeled terminal strip

- e. Control wiring and tubing labeled at all terminations, splices, and junctions
    - f. Software programmed and program simulation testing completed
  - 2. Control Power
    - a. 120Volt AC power available to panel(s)
  - 3. Testing, Adjusting, and Balancing (TAB):
    - a. TAB report approved
- 3.03 COMMISSIONING REPORT
- A. The Commissioning Report shall consist of completed Pre- Functional Performance Test Checklists and completed Functional Performance Tests organized by system and by subsystem and submitted as one package. The Commissioning Report shall also include all HVAC systems test reports, inspection reports (Preparatory, Initial and Follow-up inspections), start-up reports, TAB report, TAB verification report, Controls start-up test reports and Controls Performance Verification Test (PVT) report. The results of failed tests shall be included along with a description of the corrective action taken.

- END OF SECTION -

## SECTION 15990

### HVAC TESTING, ADJUSTING, AND BALANCING

#### PART 1 - GENERAL

##### 1.01 THE REQUIREMENT

- A. This Section specifies the requirements and procedures for testing, adjusting, and balancing the HVAC systems. Requirements include measurement and establishment of the fluid quantities of the HVAC systems as required to meet design specifications, and recording and reporting the results.
- B. The following HVAC systems shall be tested, adjusted and balanced:
  - 1. Supply air systems, all pressure ranges, including new and existing systems
  - 2. Exhaust air systems
  - 3. Outside air systems, including new and existing systems
- C. This Section does not include specifications for materials for patching HVAC systems, or specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.

##### 1.02 DEFINITIONS

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes the balance of air distribution, water distribution, the adjustment of total system to provide design quantities, the electrical measurement, and the verification of performance of all equipment and automatic controls.
  - 1. Test: To determine quantitative performance of equipment.
  - 2. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
  - 3. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
  - 4. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
  - 5. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to

be used as the basis for required future testing, adjusting, and balancing.

6. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets or supply outlets on air terminals and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
7. Main: Duct containing the system's major or entire fluid flow.
8. Submain: Duct containing part of the systems' capacity and serving two or more branch mains.
9. Branch Main: Duct serving two or more terminals.
10. Branch: Duct serving a single terminal.

### 1.03 SUBMITTALS

- A. Prior to balancing, the Contractor shall perform Equipment Testing as indicated in section 1.1. Prior to performing System Testing, the Contractor shall have the system balanced as indicated in section 3.1.
- B. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. The Contractor shall submit a detailed testing procedure which shall include:
  1. Step by step instructions as to how the tests will be performed including but not limited to temporary layout modifications, procedures for testing instrument functionality, steps required to prove that the Control Strategy has been properly implemented, and steps required to compensate for ambient air temperature versus normal operating temperature such as thermostat setpoint adjustment. The steps shall indicate all actions to be taken, the expected result of the actions, and what the expected result verifies in regards to proving that the unit operates as designed.
  2. A list of any additional or temporary equipment necessary to perform the tests.
  3. Provide a checklist of items that will be checked during the test as listed in Section 3.1. Each item shall be initialed by the Contractor's Testing and Balancing Technician conducting the test. The Contractor's Testing and Balancing Engineer shall sign and date the bottom of the test sheet verifying all results.
- D. The Contractor shall submit the signed results of the equipment testing to the Engineer for approval. The equipment manufacturer's representative shall be present for all testing. The results shall include a letter from the manufacturer's representative stating that the equipment has been installed per the manufacturer's installation requirements and is in satisfactory working order.

- E. The Contractor shall submit an adjusting and balancing procedure which shall include:
1. Standard procedure the Contractor will use for balancing the systems.
  2. Tables specific to the equipment for this project for recording the required information from Part 3 – Execution.
  3. Flow diagrams specific to the systems present on this project. The flow diagrams shall contain at a minimum:
    - a. A diagrammatic representation of the system
    - b. All duct or pipe sizes
    - c. All inline equipment such as fans, pumps, duct heaters, filters, and strainers
    - d. All air inlet and outlet grilles and registers
    - e. All dampers, valves, or flow control equipment
  4. A list of the equipment the balancing technician will use to balance the system
- F. Submit completed adjusting and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. The adjusting and balancing reports shall contain at a minimum
1. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
    - a. General Information and Summary
    - b. Technician Qualifications and Certificates
    - c. Completed Adjusting and Balancing Report including procedure
    - d. Temperature Control System Settings
    - e. Calibration Certificates of all Instruments Used

2. Report Contents: Provide the following minimum information, forms and data:

- a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer.
- b. Calibration Certificates: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to the date of the start of balancing.
- c. Flow Diagrams
- d. Balancing Datasheets
- e. Balancer Comments: The Balancer shall provide comments, suggestions, and corrective actions to any issues that occur during balancing including excessive noise, excessive vibration, or an inability to meet design conditions.

1.04 QUALITY ASSURANCE

- A. Test and Balance Personnel Qualifications: The personnel responsible for testing, adjusting, and balancing the specified systems shall have at least three years' experience in testing and balancing systems similar to this project and shall be an employee of the installer or an independent testing and balancing agency.
- B. Codes and Standards:
  - 1. NEBB, "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
  - 2. ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.
- C. Contractor shall provide all necessary instrumentation, tools, ladders, and labor etc. to complete all air balancing, tests and adjustments.
- D. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.
- E. All testing, adjusting, and balancing of air systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with NEBB, AABC, or SMACNA Organization. Testing, adjusting, and balancing technician shall hold current certification by one of these organizations. Submit certification to Engineer for approval.

- F. Contractor shall be solely responsible for the protection and safeguarding of his work and shall provide every protection against accidents, injury, and damage to persons and property.
- G. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.
- H. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.

#### 1.05 SEQUENCING AND SCHEDULING

- A. Systems shall be fully operational prior to beginning procedures.

#### 1.06 RELATED SECTIONS

- A. Section 15500 - Basic HVAC Requirements
- B. Section 15590 - Fans

### PART 2 - MATERIALS

(NOT USED)

### PART 3 - EXECUTION

#### 3.01 HVAC TESTING

- A. Equipment to be tested shall include at a minimum all fans, duct heaters, unit heaters, CRAC units, H&V units, dehumidifiers, and electric control systems. The specific requirements for equipment indicated below shall be performed in addition to any requirements of the Manufacturer for startup and initial operation.
- B. The equipment manufacturer's representative shall be present for all testing.
- C. Fans:
  - 1. Pre Startup Inspection:
    - a. Verify proper equipment mounting and setting
    - b. Verify that control, interlock and power wiring is complete
    - c. Verify alignment of motors and drives
    - d. Verify proper belt tension
    - e. Verify proper duct connections and accessories



- f. Verify that lubrication is completed
  - g. Verify that equipment is in good condition and free from damage
  - h. Verify that all packing materials, temporary stops, and temporary supports used during shipping have been removed
  - i. Verify that equipment and associated ducts are free from debris
  - j. Verify that equipment is installed per the Manufacturer's requirements
2. Equipment Test:
- a. Prior to energizing motor, verify and record voltage of power supply
  - b. Bump motor to verify direction of rotation
  - c. Run the fan for 1 hour of continuous trouble free operation. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of this procedure.
  - d. Monitor heat build-up in bearings
  - e. Monitor for any abnormal noises or vibration
  - f. Check motor loads against nameplate data
  - g. Record fan sound levels ten (10) feet from the surface of the fan in five (5) minute intervals during 1 hour run period. The sound levels shall not be used for any sound rating verification. The sound levels shall be used for information by the owner to identify areas that will require hearing protection.
3. System Test:
- a. Verify the system operates per the respective equipment specification 15590-Fans and Section 15608-HVAC Electric Control Systems including all modes of operation, interlocks, alarms, and safeties.

D. Ductwork

- 1. All openings in the ductwork shall be temporarily sealed and the ductwork shall be pressurized and leak tested to demonstrate that the installation meets the specified SMACNA leakage class requirements. The Contractor shall follow SMACNA procedures for testing as outlined in SMACNA's HVAC Air Duct Leakage Test Manual.

E. At the completion of all of the individual equipment testing, the Contractor perform a HVAC

System Run Test. The Run Test shall consist of operating the entire HVAC system as a whole using automatic controls for a period of not less than 15 consecutive days with no significant disruptions, repairs, reprogramming, or outages. Any issues during this period shall reset the testing period until it passes.

### 3.02 ADJUSTMENT AND BALANCING REQUIREMENTS

- A. Identify and list size, type, and manufacturer of all equipment to be balanced, including air terminals and all end user equipment.
- B. Test and record motor voltages, running amperes, shaft rpm and power factor including motor nameplate data, and starter heater ratings for each unit listed above.
- C. Air Equipment Balancing
  - 1. The Contractor shall start the fan and verify that the fan amperage and speed are within the design requirements. The Contractor shall then proportionally balance the air distribution system using the dampers at the air terminals. When the system is proportionally balanced, the Contractor shall adjust the fan speed to achieve the total design flowrate of the system. Fan speed adjustment shall be accomplished by adjusting variable pitch drives or by replacing the fan sheaves. The Contractor shall then take final readings for the total system flow as well as readings for each air terminal.
  - 2. For all ducted air systems, the Contractor shall measure the flow rate in cfm at each air inlet, at the fan, and at each outlet for each system. The Contractor shall provide this information in the report to demonstrate that the system as installed meets the seal class rating as indicated in section 15598 - Metallic Ductwork and Duct Accessories.
  - 3. Test and record the following:
    - a. Fan system static pressure.
    - b. All fan speeds.
    - c. Air quantity delivered by each grille and register.
    - d. Pressure drop across each piece of inline equipment such as a duct heater or filter bank. Filters shall be new and clean at time of testing and balancing.
    - e. Final damper and air extractor positions for all dampers and extractors
  - 4. Distribution:
    - a. Adjust volume dampers, control dampers, etc., to provide the proper design CFM in ducts.

5. Verification:

- a. At the completion of the balancing work, the Contractor shall check and record the flow rate and static pressure at all supply, return, and exhaust air points to show final balanced conditions. The Contractor shall provide in the report a table with a summation of readings comparing the required cfm, final cfm, and final static pressure for each supply, return, and exhaust terminal and all final damper positions.
  - b. Verify design cfm at fans as described above.
  - c. If the air systems are not properly balanced, the Contractor shall re-balance and recheck all data.
- D. The testing and balancing activities described in this Section shall culminate in a report to be provided in quadruplicate (4), individually bound and also provided electronically to the Engineer for approval. Neatly type and arrange data. Include with the data, the dates tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the report is to provide a reference of actual operating conditions for the Owner's operations personnel.
- E. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

3.03 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified in accordance with the detailed procedures outlined in the referenced standards.
- B. Cut insulation and ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings using materials identical to those removed.
- D. Seal ducts, test, and repair leaks created during the testing and balancing procedures on the hydronic and air systems.
- E. Seal insulation to re-establish integrity of the vapor barrier at all locations where the vapor barrier was disturbed during the testing and balancing procedures.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

### 3.04 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with standard practices and the specific requirements identified in this section.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

- END OF SECTION -

## SECTION 16000

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.
- B. Reference Section 17000, Control and Information System Scope and General Requirements for scope of work details as they relate to the Division 17 Subcontractor.
- C. The electrical scope of work for this project primarily includes, but is not limited to, the following:
  - 1. Furnish and install infrastructure for Pacific Gas and Electric (PG&E) pad-mounted transformer as required and indicated on the Project Drawings.
  - 2. Furnish and install outdoor utility meter and disconnect as indicated on the Project Drawings.
  - 3. Furnish and install new pump control panel as indicated on the Project Drawings.
  - 4. Furnish and install new generator connection panel as indicated on the Project Drawings.
  - 5. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components associated with new and existing equipment as indicated on the Project Drawings.
  - 6. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components associated with new and existing equipment as indicated on the Project Drawings.

7. Furnish and install all low voltage wire and cable resulting in a complete and operable electrical system for new and existing equipment as indicated on the Project Drawings.
  8. Furnish and install new lighting systems and wiring devices as indicated on the Project Drawings.
  9. Other electrical work as specified herein and indicated on the Project Drawings.
- D. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed and guaranteed to perform the service required; and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.
  - E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.
  - F. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.
  - G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.
  - H. All electrical components and systems, including electrical equipment foundations, shall be designed to resist operational forces as well as lateral sway and axial motion from seismic and thermal forces. Seismic support design shall be in accordance with Section 01350 – Seismic Anchorage and Bracing.

## 1.02 EQUIPMENT LOCATION

- A. The Drawings show the general location of feeders, transformers, outlets, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly; furnishing such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.
- B. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the

equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings.

### 1.03 LOCAL CONDITIONS

- A. The Contractor shall examine the site and become familiar with conditions affecting the work. The Contractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction. All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Contractor shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.
- B. In addition, the Contractor shall relocate all duct banks, lighting fixtures, receptacles, switches, boxes, and other electrical equipment as necessary to facilitate the Work included in this project. Costs for such work shall be included in the Bid.
- C. The Contractor is responsible for coordinating all electric utility equipment installations with the serving electric utility (PG&E). The Contractor shall furnish and install all electric utility equipment required by PG&E to be installed by the Contractor whether specifically shown on the Drawings or not.
- D. The Contractor shall furnish and install the following electrical utility equipment as required:
  - 1. Concrete transformer and slab boxes or pads constructed per PG&E standards.
  - 2. Primary and secondary duct bank and manholes as required per PG&E
  - 3. Metering equipment cabinets and/or bases
- E. The electric utility will furnish and install the following equipment:
  - 1. Pad-mounted transformer
  - 2. Primary and secondary conductors and terminations
- F. The Contractor is responsible for ensuring all electric utility equipment and infrastructure provided by the Contractor is furnished and installed in accordance with PG&E design specifications and requirements. The Contractor is fully responsible for coordinating his scope of work with PG&E. Any additional required PG&E construction or equipment not specified herein or shown on the Drawings shall be supplied by the Contractor at no additional cost to the Owner.
- G. The contact person at the serving electrical utility is:  
  
Eric Cookman, Industrial Power Engineer

Pacific Gas and Electric  
3965 Occidental Rd., Santa Rosa, CA  
415-726-1674  
ercl@pge.com  
(utility tracking #)

#### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions, Section 01300, Submittals and the requirements of the individual specification sections, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Operation and Maintenance Manuals
  - 3. Spare Parts List
  - 4. Proposed Testing Methods and Reports of Certified Shop Tests.
  - 5. Reports of Certified Field Tests.
  - 6. Manufacturer's Representative's Certification.
- B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.
- C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.
- D. Some individual Division 16 specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
- E. Seismic support design for all nonstructural electrical components (conduit, raceways, freestanding equipment, etc.) shall be in accordance with all applicable federal, state and local building code requirements and Section 01350 – Seismic Anchorage and Bracing.



## 1.05 APPLICABLE CODES AND REQUIREMENTS

### A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the following:
  - a. Insurance Rating Organization having jurisdiction
  - b. Pacific Gas and Electric (PG&E)
  - c. NFPA 70, National Electrical Code (NEC). Latest Edition
  - d. California Electric Code
  - e. The National Electric Manufacturers Association (NEMA)
  - f. The Institute of Electrical and Electronic Engineers (IEEE)
  - g. The Insulated Cable Engineers Association (ICEA)
  - h. The American Society of Testing Materials (ASTM)
  - i. The American National Standards Institute (ANSI)
  - j. California Occupational Safety Hazards Title 8 (CAL/OSHA)
  - k. The National Electrical Contractors Association (NECA) Standard of Installation
  - l. National Fire Protection Association (NFPA)
  - m. International Electrical Testing Association (NETA)
  - n. All other applicable Federal, State and local laws and/or ordinances.
2. All material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the class inspected by said laboratories.

### B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

### C. Certification

1. Upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the National Board of Fire Underwriters or similar inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

#### 1.06 PERMITS AND INSPECTIONS

- A. The Contractor shall reference the General Conditions and Section 01010, Summary of Work.

#### 1.07 TEMPORARY LIGHTING AND POWER

- A. The Contractor shall reference the General Conditions and Section 01510, Temporary Utilities.

#### 1.08 TESTS

- A. Contractor shall refer to each individual specification section for detailed test requirements. Upon completion of the installation, the Contractor shall perform testing per the requirements listed in the applicable Project Specifications. Testing shall be performed with, and to the satisfaction of, the Owner and Engineer.
- B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing. All defective material and workmanship disclosed shall be corrected by the Contractor at no cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition and demonstrate that electrical and control devices and equipment will function at least five (5) times without failure.
- C. The Contractor shall complete the installation and field testing of the electrical installation prior to the start-up and testing of all other equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Contractor shall make all components of the Work available for performing preliminary and final testing.
- D. Before each test commences, the Contractor shall submit a detailed test procedure, test engineer resume, manpower, and test scheduling information for the approval by the Engineer. In addition, the Contractor shall furnish detailed procedures for calibrating or testing any equipment provided by the Contractor required for field testing the new installation or other systems.

#### 1.09 INFRARED INSPECTION

- A. Just prior to the final acceptance of a piece of equipment, the Contractor shall perform an infrared (thermography) inspection to locate and correct all overheating issues (hot-spots) associated with electrical equipment terminations. The infrared inspection shall be performed by a third party, independent testing agency, not the Electrical Contractor.

- B. The infrared inspection shall apply to all new equipment and existing equipment that is in any way modified under this Contract. All overheating issues detected in new equipment furnished and installed under the Scope of this Contract shall be corrected by the Contractor. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor.
- C. Any issues detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Contractor. Despite the Contractor not being held responsible for these problems, the Contractor shall report them to the Owner and Engineer immediately for resolution.
- D. The infrared inspection report shall include both digital and infrared images positioned side by side. Both the digital and infrared images shall be clear and high quality. Fuzzy, grainy, or poorly illuminated pictures are not acceptable. The infrared images shall be provided with a temperature scale and indicate the temperature of the hot spot. Reports shall be furnished in a 3-ring binder with all pages printed in full color and equipment assemblies separated by tabs.

#### 1.10 PROTECTIVE DEVICE SETTING AND TESTING

- A. The Contractor shall provide the services of a qualified, independent, third party testing company using NETA. certified technicians to adjust, set, calibrate and test all protective devices in the electrical system. The company shall not be a subsidiary of the electrical equipment manufacturer. The qualifications of the testing company and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.
- B. All protective devices in the electrical equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.
- C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.
- D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers recommended test devices and procedures.
- E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.
- F. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.
- G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

#### 1.11 NOT USED

#### 1.12 SCHEDULES AND FACILITY OPERATIONS

- A. Since the equipment testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the Engineer for review and approval one (1) month prior to the start of testing. In addition, all testing that requires temporary shutdown of facility equipment must be coordinated with the Owner/Engineer so as not to affect proper facility operations.
- B. At the end of the workday, all equipment shall be restored to full operation and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing the equipment shall be placed back in service immediately and turned over to Owner personnel if required by the Owner.
- C. In the event of accidental shutdown of Owner equipment, the Contractor shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.
- D. Maintaining the operation of critical and necessary facilities during the duration of the construction period is essential and required. The Contractor shall furnish and install temporary equipment as required to maintain facility operation. Reference Section 01520 of the Specifications for construction sequencing and specific operational constraint information.

#### 1.13 MATERIALS HANDLING

- A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01550, Site Access and Storage.

#### 1.14 WARRANTIES

- A. Unless otherwise specified in an individual specification section, all equipment and electrical construction materials furnished and installed under Division 16 shall be provided with a warranty in accordance with the requirements of Section 11000, Equipment General Provisions and the General Conditions.

#### 1.15 TRAINING

- A. Unless otherwise specified in an individual specification section, all training for equipment furnished and installed under Division 16 shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

## PART 2 -- PRODUCTS

### 2.01 PRODUCT REQUIREMENTS

- A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.
- C. All equipment and materials shall be new, unless indicated or specified otherwise.
- D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming to this requirement.

### 2.02 SUBSTITUTIONS

- A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Contractor, in such cases may, at his option use any article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified.

### 2.03 CONCRETE

- A. The Contractor shall furnish all concrete required for the installation of all electrical work, Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 3 of the Specifications.
- B. The Contractor shall provide concrete equipment pads for all free standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The exact location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to standard detail for

equipment pads shown on the Contract Drawings. Equipment pads shall not have more than 3" excess concrete beyond the edges of the equipment.

- C. The Contractor shall provide concrete foundations for all free standing electrical apparatus and equipment located outdoors or where floors or slabs do not exist and/or are not provided by others under this Contract. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of the foundations. Equipment foundations shall be constructed as detailed on the Drawings or if not detailed on the Drawings shall be 6 inches thick minimum reinforced with #4 bars at 12-inch centers each way placed mid-depth. Concrete shall extend 6 inches minimum beyond the extreme of the equipment base and be placed on a compacted stone bed (#57 stone or ABC) 6 inches thick minimum.

#### 2.04 RUBBER INSULATING MATTING

- A. Rubber insulating matting shall be furnished and installed on the floor and in front of each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. The mat shall be long enough to cover the full length of the equipment. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.
- B. Matting shall be provided for the following equipment:
  - PLC/RTU Enclosures

### PART 3 -- EXECUTION

#### 3.01 CUTTING AND PATCHING

- A. Coordination
  - 1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.
- B. Damage
  - 1. The Contractor shall perform all chasing, channeling, drilling and patching necessary to the proper execution of his Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Contractor shall replace damaged equipment at his own expense.

C. Existing Equipment

1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

3.02 EXCAVATION AND BACKFILLING

- A. The Contractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 2.

3.03 CORROSION PROTECTION

- A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

- END OF SECTION -

## SECTION 16111

### CONDUIT

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install conduits and conduit fittings to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.
- B. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Section 16190, Electrical Supporting Devices, for these requirements.
- C. Reference Section 16000, Basic Electrical Requirements.

##### 1.02 CODES AND STANDARDS

- A. Conduits and conduit fittings shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. American National Standards Institute (ANSI)
    - a. ANSI B1.20.1 – Pipe Threads, General Purpose
    - b. ANSI C80.1 – Electrical Rigid Steel Conduit
    - c. ANSI FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
  - 2. Underwriters Laboratories (UL)
    - a. UL 6 - Electrical Rigid Metal Conduit-Steel
    - b. UL 360 – Standard for Liquid-tight Flexible Metal Conduit
    - c. UL 467 – Grounding and Bonding Equipment
    - d. UL 514B – Conduit, Tubing, and Cable Fittings
    - e. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings
    - f. UL 1479 – Standard for Fire Tests of Penetration Fire Stops
    - g. UL 1660 – Liquid-tight Flexible Nonmetallic Conduit
  - 3. National Electrical Manufacturer's Association (NEMA)



- a. NEMA RN 1 – PVC Externally Coated Galvanized Rigid Steel Conduit
- b. NEMA TC-2 – Electrical PVC Conduit
- c. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

B. Others

- 1. ACI-318 – Building Code Requirements for Structural Concrete

### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

- 1. Shop Drawings

- B. Each submittal shall be identified by the applicable specification section.

### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

- C. Shop drawings shall include but not be limited to:

- 1. Product data sheets for conduits and fittings.
- 2. Conduit identification methods and materials.
- 3. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

### 1.05 DEFINITIONS

- A. Conduits are categorized by the circuit type of the wiring to be installed inside. Conduits are defined as follows:

- 1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.
- 2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Conduits that carry fiber optic cables between devices and/or equipment.

3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment.
- B. Conduit categories are indicated on the Drawings by the leading letter of the conduit tag. Conduit tag leading letters are defined as follows:
1. P – Power Conduit
  2. C – Control Conduit
  3. I – Instrumentation Conduit

## PART 2 – PRODUCTS

### 2.01 GENERAL

- A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses and installation requirements of these conduits and conduit fittings.
- B. All metallic conduit fittings shall be UL 514B and UL 467 Listed, and constructed in accordance with ANSI FB 1. All metallic conduit fittings for use in Class I Division I hazardous areas shall be UL 1203 Listed. All non-metallic fittings shall be UL 651 Listed and constructed in accordance with NEMA TC-3.
- C. Flexible conduit couplings for use in Class I Division I hazardous areas shall have threaded stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of stainless steel where available in the conduit trade size required for the application. Where stainless steel braid is not available, the braid shall be provided with a PVC coating. No other braid types or materials are acceptable.
- D. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.
- E. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.
- F. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to  $\frac{3}{4}$  inch of expansion/contraction along the axis of the conduit as well as up to  $\frac{3}{4}$  inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs by stainless steel clamps.
- G. Conduit seals shall either be Listed and labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.

- H. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.
- I. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

## 2.02 RIGID GALVANIZED STEEL (RGS) CONDUIT AND ASSOCIATED FITTINGS

### A. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1, and shall be UL 6 Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

### B. Conduit Bodies for use with Rigid Galvanized Steel

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.
3. Conduit bodies for all other areas shall be provided with covers that are affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Covers shall be provided with matching gasket.

### C. Conduit Couplings, Nipples, and Unions for use with Rigid Galvanized Steel

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

### D. Conduit Expansion and Deflection Fittings for use with Rigid Galvanized Steel

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Galvanized Steel

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Galvanized Steel

1. Conduit hubs shall be constructed of stainless steel and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.
3. Conduit bonding bushings shall be constructed of zinc plated malleable iron. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

## 2.03 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 651 Listed, and suitable for conductors with 90 degree C insulation.
- 2.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.
2. Conduit body shall be provided with cover that is affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut, and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.
3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

2.04 PVC COATED RIGID GALVANIZED STEEL CONDUIT AND ASSOCIATED FITTINGS

A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil (minimum) thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil (minimum) thickness.
2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.

B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1, and shall be UL 6 Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.
3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN-1.

C. Conduit Bodies for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.
3. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place by stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Rigid Galvanized Steel Conduit

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

E. Conduit Expansion and Deflection Fittings for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

F. Conduit Seals for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket. The seal shall be coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.

2. Conduits seals shall not limit the percent cross-sectional cable capacity of the raceway system. An expanded seal (e.g. 40 percent fill seal) shall be used when the total cross-sectional area of cables in the raceway exceeds 25 percent.

G. Conduit Termination Fittings for Use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.05 NOT USED

2.06 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Trade size 1-1/4 inch and smaller conduits shall be provided with an integrally woven copper bonding strip.
2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 360 Listed.

B. Conduit Termination Fittings for use with LFMC

1. Conduit termination fittings shall be constructed of either 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil (minimum) PVC jacket and coated on the interior with a 2 mil (minimum) layer of urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.
2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment, and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic insulated throat and shall be watertight when assembled to the conduit and equipment.

2.07 LIQUID TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be constructed of rigid polyvinyl chloride (PVC), fabricated to provide flexibility. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 1660 Listed.

B. Conduit Termination Fittings for use with LFNC

1. Conduit termination fittings shall be constructed PVC and shall have a threaded end with matching locknut and sealing ring for termination to equipment. Termination fittings shall be watertight when assembled to the conduit and equipment.

2.08 NOT USED

2.09 NOT USED

2.10 CONDUIT BENDS

- A. Rigid conduit bends, both factory fabricated and field fabricated, shall meet the same requirements listed in the articles above for the respective conduit type and material of construction.

- B. Conduit bend radii for standard radius bends shall be no less than as follows:

|                         |       |       |       |       |       |        |    |       |    |    |    |
|-------------------------|-------|-------|-------|-------|-------|--------|----|-------|----|----|----|
| TRADE SIZE<br>(inches)  | 3/4   | 1     | 1-1/4 | 1-1/2 | 2     | 2-1/2  | 3  | 3-1/2 | 4  | 5  | 6  |
| MIN. RADIUS<br>(inches) | 4-1/2 | 5-3/4 | 7-1/4 | 8-1/4 | 9-1/2 | 10-1/2 | 13 | 15    | 16 | 24 | 30 |

- C. Conduit bend radii for long radius bends shall be no less than as follows:

|                         |     |    |       |       |    |       |    |       |    |    |    |
|-------------------------|-----|----|-------|-------|----|-------|----|-------|----|----|----|
| TRADE SIZE<br>(inches)  | 3/4 | 1  | 1-1/4 | 1-1/2 | 2  | 2-1/2 | 3  | 3-1/2 | 4  | 5  | 6  |
| MIN. RADIUS<br>(inches) | N/A | 12 | 18    | 24    | 30 | 30    | 36 | 36    | 48 | 48 | 60 |

2.11 MISCELLANEOUS

A. Conduit Periphery Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit periphery from one space to another (where required) shall be through the use of one of the following:



- a. A conduit sleeve and pressure bushing sealing system. Acceptable products are FSK by OZ-GEDNEY, Link-Seal by Crouse-Hinds, or Engineer approved equal.
    - b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors between spaces within buildings. This method shall not be used for the sealing of conduits leaving a building and/or structure.
  - 2. Conduit penetrations through fire-rated walls and floors shall be made with an approved UL 1479 Listed product specifically intended for the trade size of the conduit.
- B. Primer and Cement
- 1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer's recommended cement that is labeled Low VOC.
- C. Galvanizing Compounds
- 1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.
- D. Conduit Interior Sealing
- 1. The sealing of the inside of conduits against water ingress shall be achieved through the use of one of the following:
    - a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit. Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Q-Pak 2000 by Chemque, FST by American Polywater Corporation, or Hydra-seal S-60 by Duraline.
    - b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products are Rayflate by Raychem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2 inch and larger.
    - c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be compressed by two stainless steel pressure plates. Acceptable products are type CSB by OZ-GEDNEY, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.

2. The use of aerosol-based expanding foam sealants or any other method of sealing against water ingress not listed above is not acceptable.

E. Pull Rope

1. Pull ropes for empty and/or spare conduits shall be woven polyester, 1/2 inch wide, with a minimum tensile strength of 1250 lbs.
2. Pull ropes for the Contractors use in installing conductors shall be the size and strength required for the pull, and shall be made of a non-metallic material.

## PART 3 – EXECUTION

### 3.01 GENERAL

- A. Minimum trade size for all rigid conduits shall be 3/4 inch in exposed applications and 1 inch in embedded applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.
- B. Minimum trade size for flexible conduits (where specifically allowed herein) shall be 1/2 inch in all applications.
- C. Some conduit routing may not be shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.
- D. Conduit routing for main electrical and control equipment is shown on the Drawings. The line type used on the Drawings indicates which conduits shall be installed concealed and which shall be installed exposed.
- E. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.
- F. Nonmetallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to ready each joint for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.
- G. Metallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be 3/4 inch per foot tapered threads in accordance with ANSI B1.20.1.
- H. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.

- I. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and blower air pipes. Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.
- J. Where non-metallic instrumentation conduits are installed exposed, the following clearances to other conduit types shall be maintained:
  - 1. Instrumentation conduits installed parallel to conduits with conductors energized at 480V or above shall be 18 inches.
  - 2. Instrumentation conduits installed parallel to conduits with conductors energized at 240V and below shall be 12 inches.
  - 3. Instrumentation conduits installed at right angles to conductors energized at 480V and below shall be 6 inches.
  - 4. Instrumentation conduits installed at right angles to conductors energized at voltages above 480V shall be 12 inches.
- K. Where conduit fittings do not include an integral insulated bushing, an insulated bushing shall be installed at all conduit termination points.
- L. Conduits which serve multi-section equipment shall be terminated in the section where wiring terminations will be made.
- M. Conduits shall not penetrate the floors or walls inside liquid containment areas without specific written authorization from the Engineer. Liquid containment areas are indicated on the Drawings.
- N. In no case shall conduit be supported or fastened to another pipe or be installed in a manner that would prevent the removal of other pipes for repairs. Spring steel fasteners may only be used to affix conduits containing lighting branch circuits within EMT conduits to structural steel members.
- O. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.
- P. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.
- Q. Conduits which emerge from within or below concrete encasement shall be PVC coated rigid galvanized steel in accordance with Standard Detail 1611102 where the conduit is not protected by an equipment enclosure that surrounds the conduit on all sides at the point where it emerges from the encasement.

### 3.02 CONCEALED AND EMBEDDED CONDUITS

A. Conduits are permitted to be installed concealed and/or embedded with the following requirements:

1. Conduits shall not be installed horizontally when concealed within CMU walls, only vertical installation is acceptable.
2. Conduits installed embedded within concrete floors or walls shall be located so as not to affect the designed structural strength of the floor or wall. Embedded conduits shall be installed in accordance with Standard Detail 0331604 and ACI-318.
3. Where conduit bends emerge from concrete embedment, none of the curved portion of the bend shall be visible. Only the straight portion of the bend shall be visible.
4. Where multiple conduits emerge from concrete embedment or from concealment below a concrete floor, ample clear space shall be provided between conduits to allow for the appropriate and required conduit termination fittings to be installed.
5. Conduits installed embedded within concrete encasement of any kind shall be installed such that conduit couplings for parallel conduits are staggered so that they are not side by side.

B. Conduits are NOT permitted to be installed concealed and/or embedded for the following situations:

1. Conduits shall not be installed embedded within any water-bearing floors or walls. Conduits shall not be installed embedded within any liquid containment area floors or walls.
2. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to Class I and II hazardous areas (Division I and Division II).
3. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to indoor Type 1 or Type 2 chemical storage/transfer areas.

### 3.03 CONDUIT USES AND APPLICATIONS

A. Rigid Conduit

1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

| RIGID CONDUIT FOR NON-HAZARDOUS AREAS              |                                                |                              |
|----------------------------------------------------|------------------------------------------------|------------------------------|
| <u>INSTALLATION AREA<br/>DESIGNATION/ SCENARIO</u> | <u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u> |                              |
|                                                    | Power and Control                              | Instrumentation              |
| Exposed in indoor wet process areas                | PVC coated rigid<br>galvanized steel conduit   | Same as Power and<br>Control |

| <b>RIGID CONDUIT FOR NON-HAZARDOUS AREAS</b>                                                                               |                                                       |                                           |
|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------|
| <b><u>INSTALLATION AREA<br/>DESIGNATION/ SCENARIO</u></b>                                                                  | <b><u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u></b> |                                           |
|                                                                                                                            | <b>Power and Control</b>                              | <b>Instrumentation</b>                    |
| Exposed in indoor dry process areas                                                                                        | Rigid galvanized steel conduit                        | Same as Power and Control                 |
| Exposed in indoor dry non-process areas                                                                                    | Rigid galvanized steel conduit                        | Same as Power and Control                 |
| Exposed in indoor Type 1 chemical storage/transfer areas                                                                   | Schedule 80 rigid non-metallic PVC conduit            | Same as Power and Control                 |
| Exposed in indoor Type 2 chemical storage/transfer areas                                                                   | PVC coated rigid galvanized steel conduit             | Same as Power and Control                 |
| Exposed in outdoor areas                                                                                                   | PVC coated rigid galvanized steel conduit             | Same as Power and Control                 |
| Concealed within underground direct-bury or concrete-encased ductbanks                                                     | Schedule 40 rigid non-metallic PVC conduit            | PVC coated rigid galvanized steel conduit |
| Concealed within non-elevated (i.e. "slab-on-grade" construction) concrete slabs                                           | Schedule 40 rigid non-metallic PVC conduit            | PVC coated rigid galvanized steel conduit |
| Concealed within elevated concrete slabs                                                                                   | PVC coated rigid galvanized steel conduit             | Same as Power and Control                 |
| Concealed below concrete slabs (within earth or fill material)                                                             | Schedule 40 rigid non-metallic PVC conduit            | PVC coated rigid galvanized steel conduit |
| Concealed within concrete walls                                                                                            | Schedule 40 rigid non-metallic PVC conduit            | PVC coated rigid galvanized steel conduit |
| Concealed within CMU walls                                                                                                 | PVC coated rigid galvanized steel conduit             | Rigid galvanized steel conduit            |
| Emerging from concealment within or below a concrete floor and transitioning to exposed conduit (Reference Detail 1611102) | PVC coated rigid galvanized steel conduit             | Same as Power and Control                 |

2. Rigid conduit for hazardous areas shall be furnished and installed in the materials of construction as follows:

| <b>RIGID CONDUIT FOR HAZARDOUS AREAS</b>                                             |                                                       |                           |
|--------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------|
| <b><u>INSTALLATION AREA<br/>HAZARD/SCENARIO</u></b>                                  | <b><u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u></b> |                           |
|                                                                                      | <b>Power and Control</b>                              | <b>Instrumentation</b>    |
| Exposed in Class I and II areas (Division I and Division II)                         |                                                       | Same as Power and Control |
| Concealed within concrete slabs in Class I and II areas (Division I and Division II) | Rigid galvanized steel conduit                        | Same as Power and Control |

|                                                                                                                                              |                                            |                                |
|----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|--------------------------------|
| Concealed below concrete slabs (within earth or fill material) in Class I and II areas (Division I and Division II)                          | Rigid galvanized steel conduit             | Same as Power and Control      |
| Concealed within concrete walls in Class I and II areas (Division I and Division II)                                                         | Rigid galvanized steel conduit             | Same as Power and Control      |
| Concealed below concrete slabs encased in at least two inches of concrete and buried 24 inches below top of slab in Class I Division I areas | Schedule 40 rigid non-metallic PVC conduit | Rigid galvanized steel conduit |
| Concealed above suspended ceilings in Class I and II areas (Division I and Division II)                                                      |                                            | Same as Power and Control      |

3. The tables for the materials of construction for rigid conduits are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be rigid galvanized steel. This discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution.

#### B. Conduit Bends

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:
  - a. All 90 degree bends or combinations of adjacent bends that form a 90 degree bend where concealed within concrete or below a concrete slab shall be PVC-coated rigid galvanized steel.
2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends shall have minimum bending radii in accordance with the associated tables in Part 2 herein.
3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.
4. Long radius bends shall be furnished and installed for underground installations and the following specific applications, all other bends shall be standard radius:
  - a. All conduits containing medium voltage cable.
  - b. All conduits containing fiber optic cable.
  - c. Where specifically indicated on the Drawings.

#### C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:
  - a. Connections to motors and engine-generator sets (and similar vibrating equipment)
  - b. Connections to solenoid valves and limit switches
  - c. Connections to lighting fixtures installed in suspended ceilings
  - d. Connections to lighting transformers
  - e. Connections to pre-fabricated equipment skids
  - f. Connections to HVAC equipment
  - g. Connections to instrument transmitters and elements
  - h. Where specifically indicated in the Standard Details
2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.
3. Flexible conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

| <b>FLEXIBLE CONDUIT FOR NON-HAZARDOUS AREAS</b>          |                                                       |                           |
|----------------------------------------------------------|-------------------------------------------------------|---------------------------|
| <b><u>INSTALLATION AREA<br/>DESIGNATION/SCENARIO</u></b> | <b><u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u></b> |                           |
|                                                          | <b>Power and Control</b>                              | <b>Instrumentation</b>    |
| Exposed in indoor wet process areas                      | Liquid-tight flexible metal conduit                   | Same as Power and Control |
| Exposed in indoor dry process areas                      | Liquid-tight flexible metal conduit                   | Same as Power and Control |
| Exposed in indoor dry non-process areas                  | Liquid-tight flexible metal conduit                   | Same as Power and Control |
| Exposed in indoor Type 1 chemical storage/transfer areas | Liquid-tight flexible non-metallic conduit            | Same as Power and Control |
| Exposed in indoor Type 2 chemical storage/transfer areas | Liquid-tight flexible metal conduit                   | Same as Power and Control |
| Exposed in outdoor areas                                 | Liquid-tight flexible metal conduit                   | Same as Power and Control |

4. For Class I Division I hazardous areas, the NEC does not permit the installation of flexible conduit. In lieu of flexible conduit in these areas, flexible conduit couplings

shall be installed as specified in Part 2 herein. Flexible conduit for all other hazardous areas shall be furnished and installed in the materials of construction as follows:

| <b>FLEXIBLE CONDUIT FOR HAZARDOUS AREAS</b>                                             |                                                       |                           |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------|
| <b><u>INSTALLATION AREA<br/>HAZARD/SCENARIO</u></b>                                     | <b><u>CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE</u></b> |                           |
|                                                                                         | <b>Power and Control</b>                              | <b>Instrumentation</b>    |
| Exposed in Class I Division II areas                                                    | Liquid-tight flexible metal conduit                   | Same as Power and Control |
| Exposed in Class II (Division I and Division II) areas                                  | Liquid-tight flexible metal conduit                   | Same as Power and Control |
| Concealed above suspended ceilings in Class I and II (Division I and Division II) areas | Same material as exposed conduit in same area         | Same as Power and Control |

### 3.04 CONDUIT FITTING USES AND APPLICATIONS

#### A. General

1. Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.
2. Conduit fittings shall be provided in the trade size and configuration required to suit the application.

#### B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.
2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

#### C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings (unions) or close nipples. After installation of a conduit fitting of any kind, there shall be no more than ¼ inch of exposed threads visible. Factory fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

#### D. Conduit Expansion and Deflection Fittings



1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.
2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed (exposed and concealed) across structural expansion joints.

#### E. Conduit Seals

1. Conduit seals shall be installed for conduits installed within or associated with hazardous areas and other areas as required by the NEC. In addition, conduit seals shall also be furnished and installed as follows:
  - a. All conduits entering or leaving enclosed areas which store or distribute chlorine gas.
  - b. All conduits entering or leaving enclosed areas which store or distribute sulfur dioxide gas.

#### F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.
2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the locknut.
3. Conduits shall not be installed such that conduit fittings penetrate the top of any enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

### 3.05 MISCELLANEOUS

#### A. Conduit Periphery Sealing

1. All conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein to prevent air and/or water entry into the structure.

2. All conduit penetrations through interior walls and floors shall be sealed through the use of with conduit sleeves and caulk as specified in Part 2 herein. Alternatively, mortar may be used to seal around the conduit periphery.
3. Conduit penetrations through fire-rated walls as floors shall be made with the appropriate fire rated penetration product.

B. Conduit Interior Sealing

1. All conduits (including spares) entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.

### 3.06 CONDUIT IDENTIFICATION

- A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:
1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
  2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g. TO: PMP-1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule (e.g. FROM: PNL-1). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.
  3. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18 point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24 point font.
  4. Label height shall be 3/4 inch minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
  5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
  6. Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.

- B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:
  - 1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
  - 2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
- C. Conduits for lighting and receptacle circuits shall not require identification.
- D. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

### 3.07 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

### 3.08 TRAINING OF INSTALLATION PERSONNEL

- A. All Contractor personnel that install PVC coated RGS conduit shall be trained by the PVC coated RGS conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit, or shall be trained/re-trained as required prior to commencement of conduit installation.

- END OF SECTION -

SECTION 16118  
UNDERGROUND ELECTRICAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install underground duct systems, electric manholes, and electric handholes as specified herein and as indicated on the Drawings. The work shall be complete and shall include excavation, concrete construction, backfilling, and all materials, items, and components required for a complete system.
- B. The provisions of this Division are applicable to all underground conduit work. All work shall be coordinated with that of the various utility companies and other Contractors. The Contractor shall adhere to all utility company requirements including the serving electric utility.
- C. Reference Section 16000, Basic Electrical Requirements; Section 16111, Conduit; Section 16170, Grounding and Bonding; the applicable sections of Division 2, Sitework; Section 03200, Reinforcing Steel; and 03300, Cast-In-Place Concrete.

1.02 CODES AND STANDARDS

- A. Products specified herein shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. AASHTO H20
  - 2. ANSI/SCTE 77-2010 – Specification for Underground Enclosure Integrity

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit Shop Drawings. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to, the following:

1. Product data sheets.
2. Outline and dimensional drawings including detailed sections of the manholes and/or handholes.
3. Materials specifications and structural calculations for the manholes sealed by a Professional Engineer in the California.

#### 1.05 IDENTIFICATION

A. Each electric manhole and handhole cover shall be lettered with the word "Electric", the manhole or handhole identification number (e.g. EHH-1, etc.), manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

#### 2.02 DUCT SYSTEM

- A. The underground duct system shall be comprised of conduits, conduit bends, and conduit fittings as specified in Section 16111, Conduit. Conduits shall be encased in reinforced concrete envelopes, unless otherwise specified herein or indicated on the Drawings.
- B. Base and intermediate conduit spacers shall be furnished to provide a minimum of two-inch (2") separation between conduits. Conduit spacers shall be provided in the proper size as required for the conduit that they secure. For example, a 4" conduit spacer shall not be used to secure a 2" conduit. Conduit spacers shall be as manufactured by Carlon Electrical Products Company, Aeroquip Corporation, Underground Devices, Incorporated, or equal.

#### 2.03 ELECTRIC MANHOLES

- A. The concrete manholes shall be complete with metal frames and covers of size and location as specified herein and shown on the Drawings.
- B. Manhole frames and covers shall be Neenah R-1640C1, or equal, with Type A anchor ring. Entire manhole assembly shall be AASHTO H20 heavy duty rated. Covers shall be furnished with drop handles.

- C. All electric manholes shall be provided with non-metallic cable racks. Cable racks shall be rated for the application, with a minimum loading capacity of 450lbs per rack arm. Cable rack system shall be Heavy Duty type as manufactured by Underground Devices, Incorporated or equal.

#### 2.04 ELECTRIC HANDHOLES

- A. The electric handholes shall be a precast polymer concrete enclosure suitable for use as part of an underground electric raceway system. The enclosure shall meet or exceed the requirements of ANSI/SCTE 77-2010.
- B. The enclosure and cover design and test load rating shall be Tier 15. Covers shall be provided with cover hooks.
- C. The enclosure shall be the straight side design to allow easy adjustment of box to grade. The box shall be stackable for increased depth.
- D. Handhole opening size shall be as required to suit the application, 6" X 8", minimum.
- E. The electric handholes shall be manufactured by Hubbell, Pencil Plastics equivalent, Highline Products equivalent, or equal.

### PART 3 -- EXECUTION

#### 3.01 GENERAL

- A. The underground duct system, manholes, and handholes shall be installed as specified herein, indicated on the Drawings, and in accordance with manufacturers' instructions.

#### 3.02 DUCT SYSTEM

- A. All underground conduit shall be encased in concrete and shall be reinforced. Encasement and reinforcement shall be as indicated in the standard details. Concrete shall be furnished and installed in accordance with Section 03300. Reinforcing steel shall be furnished and installed in accordance with Section 03200. Concrete electrical duct banks shall contain red dye; the red dye shall be mixed into the concrete mix before being poured. Red dye applied to the top of concrete encasement after placement of concrete is not acceptable.
- B. Concrete pours shall be complete from handhole to handhole and from manhole to manhole where practicable. Partial pours in general shall not be permitted. Where a complete pour is impractical, written authorization shall be obtained from the Engineer for the partial pour.
- C. Conduit ductbank elevations at the manholes and handholes shall be based on minimum ductbank cover as indicated in the standard details, or deeper to avoid conflicts with other obstacles. Where deviation is necessary to clear unforeseen obstacles, the elevations may be changed after authorization by the Engineer.

- D. Slope all conduits continuously away from structures, buildings, and utility equipment with a minimum slope of 3" per 100' unless otherwise indicated on the Drawings. Pull box installation to prevent water intrusion.
- E. The minimum clearance from the top of the concrete encasement and finished grade shall be as indicated in the standard details, except where otherwise accepted in writing by the Engineer or shown on the Drawings.
- F. Care shall be exercised during excavation for the duct banks to prevent digging too deep. Backfilling of low spots with earth fill will not be permitted unless thoroughly compacted and acceptable to the Engineer.
- G. If a specific ductbank arrangement is shown on the Drawings, the conduits in that ductbank shall be arranged as shown. Where no specific ductbank arrangement is shown on the Drawings, the Contractor shall arrange conduits within each ductbank based on field conditions. Spare conduits shown going from ductbanks into buildings or structures shall be stubbed up in the location(s) as indicated on the Drawings.
- H. A minimum of one (1) ground rod, furnished in accordance with Section 16170, shall be driven adjacent to each manhole, handhole, or other concrete box. A No. 4/0 AWG bare copper ground cable shall be connected between this rod and the copper ground strap using a silicon bronze connector. All ground rods shall be interconnected by means of the No. 4/0 AWG bare copper ground cable located within each duct bank. The ends of these cables shall also be connected to substation and/or building ground buses where the conduits terminate.
- I. Care shall be exercised and temporary plugs shall be installed during installation to prevent the entrance of concrete, mortar, or other foreign matter into the conduit system. Conduit spacers shall be utilized to support conduit during the pouring of concrete to prevent movement and misalignment of the conduits. Conduit spacers shall be installed in accordance with manufacturer's instructions unless otherwise noted. Horizontal spacing of conduit spacers along ductbank shall be as indicated on the Standard Details.
- J. Where connections to existing underground conduits are indicated, excavate to the maximum depth necessary. After addressing the existing conductors, cut the conduits and remove loose concrete from the conduits before installing new concrete encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct line, to take the shear at the joint of the duct lines.
- K. Construct concrete-encased conduits connecting to underground structures to have a flared section adjacent to the manhole to provide shear strength. Construct underground structures to provide shear strength. Construct underground structures to provide for keying the concrete encasement of the duct line into the wall of the structure. Use vibrators when this portion of the encasement is poured to ensure a seal between the encasement and the wall of the structure.
- L. Six (6) inches above all duct banks, the Contractor shall furnish and install a two (2) inch wide red plastic electrical hazard tape. Tapes shall be metallic detectable type and shall

have a continuous message in bold black letters: "ELECTRIC LINE BURIED BELOW."  
Tape shall be Detectable Identoline by Brady, or equal.

- M. The Contractor shall perform all earthwork including excavation, backfill, bedding, compaction, shoring and bracing, grading and restoration of surfaces and seeded areas disturbed during the execution of the work.
- N. All conduit joints in the duct system shall be staggered such that adjacent conduits do not have joints in the same location.

### 3.03 ELECTRIC MANHOLES

- A. Electric manholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 14" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to the roof. All manholes shall be built on, or placed over a 6" layer of well-tamped gravel.
- B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.
- C. All concrete work and fully assembled manholes shall be completely watertight and shall be furnished with sloped floors that pitch towards a sump pit. The outside surfaces shall be coated with an approved asphaltic waterproofing compound (all sides, bottom, and roof). Precast concrete manholes may be installed; however, all requirements of this section and other divisions of the Specifications and the details shown on the Drawings shall apply.
- D. Install pulling eye irons imbedded in walls opposite each duct entrance securely fastened to manhole reinforcing rods. All hardware shall be hot-dipped galvanized steel. Copper bars shall be provided in the walls for grounding. No. 4/0 AWG bare copper cables shall be connected to these bars and all non-current carrying metal parts shall be grounded to these copper bars.
- E. All cables shall be well supported on walls by nonmetallic cable racks. The cable racks shall be heavy-duty type for medium and low voltage power cables and light duty type for control, signal, communications and similar small conductors. All racks shall be rigidly attached to the wall and equipped with adjustable rack arms.

### 3.04 ELECTRIC HANDHOLES

- A. Electric handholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 9" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to roof. All handholes shall be built on, or placed over a 6" layer of well-tamped gravel.
- B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.



- C. All fully assembled handholes shall be completely watertight.
- D. All individual cables and/or bundles of conductors shall be identified and “dressed” along the wall of the enclosure. Cable racks as specified herein shall be provided if any handhole dimension exceeds 24 inches.

### 3.05 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Field tests
    - a. Field tests for all completed duct systems shall consist of pulling a swab through each conduit followed by a mandrel equal in size to 85% of the conduit inside diameter.
    - b. After testing, all conduits shall be capped after installation of a suitable pull rope. All field tests shall be witnessed by the Engineer.

- END OF SECTION -

## SECTION 16123

### LOW VOLTAGE WIRE AND CABLE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, all low voltage wire and cable indicated on the Drawings and as specified herein and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of wire and cable systems shall be furnished and installed by the Contractor.
- B. The scope of this Section does not include internal wiring factory installed by electrical equipment manufacturers.
- C. Reference Section 16000 – Basic Electrical Requirements and Section 16130 – Boxes.

##### 1.02 CODES AND STANDARDS

- A. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. Underwriters Laboratories (UL)
    - a. UL 13 – Standard for Power-Limited Circuit Cables
    - b. UL 44 – Thermoset-Insulated Wires and Cables
    - c. UL 83 – Thermoplastic-Insulated Wires and Cables
    - d. UL 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
    - e. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords
    - f. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
    - g. UL 2250 – Standard for Instrumentation Tray Cable
    - h. UL 2556 – Wire and Cable Test Methods
  - 2. American Society for Testing and Materials (ASTM)

- a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire
- b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- c. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
- d. ASTM D69 – Standard Test Methods for Friction Tapes
- e. ASTM D4388 – Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes
- 3. Insulated Cable Engineers Association (ICEA)
  - a. ICEA S-58-679 – Standard for Control, Instrumentation and Thermocouple Extension Conductor Identification
  - b. ICEA T-29-250 – Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour
- 4. Institute of Electrical and Electronics Engineers (IEEE)
  - a. IEEE 1202 – Standard for Flame Testing of Cables

#### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Reports of Field Tests
- B. Each submittal shall be identified by the applicable specification section.

#### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets for wire and cable, terminations, and pulling lubricant.

2. Cable pulling calculations (if required).
  3. Wiring identification methods and materials.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.
- 1.05 CABLE PULLING CALCULATIONS
- A. Prior to the installation of the wire and cable specified herein, the Contractor shall submit cable pulling calculations for engineer review and approval when all of the following are true:
1. The amount of cable to be installed will be greater than 200 linear feet between pull points.
  2. The installation will have one or more bends.
  3. The wire and cable is size #1/0 AWG and larger.
- B. Cable pulling calculations shall be performed by a currently registered professional engineer in the California and shall define pulling tension and sidewall loading (sidewall bearing pressure values).

## PART 2 -- PRODUCTS

### 2.01 MANUFACTURERS

- A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one (1) manufacturer for each wire and cable type shall be permitted.

### 2.02 POWER AND CONTROL WIRE AND CABLE

- A. Power wire of size 10 AWG or larger shall have ethylene propylene rubber (EPR) insulation with a PVC or cross-linked chlorinated polyethylene (XL-CPE) jacket, NEC type RHW-2, and be rated for 90°C in both wet and dry locations at 600V.
- B. Power wire and control wire of size 12 AWG or less (except lighting and receptacles) shall consist of copper conductors insulated with a cross-linked polyethylene (XLP) outer jacket.

Conductor insulation shall be rated 90°C for dry and wet locations, and 600V. Insulated conductors for power and control shall be UL 44 Listed as NEC Type XHHW-2.

- C. Wire for lighting and receptacles shall consist of copper conductors insulated with a nylon (or equivalent) outer jacket. Conductor insulation shall be rated 90°C for dry locations, 75°C for wet locations, and 600V. Insulated conductors shall be UL 83 Listed as NEC Type THHN/THWN.
- D. Unless specified otherwise herein, conductors shall be stranded copper per ASTM B-8 and B-3, with Class B or C stranding contingent upon the size.
- E. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.
- F. Multi-conductor cable assemblies shall include a grounding conductor and an overall PVC jacket. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Multi-conductor cable assemblies shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- G. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or equal.

## 2.03 INSTRUMENTATION CABLE

- A. For single-analog signal applications, instrumentation cable shall consist of a single, twisted pair or triad of individually insulated and jacketed copper conductors with an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- B. For multiple-analog signal applications, instrumentation cable shall consist of multiple, twisted pairs or triads (i.e. groups) of individually insulated and jacketed copper conductors with individual pair/triad shields (i.e. group shields) and an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- C. Cable and group shields shall consist of overlapped aluminum/polyester tape/foil providing 100% coverage. Instrumentation cables shall include an overall copper shield drain wire. Cables containing multiple twisted pairs or triads shall also include group shield drain wires.
- D. Conductors, including drain wires, shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM B-8, with Class B stranding unless otherwise specified.
- E. Instrumentation signal conductor size shall be no smaller than No. 16 AWG.

- F. Instrumentation cable shall be Okoseal-N Type P-OS (for single pair or triad applications) or Okoseal-N Type SP-OS (for multiple pair or triad applications) as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or equal.

#### 2.04 NOT USED

#### 2.05 CONDUCTOR IDENTIFICATION

- A. Conductors shall be identified using a color coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:

1. 480/277V AC Power
  - a. Phase A - BROWN
  - b. Phase B - ORANGE
  - c. Phase C - YELLOW
  - d. Neutral – GREY
2. 120/240 3Ø AC Power
  - a. Phase A - BLACK
  - b. Phase B - RED WITH ORANGE TAPE
  - c. Phase C - BLUE
  - d. Neutral – WHITE
3. 120/208V or 120/240V AC Power
  - a. Phase A - BLACK
  - b. Phase B - RED
  - c. Phase C - BLUE
  - d. Neutral - WHITE
4. DC Power
  - a. Positive Lead - RED
  - b. Negative Lead - BLACK
5. DC Control
  - a. All wiring - BLUE

- b.
  - 6. 120 VAC Control
    - a. 120 VAC control wire shall be RED except for a wire entering a motor control center compartment, motor controller, or control panel which is an interlock. This interlock conductor shall be color coded YELLOW. For the purposes of this Section, an interlock is defined as any wiring that brings voltage into the above mentioned equipment from a source outside that equipment.
  - 7. 24 VAC Control
    - a. All wiring - ORANGE
  - 8. Equipment Grounding Conductor
    - a. All wiring - GREEN
  - B. Individual conductors No. 2 AWG and smaller shall have factory color coded insulation. It is acceptable for individual conductors larger than No.2 AWG to be provided with factory color coded insulation as well, but it is not required. Individual conductors larger than No.2 AWG that are not provided with factory color coded insulation shall be identified by the use of colored tape in accordance with the requirements listed in Part 3 herein. Insulation colors and tape colors shall be in accordance with the color coding requirements listed above.
  - C. Conductors that are part of multi-conductor cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor No.2 AWG and smaller within the cable assembly shall also be identified with a heat shrink tag with color coded background. Each conductor larger than No.2 AWG within the cable assembly shall also be identified by the use of colored tape. Heat shrink tags and colored tape shall be in accordance with the requirements listed in Part 3 herein. Tape color and heat shrink tag background color shall be in accordance with the color coding requirements listed above.
- 2.06 CABLE PULLING LUBRICANTS
- A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

## PART 3 -- EXECUTION

### 3.01 WIRE AND CABLE INSTALLATION

- A. General

1. Wire and Cable shall be installed as specified herein and indicated on the Drawings. Unless specifically indicated otherwise on the Drawings, wire and cable shall be installed in separate raceways according to wiring type. For example, power wiring shall not be combined with control wiring, and control wiring shall not be combined with instrumentation analog signal wiring.
2. Wire shall be furnished and installed as single conductor cables, with limited exceptions. Multi-conductor cable assemblies shall only be installed where indicated on the Drawings, required by the NEC, or after obtaining written permission from the Engineer.
3. Where instrumentation cables are installed in control panels, motor controllers, and other locations, the Contractor shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.
4. Instrumentation cable shielding shall be continuous and shall be grounded at one point only.

B. Splices

1. Splices shall not be allowed in power or control wire and cable unless indicated on the drawings or approved in writing by the Engineer. If unique field conditions exist or pulling calculations indicate that splices may be required, the Contractor shall submit a detailed request indicating why splices are required to the Engineer. The Engineer shall be under no obligation to grant such request.
2. Splicing materials shall be barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.
3. No splicing of instrumentation cable is permitted.

C. Wire and Cable Sizes

1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be increased so that the voltage drop measured from source to load does not exceed 3%.

D. Additional Conductor Identification

1. In addition to the color coding identification requirements specified in Part 2 herein, individual conductors shall be provided with heat shrinkable identification tags. Identification tags for individual conductors shall have a white background where the conductor insulation is colored. Identification tags for individual conductors shall have a colored background where the conductor insulation is black. Background color shall match that of the taping provided on the individual black conductors.



2. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.
3. All wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.
4. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.
5. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.
6. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.
7. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.
8. Wire identification in manholes, handholes, pull boxes, and other accessible components in the raceway system where the wiring is continuous (no terminations are made) shall be accomplished by means of a tag installed around the bundled group of individual conductors or around the outer conductor jacket of a multi-conductor cable. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all of the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that particular conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle by the use of nylon wire ties, and shall be made of polyethylene as manufactured by Brady, Seton, Panduit, or equal.
9. Where colored tape is used to identify cables, it shall be wrapped around the cable with a 25% overlap and shall cover at least 2 inches of the cable.

E. Wiring Supplies

1. Rubber insulating tape shall be in accordance with ASTM D4388. Friction tape shall be in accordance with ASTM D69.

F. Training of Cable in Manholes, Handholes, and Vaults

1. The Contractor shall furnish all labor and material required to train cables around cable vaults, manholes, and handholes. Sufficient length of cable shall be provided in each handhole, manhole, and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. The training shall be done in such a manner as to minimize chaffing.
2. Instrumentation cable shall be racked and bundled separate from AC wiring to maintain the required separation as follows:
  - a. 18 inches for 480/277 VAC wiring
  - b. 12 inches for 208/120 VAC wiring
  - c. 6 inches for 24 VAC wiring

G. Conductor Terminations

1. Where wires are terminated at equipment which requires lugs, connections shall be made by solderless mechanical lug, crimp type ferrule, or irreversible compression type lugs. Reference individual equipment specification sections as applicable for additional termination requirements.
2. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make terminations impractical due to the size of the field wiring, the Contractor shall terminate field wiring in an adjacent junction box per the requirements of Section 16130 – Boxes, complete with terminal strips. Contractor shall install the smaller wiring from the device to the junction box in a conduit, using the terminal strip as the means for joining the two different wire sizes. Splicing of wires in lieu of using terminal strips is not acceptable.
3. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
4. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or equal.
5. All spare conductors shall be terminated on terminal blocks mounted within equipment or junction boxes. Unless otherwise noted, coiling up of spare conductors within enclosure is not acceptable.

H. Pulling Temperature

1. Cable shall not be installed when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the work day for which the cable is removed from the protected storage. Any cable reels with wire remaining on them shall be returned to storage at the completion of the workday.

### 3.02 FIBER OPTIC CABLE INSTALLATION

- A. The Contractor shall install the fiber optic cable furnished by the General Contractor and/or the Instrumentation and Control Subcontractor. The cable shall be installed in its respective raceway system(s) as specified herein, indicated on the Drawings, and in accordance with the cable manufacturer's instructions. Reference Division 17 for additional information regarding the fiber optic cable.

### 3.03 TESTING

- A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  1. Shop Test
    - a. Wires and cables shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer's standards.
  2. Field Tests
    - a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be "test light" or "buzzer" style.
    - b. After installation, some wires and cables shall be tested for insulation levels. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:
      - i. For #8 AWG and larger 600V wire and cable, apply 1,000 VDC from a Megohmmeter for one (1) minute. Resistance shall be no less than 100 Megohms. Insulation testing is not required for power and control cables smaller than #8 AWG.
      - ii. Instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 Megohms or greater.

- B. Wires and cables shall be tested after required terminations are made, but before being connected to any equipment.
- C. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.
- D. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

| (EXHIBIT A)<br>TEST DATA - MEGOHMS<br>TEST NO. ____       |                 |         |                       |         |                                              |       |                       |
|-----------------------------------------------------------|-----------------|---------|-----------------------|---------|----------------------------------------------|-------|-----------------------|
| Date:                                                     |                 |         | Company:              |         |                                              |       |                       |
| Time:                                                     |                 |         | Location:             |         |                                              |       |                       |
| Circuit:                                                  | Circuit Length: | Aerial: | Duct:                 | Buried: | No. of Conductors                            | Size: | AWG<br>MCM<br>Shield: |
| Insulation Material:                                      |                 |         | Insulation Thickness: |         | Voltage Rating:                              |       | Age:                  |
| Type: ____ Pothead ____ Terminal                          |                 |         |                       |         | Location:      Indoors ____<br>Outdoors ____ |       |                       |
| Number and Type of Joints:                                |                 |         |                       |         |                                              |       |                       |
| Recent Operating History:                                 |                 |         |                       |         |                                              |       |                       |
| Manufacturer:                                             |                 |         |                       |         |                                              |       |                       |
| State if Potheads or Terminals were grounded during test: |                 |         |                       |         |                                              |       |                       |
| List associated equipment included in test:               |                 |         |                       |         |                                              |       |                       |
| Miscellaneous Information:                                |                 |         |                       |         |                                              |       |                       |

| (EXHIBIT A)<br>TEST DATA - MEGOHMS<br>TEST NO. _____                                              |                                  |                                  |                                                                                                                                 |                   |                                  |                                  |                                  |
|---------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------|----------------------------------|----------------------------------|
| Part Tested:                                                                                      |                                  |                                  | Test Performed: _____<br>Hours/Days: _____<br>After Shutdown: _____                                                             |                   |                                  |                                  |                                  |
| Grounding Time:                                                                                   |                                  |                                  | Dry Bulb Temperature: _____<br>Wet Bulb Temperature: _____                                                                      |                   |                                  |                                  |                                  |
| Test Voltage:                                                                                     |                                  |                                  | Equipment Temperature: _____<br>How Obtained: _____<br>Relative Humidity: _____<br>Absolute Humidity: _____<br>Dew Point: _____ |                   |                                  |                                  |                                  |
| Megohmmeter:    Serial Number: _____    Range: _____<br>Voltage: _____    Calibration Date: _____ |                                  |                                  |                                                                                                                                 |                   |                                  |                                  |                                  |
| Test Connections                                                                                  | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground                                                                                                | Test Connections  | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground |
| 1/4 Minute                                                                                        |                                  |                                  |                                                                                                                                 | 5 Minutes         |                                  |                                  |                                  |
| 1/2 Minute                                                                                        |                                  |                                  |                                                                                                                                 | 6 Minutes         |                                  |                                  |                                  |
| 3/4 Minute                                                                                        |                                  |                                  |                                                                                                                                 | 7 Minutes         |                                  |                                  |                                  |
| 1 Minute                                                                                          |                                  |                                  |                                                                                                                                 | 8 Minutes         |                                  |                                  |                                  |
| 2 Minutes                                                                                         |                                  |                                  |                                                                                                                                 | 9 Minutes         |                                  |                                  |                                  |
| 3 Minutes                                                                                         |                                  |                                  |                                                                                                                                 | 10 Minutes        |                                  |                                  |                                  |
| 4 Minutes                                                                                         |                                  |                                  |                                                                                                                                 | 10/1 Minute Ratio |                                  |                                  |                                  |
| Remarks:                                                                                          |                                  |                                  |                                                                                                                                 |                   |                                  |                                  |                                  |

## SECTION 16130

### BOXES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The scope of work under this Section includes furnishing and installing all pull boxes, junction boxes, and outlet boxes.
- B. Requirements for other boxes and enclosures are not included in this Section. Reference each specific Division 16 equipment Section for requirements related to that equipment's respective enclosure.
- C. Reference Section 16000, Basic Electrical Requirements, and Section 16111, Conduit.

##### 1.02 CODES AND STANDARDS

- A. Boxes shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. UL 514A - Metallic Outlet Boxes
  - 2. UL 514C - Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers
  - 3. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations
  - 4. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations
  - 5. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
  - 6. NEMA 250 – Enclosures for Electrical Equipment

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:
  - 1. Shop Drawings
- B. Each submittal shall be identified by the applicable specification section.

##### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets for boxes, terminal strips, and all accessories

#### 1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.
- B. As-built drawings showing dimensions, internal box layout, terminal strip information, and terminal strip identification information shall be provided for all junction boxes. As-built drawings are not required for pull boxes or outlet boxes.

#### 1.06 IDENTIFICATION

- A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings (e.g. PPB-XXX, CJB-YYY) or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 16195, Electrical – Identification.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

#### 2.02 PULL AND JUNCTION BOXES

- A. General
  - 1. All pull and junction boxes shall be UL listed and labeled.
  - 2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.
  - 3. Pull and junction boxes mounted embedded in concrete shall be UL listed for embedment.



4. Where metallic boxes are used they shall be of all welded construction. Tack welded boxes are not acceptable.

#### B. Pull Boxes

1. All pull boxes shall be provided with a matching gasketed cover. For covers with dimensions of 24 inches by 24 inches or less, the cover shall be held in place by machine screws. Other screw types are not acceptable. For covers with dimensions greater than 24 inches by 24 inches, the cover shall be hinged and held in place by screw-operated clamp mechanisms. Hinge pins shall be removable. Clamp mechanism material of construction shall match that of the associated box.
2. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.
3. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC.
4. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:
  - a. Power wiring
  - b. AC control wiring
  - c. DC control wiring
  - d. Instrumentation wiring

#### C. Junction and Termination Boxes

1. Junction and termination boxes used for lighting and receptacle circuits only shall be provided with a matching gasketed cover held in place by machine screws. Other screw types are not acceptable.
2. Junction and termination boxes for all uses other than lighting and receptacle circuits shall be provided with a hinged, gasketed cover. Hinge pins shall be removable. Cover shall be held in place by screw-operated clamp mechanisms. Clamp mechanism material of construction shall match that of the associated box.
3. Barriers shall be provided in junction and termination boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of

construction shall match that of the box. Isolation shall be provided between the following groups:

- a. Power wiring
  - b. AC control wiring
  - c. DC control wiring
  - d. Instrumentation wiring
4. Junction and termination boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.
  5. Termination boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected, with a 10A minimum capacity. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the junction box (minimum of two) shall be provided as spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.
  6. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

D. Enclosure Types and Materials

1. In non-hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION            | ENCLOSURE TYPE AND MATERIAL       |
|-----------------------------|-----------------------------------|
| Indoor Wet Process Area     | NEMA 4X, Type 304 Stainless Steel |
| Indoor Dry Process Area     | NEMA 12, Painted Steel            |
| Indoor Dry Non-process Area | NEMA 1, Painted Steel             |

|                                              |                                   |
|----------------------------------------------|-----------------------------------|
| Indoor Type 1 Chemical Storage/Transfer Area | NEMA 4X, Fiberglass or PVC        |
| Indoor Type 2 Chemical Storage/Transfer Area | NEMA 4X, Type 304 Stainless Steel |
| All Outdoor Areas                            | NEMA 4X, Type 304 Stainless Steel |

2. In hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

| AREA CLASSIFICATION          | ENCLOSURE TYPE AND MATERIAL       |
|------------------------------|-----------------------------------|
| Class 1, Division 1, Group D | NEMA 7, Die Cast Aluminum         |
| Class 1, Division 2, Group D | NEMA 4X, Type 304 Stainless Steel |

3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.

## 2.03 OUTLET BOXES

### A. General

1. Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 16141, Wiring Devices, for outlet box trim requirements. An appropriate outlet box trim is required to achieve the NEMA rating of the outlet boxes as specified herein.

### B. Surface Mount Outlet Boxes

1. Outlet boxes shall be the deep type, no less than 2.5 inches deep.
2. Outlet boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.
3. In non-hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION                             | ENCLOSURE TYPE AND MATERIAL |
|----------------------------------------------|-----------------------------|
| Indoor Wet Process Area                      | NEMA 4X, Cast Aluminum      |
| Indoor Dry Process Area                      | NEMA 1, Cast Aluminum       |
| Indoor Dry Non-process Area                  | NEMA 1, Cast Aluminum       |
| Indoor Type 1 Chemical Storage/Transfer Area | NEMA 4X, PVC                |

|                                              |                        |
|----------------------------------------------|------------------------|
| Indoor Type 2 Chemical Storage/Transfer Area | NEMA 4X, Cast Aluminum |
| All Outdoor Areas                            | NEMA 4X, Cast Aluminum |

4. In hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

| AREA CLASSIFICATION          | ENCLOSURE TYPE AND MATERIAL                       |
|------------------------------|---------------------------------------------------|
| Class 1, Division 1, Group D | NEMA 7, Die Cast Aluminum                         |
| Class 1, Division 2, Group D | NEMA 4X, Cast Aluminum; NEMA 7, Die Cast Aluminum |

5. Outlet boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as a part of the box wall are not acceptable.

C. Flush Mount Outlet Boxes

- Outlet boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL listed and labeled. Pre-punched single diameter conduit knockouts are acceptable; however, concentric and eccentric knockouts are not acceptable.
- Outlet boxes mounted flush in CMU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.
- Outlet boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes are not acceptable for this application. Sectional type boxes are not acceptable for this application.
- Outlet boxes mounted cast into concrete shall be concrete tight and shall be made of galvanized steel or PVC.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Pull and Junction Boxes

1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be of the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.
4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Reference Section 16111, Conduit, for conduit hub requirements.
5. Pull and junction boxes may be installed flush mounted in gypsum, concrete or CMU walls where appropriate provided that covers are easily removed or opened.
6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. Outlet Boxes

1. Outlet boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Flush mounted outlet boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.
4. Outlet boxes shall be flush mounted in finished areas and other areas where practical. Flush mounted outlet boxes shall not be installed in hazardous areas and type 1 or 2 chemical storage/transfer areas.
5. For the below-named items, mounting heights from finished floor, or finished grade to top is applicable, depending on the type of wiring device to be installed in the outlet box. Mounting heights for outlet boxes shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):
  - a. Light switches and wall mounted occupancy sensors, 48 inches
  - b. Receptacles in indoor dry process/non-process areas, 16 inches

- c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 48 inches
  - d. Receptacles in outdoor locations, 24 inches
  - e. Ceiling mounted occupancy sensors, as indicated on the Drawings
6. Outlet boxes shall be provided in the material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

- END OF SECTION -

## SECTION 16141

### WIRING DEVICES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all switches, occupancy sensors, and receptacles of the type and at the locations as shown on the Drawings.
- B. All switches and receptacles shall be furnished and installed in outlet boxes. Reference Section 16130, Boxes, for outlet box requirements.
- C. Reference Section 16000, Basic Electrical Requirements, and Section 16123, Low Voltage Wire and Cable.

##### 1.02 CODES AND STANDARDS

- A. Wiring devices shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. UL 20 – General Use Snap Switches
  - 2. UL 498 – Standard for Attachment Plugs and Receptacles
  - 3. UL 943 – Ground Fault Circuit Interrupters
  - 4. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

##### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include, but not be limited to:
  - 1. Product data sheets.

#### 1.05 SPARE PARTS

- A. The Contractor shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.
- B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

#### 1.06 IDENTIFICATION

- A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. The Contractor shall use the products of a single manufacturer for each type of wiring device.
- C. The Contractor shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:
  - 1. Where the selected plate manufacturer does not manufacture a suitable finish plate.
  - 2. For heavy-duty receptacles rated at more than 30A.
  - 3. Where non-standard plates are required, specified, or shown.



- D. The Contractor shall furnish and install all wiring devices and device plates.
- E. In non-hazardous areas, provide specification grade devices manufactured by Appleton, Crouse-Hinds, Leviton, Hubbell, Pass & Seymour, Meltric (for pump disconnect with aux contacts) or Engineer approved equal.
- F. In hazardous areas, provide devices manufactured by Appleton, Cooper Crouse-Hinds, Hubbell-Killark, or Engineer approved equal.

## 2.02 WIRING DEVICES

- A. Wall switches for non-hazardous areas shall be rated for the current required to suit the application, but not less than 20A. Double pole, three-way, and four-way switches shall be provided where indicated on the Drawings, and as required. Switches shall be rated for 120/277VAC and shall be UL 20 Listed.
- B. Convenience receptacles for non-hazardous areas shall be rated for 20A at 125VAC. Convenience receptacles shall be UL 498 Listed. Tamper resistant receptacles are not acceptable.
- C. Special purpose receptacles (welders, lab equipment, etc.) shall be provided with the proper NEMA configuration and ampacity as indicated on the Drawings. The coordinating plug for each special purpose receptacle shall be provided with the equipment which it is serving.
- D. Ground fault circuit interrupter receptacles shall be rated for 20A at 125VAC. Ground fault circuit interrupter receptacles shall be UL 943 Listed. Tamper resistant receptacles are not acceptable.
- E. Wall switches for hazardous areas shall be the factory sealed type, UL 1203 Listed for use in the hazardous area. Wall switches shall be rated for 120-277VAC, and shall be rated for the current required to suit the application, but not less than 20A
- F. Receptacles for hazardous areas shall be rated 20A at 120-240VAC. Receptacles shall be UL 1203 listed for use in the hazardous area, utilizing delayed-action construction.
- G. All wiring devices shall be approved for use with stranded conductors. Reference Section 16123, Low Voltage Wire and Cable for conductor requirements

## 2.03 DEVICE PLATES

- A. Device plates for indoor flush-mounted receptacles and switches shall be non-metallic, not less than 0.032 of an inch thick, with beveled edges and milled on the rear so as to lie flat against the wall. Devices plates shall be provided with a gasket.
- B. Device plates for outdoor installations, indoor wet process areas, and chemical storage/transfer areas shall be Appleton Type FSK, Crouse-Hinds #DS185, or equal for wall switches. Device plates for receptacles shall be "in-use" style. "In-use" weatherproof

covers shall be rugged, minimum 3 ¼" depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or equal.

- C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32, or equal for switches, and Crouse-Hinds DS23 or equal for receptacles.

## 2.04 PLUGS

- A. The Contractor shall furnish suitable plugs with equipment furnished under the respective specification Section. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

## 2.05 PROCESS INSTRUMENTS

- A. The Contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument etc.) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or equal. For hazardous locations, the device shall be UL 1203 Listed.

## 2.06 NOT USED

# PART 3 -- EXECUTION

## 3.01 INSTALLATION

- A. Where more than one (1) switch occurs at one (1) location, gang plates shall be used.
- B. All device plates shall be set true and plumb and shall fit tightly against the finished wall surfaces and outlet boxes.
- C. Wiring device box (outlet box) mounting heights shall be as specified in Section 16130, Boxes.
- D. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Contractor shall bring it to the attention of the Engineer for a decision.
- E. Receptacles installed in toilet, locker, and bathrooms, and within 6 feet of a sink, shall be of ground fault interrupter type. Ground fault circuit interrupter receptacles shall also be furnished and installed in additional locations where indicated on the Drawings, and as required by the NEC.

- F. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from. Labels shall have a white background and black lettering in 14 point font.

### 3.02 CIRCUITING

- A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit, unless otherwise indicated on the Drawings.

- END OF SECTION -

SECTION 16170  
GROUNDING AND BONDING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install grounding systems complete in accordance with the minimum requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered a minimum requirement for compliance with this Specification.
- B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100. Conflicts shall be promptly brought to the attention of the Engineer.
- C. In addition to the NEC requirements, newly constructed building structural steel columns shall be permanently and effectively grounded.
- D. Reference Section 16000, Basic Electrical Requirements

1.02 CODES AND STANDARDS

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. UL 467 – Grounding and Bonding Equipment
  - 2. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
  - 3. IEEE 1100 – Recommended Practice for Power and Grounding Electronic Equipment

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Reports of certified field tests.
- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

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- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
  - 2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

## PART 2 -- PRODUCTS

### 2.01 MANUFACTURERS

- A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

### 2.02 GROUND RODS AND GRID

- A. Ground rods shall be rolled to a commercially round shape from a welded copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000 pounds per square inch (psi) and an elastic limit of 49,000 psi. The rods shall be not less than 3/4 inch in diameter by 10 feet in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.010 inch at any point on the rod. Ground rods shall be UL 467 listed. The ground rods shall be manufactured by Erico Products, Blackburn, or equal.
- B. Except where specifically indicated otherwise, all exposed non current-carrying metallic parts of electrical equipment and metallic raceway systems shall be grounded.
- C. The system ground shall connect to the main service equipment and shall be extended to a ground grid surrounding the structure.
- D. A grounded conductor (neutral) bonding jumper shall be installed in only one location for each service or separately derived system. The bonding jumper shall be located at the source or the first immediate distribution point (e.g. service disconnect) downstream from the source. The neutral and ground buses shall be kept isolated from each other except where the bonding jumper is installed.

- E. Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.
- F. The metallic water service shall be connected to the grounding system at its point of entrance to the structure. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection.

## 2.03 FITTINGS

- A. Grounding connections to equipment shall be bolted. Cable end connections shall be made by hydraulic crimp or exothermically welded. Split bolt type connectors are not acceptable. Fittings shall be UL 467 listed.

## 2.04 EQUIPMENT GROUNDING CONDUCTORS

- A. An insulated equipment grounding conductor shall be furnished and installed for all alternating current (AC) circuits. Insulation shall be of the same type as the ungrounded conductors in the raceway and shall be green in color. Equipment grounding conductors shall be furnished and installed in all conduits with AC power and control circuits and shall be sized per NEC Article 250. Conduits and other methods approved by the NEC as suitable for equipment grounding conductors are not acceptable.

## 2.05 SYSTEM GROUND CONDUCTOR

- A. Unless otherwise specified, equipment casings and structural building steel shall be connected to the System ground or ground grid by a System Ground Conductor. The System Ground Conductor shall be soft-drawn, bare annealed copper, concentric stranded, as specified. The minimum sizes shall be as follows, where American Wire Gage (AWG) conductor sizes are not shown or specified on the Drawings:

|    |                         |         |
|----|-------------------------|---------|
| 1. | 5 and 15 kV switchgear  | 4/0 AWG |
| 2. | 5 kV-480V transformers  | 4/0 AWG |
| 3. | 480V switchgear         | 2/0 AWG |
| 4. | 480V switchboards       | 2/0 AWG |
| 5. | 480V MCC                | 2/0 AWG |
| 6. | Large motors 250 hp & > | 2/0 AWG |
| 7. | Lighting & Power panels | 2 AWG   |
| 8. | Exposed metal cabinets  | 2 AWG   |
| 9. | Electrical equipment    | 2 AWG   |

- 10. Buildings and enclosure 2 AWG
- 11. Fences and gates 2 AWG
- 12. Motors 25 hp to 250 hp 2 AWG

- B. For all control panels, disconnect switches, and other electrical enclosures, equipment grounds and bonding jumpers shall be terminated individually on a ground bar or mechanical lugs. No wire nuts will be permitted.

## 2.06 EXOTHERMIC WELDS

- A. All exothermic welding shall be completed per welding kit manufacturer's instructions. Exothermic welds shall be CadWeld by Erico or ThermoWeld.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.
- B. Ground Grid
  - 1. A main ground grid shall be provided if required and as shown on the Drawings. Ground rods shall be driven straight down into the earth or, if objects are encountered, at an angle to avoid the obstruction.
  - 2. The ground rods shall be interconnected by the use of copper cable exothermically welded to the rods. For newly constructed structures, the grounding cables shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtailed" shall be connected to the ground grid and shall enter the buildings and structure from the outside and shall be connected to steel structures, and equipment as described in this Section and as required to provide a complete grounding system. The copper pigtailed shall be exothermically welded to the ground grid, and connected to building reinforcement steel by hydraulic crimp.
  - 3. Grounding conductors shall be continuous between points of connection; splices are not be permitted.
  - 4. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in metal raceway. The raceway shall be bonded to the grounding system.

5. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.
6. Buried exothermic welds and ground ring shall not be backfilled until inspected by Engineer.

C. Raceways

1. Conduit which enters equipment such as switchgear, motor control centers, transformers, panelboards, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus or ground lug, where provided, and as otherwise required by the NEC.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  1. Witnessed Shop Tests
    - a. None required.
  2. Field Tests
    - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.
    - b. Fall of potential tests shall be performed on the ground grid per IEEE81 recommendations by a third party, independent testing firm. A fall of potential plot shall be submitted at the conclusion of testing for Engineer review. Documentation indicating the location of the rod and grounding system as well as the resistance and soil conditions at the time the measurements were made shall be submitted. Testing shall show that the ground grid has 5 ohms resistance or less. Due to soil conditions and/or unforeseen field conditions, ground resistances greater than 5 ohms may be acceptable if specifically approved in writing by the Engineer. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground grid under test isolated from other grounds.
    - c. Continuity tests for the grounding electrode conductor shall be performed. Test will be accepted when a resistance of less than 1 ohm is shown for this conductor.

- END OF SECTION -



SECTION 16190  
SUPPORTING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install structural supports for mounting and installing all conduit, electrical equipment, lighting, alarm systems, instrumentation, and communications equipment furnished under this Contract.
- B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation.
- C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
  - 2. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
  - 3. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  - 4. ASTM A276 – Standard Specification for Steel Bars and Shapes
  - 5. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop drawings

2. Structural support calculations (if required)

B. Each submittal shall be identified by the applicable Specification section.

#### 1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal. Contractor shall provide copies of submittals in Portable Document Format (PDF) copies before and after Owner or Engineer reviews and revises.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

#### 2.02 MATERIALS

A. Support channel shall be 1-5/8" by 1-5/8" minimum, with 12 gage material thickness.

B. Support channel, support channel fittings, and threaded rod shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION                             | MATERIAL OF CONSTRUCTION |
|----------------------------------------------|--------------------------|
| Indoor Wet Process Area                      | Type 304 Stainless Steel |
| Indoor Dry Process Area                      | Type 304 Stainless Steel |
| Indoor Dry Non-process Area                  | Type 304 Stainless Steel |
| Indoor Type 1 Chemical Storage/Transfer Area | Fiberglass               |
| Indoor Type 2 Chemical Storage/Transfer Area | Type 304 Stainless Steel |
| All Outdoor Areas                            | Type 304 Stainless Steel |
| All Hazardous Areas                          | Type 304 Stainless Steel |

- C. Fastening hardware (bolts, nuts, washers, and screws) shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION                             | MATERIAL OF CONSTRUCTION |
|----------------------------------------------|--------------------------|
| Indoor Wet Process Area                      | Type 304 Stainless Steel |
| Indoor Dry Process Area                      | Type 304 Stainless Steel |
| Indoor Dry Non-process Area                  | Type 304 Stainless Steel |
| Indoor Type 1 Chemical Storage/Transfer Area | Fiberglass               |
| Indoor Type 2 Chemical Storage/Transfer Area | Type 304 Stainless Steel |
| All Outdoor Areas                            | Type 304 Stainless Steel |
| All Hazardous Areas                          | Type 304 Stainless Steel |

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

#### A. Concrete or Masonry Inserts

1. The Contractor shall be responsible for the furnishing and installation of all anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.
2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.
3. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling channels shall be provided for embedment in the equipment housekeeping pads.

Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain concrete coverage of the reinforcement bars while not causing associated equipment to exceed the maximum mounting height requirements of the NEC.

#### B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel.
2. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars where possible, to facilitate removal of ceiling panels.
3. Support channel shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.
4. All equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Support channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.
5. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework.
6. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.
7. Actual designs for supporting framework should take the nature of a picture frame of support channels and bracket with a plate for mounting the components. The Contractor is responsible for the design of supporting structure; he shall submit design details to the Engineer for acceptance before proceeding with the fabrication.
8. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.
9. For all installations where fiberglass supporting materials are required, the Contractor shall submit structural calculations and the details of the proposed system of support. Structural calculations shall be signed and sealed by a registered professional engineer in the California.
10. For the following installations where conduits are provided with a support system suspended from the above or attached to a vertical structure, the Contractor shall submit structural calculations and details of the proposed system of support. Structural calculations shall be signed and sealed by a registered professional engineer in the California.

- a. A quantity of twelve (12) or more conduits trade size 1" and smaller are proposed for a conduit support rack.
  - b. A quantity of eight (8) or more conduits trade sizes 1 1/2" to 2 1/2" are proposed for a conduit support rack.
  - c. A quantity of four (4) or more conduits trade sizes 3" and larger are proposed for a conduit support rack.
11. Single conduits installed exposed along walls and ceilings shall be secured to the wall or ceiling with a one-hole conduit clamp and clamp-back. Where multiple conduits are installed exposed together, support channel and conduit clamps shall be used.

- END OF SECTION -

## SECTION 16195

### ELECTRICAL - IDENTIFICATION

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All switchgear, switchboards, motor control centers, variable frequency drives, lighting and distribution panelboards, combination starters, control panels, pull and junction boxes, enclosures, disconnect switches, control stations, and similar equipment shall be identified in the manner described, or in an equally approved manner.
- B. The types of electrical identification specified in this section include, but are not limited to, the following:
  - 1. Operational instructions and warnings.
  - 2. Danger signs.
  - 3. Equipment/system identification signs.
  - 4. Nameplates.

##### 1.02 SIGNS

- A. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms.

##### 1.03 LETTERING AND GRAPHICS

- A. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

##### 1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

#### SHOP DRAWINGS

- B. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- C. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- D. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.

## PART 2 -- PRODUCTS

### 2.01 MANUFACTURERS

- A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

### 2.02 NAMEPLATES

- A. Nameplates shall be engraved, high pressure plastic laminate, white with black lettering.
- B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or equal.

### 2.03 HIGH VOLTAGE SIGNS

- A. Standard "DANGER" signs shall be of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

### 2.04 CONDUIT IDENTIFICATION

- A. Conduit identification shall be as specified in Section 16111, Conduit.

### 2.05 WIRE AND CABLE IDENTIFICATION

- A. Field installed wire and cable identification shall be as specified in Section 16123 and Low Voltage Wire and Cable.
- B. A plastic laminate nameplate shall be provided at each panelboard, motor control center, switchgear assembly, and switchboard assembly. This nameplate shall be used to clearly

convey the conductor identification means used at that piece of equipment (i.e. Phase A=Brown, Phase B=Orange, C = Yellow).

- C. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective section.

## 2.06 BOX IDENTIFICATION

- A. Pull, junction, termination and device box identification shall be as specified in Section 16130 – Boxes.

## PART 3 -- EXECUTION

### 3.01 NAMEPLATES

- A. Nameplates shall be attached to the equipment enclosures with (2) two stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

### 3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

### 3.03 POWER SOURCE IDENTIFICATION

- A. After installation of all field equipment (i.e. valves, motors, fans, unit heaters, instruments, etc) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC number, panelboard, etc), circuit number, conduit number from schedule and voltage/phase.
- B. Contractor to coordinate with the Engineer and the Owner regarding exact nameplate placement during construction.
- C. Nameplates shall be as specified herein.

- END OF SECTION -



SECTION 16280  
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, and place in satisfactory operation, the surge protective devices (SPD) as specified herein and indicated on the Drawings.
- B. The surge protective devices specified under this Section shall be provided as a stand-alone unit, separate from the enclosure of the equipment to which they are connected. The requirements of this Section shall not apply to equipment where an integral SPD is specified.
- C. Reference Section 16123, Low Voltage Wire and Cable, and Section 16195, Electrical Identification.

1.02 CODES AND STANDARDS

- A. The surge protective device shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. Underwriters Laboratories, Inc. (UL)
    - a. UL1449, latest edition: Surge Protective Devices
    - b. UL1283, latest edition: Electromagnetic Interference Filters
- B. American National Standards Institute (ANSI)/Institute of Electrical & Electronic Engineers (IEEE)
  - 1. C62.41.1: 2002 Guide for Surge Voltages in Low-Voltage AC Power Circuits
  - 2. C62.41.2: 2002 Recommend Practice on Characterization of Surges in Low Voltage (100V and Less) AC Power Circuits.
  - 3. C62.45: 2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits
  - 4. C62.62: 2000 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Operation and Maintenance Manuals
  - 3. Spare Parts List

#### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for re-submittal.
- C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.
- D. Shop drawings for each SPD shall include but not be limited to:
  - 1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
  - 2. Product Data Sheets.
  - 3. Detailed drawings showing weights and dimensions.
  - 4. Wiring diagrams showing field connections.
  - 5. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL1449, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving

compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.

6. Proof of Short Circuit Current Ratings (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV), Nominal Discharge Current (In), and device listing Type shall be submitted using the same means as described in the paragraph above.
7. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL 1283, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.
8. Warranty Information

- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

#### 1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

#### 1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.
- B. The Contractor shall furnish one (1) spare field replacement module of each rating provided under this Contract.
- C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.
- E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

- F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

#### 1.07 IDENTIFICATION

- A. Each SPD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each SPD. Nameplates shall be as specified in Section 16195, Electrical - Identification.

#### 1.08 WARRANTY

- A. All SPDs, associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years after acceptance of the equipment by the Owner.
- B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the five (5) year warranty period, shall be replaced by the manufacturer at no additional cost to the Owner.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. The SPD units shall be UL 1449 Listed and must bear the UL mark. Units that are "manufactured in accordance with" UL 1449 or tested by other testing agencies "in accordance with" UL 1449 are not acceptable and will be rejected.
- B. Type II SPD units shall be UL 1283 Listed and must bear the UL mark. Units that are "manufactured in accordance with" UL 1283 or tested by other testing agencies "in accordance with" UL 1283 are not acceptable and will be rejected. Further, SPD units using UL 1283 capacitors but not tested to UL 1283 will be rejected.
- C. SPDs shall be provided as a stand-alone unit, separate from the equipment to which they are connected.
- D. All SPDs furnished and installed under this Contract shall be from the same manufacturer.

#### 2.02 PRODUCTS

- A. Type I surge protective devices (SPD) shall be furnished and installed when shown without upstream overcurrent protection on the Drawings. Type II SPDs shall be provided in all other locations. Type II SPDs shall not require the use of a specific upstream overcurrent device. SPDs shall be provided in the location and quantity as shown on the Drawings.
- B. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.

- C. Each Type II SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
- D. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Drawings for short circuit current rating of each piece of equipment.
- E. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

| <b>SYSTEM CONFIGURATION</b> | <b>MODES OF PROTECTION</b> | <b>NUMBER OF MODES</b> |
|-----------------------------|----------------------------|------------------------|
| 3-Phase Wye                 | L-N, L-G, N-G              | 7                      |
| 3-Phase Delta               | L-L, L-G                   | 6                      |
| 3-Phase Impedance Grounded  | L-L, L-G                   | 6                      |
| Single-Phase                | L-N, L-G, N-G              | 3                      |

- F. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.
- G. The Nominal Discharge Current (In) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
- H. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

| <b>SYSTEM VOLTAGE</b> | <b>L-N</b> | <b>L-G</b> | <b>L-L</b> | <b>N-G</b> |
|-----------------------|------------|------------|------------|------------|
| 208Y/120              | 800V       | 800V       | 1200V      | 800V       |
| 480Y/277              | 1200V      | 1200V      | 2000V      | 1200V      |
| 480 DELTA             | N/A        | 1800V      | 2000V      | N/A        |
| 240 DELTA             | N/A        | 1200V      | 1200V      | N/A        |
| 120/240               | 800V       | 800V       | 1200V      | 800V       |

- I. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated on single line diagrams and in panel schedules. Surge current rating indicated is on a per phase basis.
- J. Each SPD shall be provided in an enclosure to match or exceed the NEMA rating of the equipment enclosure that it is serving (i.e. NEMA1, NEMA 12, NEMA 4X, etc).
- K. Each SPD shall be provided with the following accessories:
  - 1. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.
  - 2. Surge counter and audible alarm with reset/silence switch.

- 3. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.
- L. SPDs shall be as manufactured by Eaton, Thor Systems, ASCO/Emerson Network Power, General Electric, or Square D.

### PART 3 -- EXECUTION

#### 3.01 INSTALLATION

- A. The SPD units shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- B. The SPD units shall be mounted such that the conductor lengths are as short as possible, but no greater than 36 inches. Any installation resulting in a conductor length of greater than 36 inches shall be reviewed with the Engineer as a special type of cable may need to be installed. For equipment such as panelboards, the Contractor shall relocate the circuit breaker that is to be connected to the SPD as needed to achieve the shortest conductor length possible.
- C. The Contractor shall use a close nipple to enclose the conductors between the SPD and the equipment served. However, if due to field conditions a 90 degree conduit bend is required to connect the SPD to the equipment that it serves, the bend shall have a minimum radius of 36 inches to eliminate any potential for sharp bends in the conductors.
- D. Conductors between the equipment served and the SPD shall be 600V power wire and cable as specified in Section 16123 – Low Voltage Wire and Cable. The individual conductors shall be gently twisted, and shall be sized as indicated on the Drawings.
- E. Prior to energizing, the Contractor shall verify that the SPD unit voltage and configuration is suitable for the system to which it is connected.
- F. Prior to energizing, the Contractor shall also verify that any Neutral to Ground bonding jumpers are installed as required.
- G. Prior to energizing, the Contractor shall also verify that the impedance of the equipment grounding conductor between the SPD and the grounding electrode system is less than 1 ohm.

#### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Tests
  - a. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, ANSI, and UL standards.
  - b. All surge protective devices, subassemblies, and components shall be 100% tested and certified by the manufacturer to meet their published performance parameters.
2. Field Tests
  - a. None required.

- END OF SECTION -

## SECTION 16461

### DRY TYPE DISTRIBUTION TRANSFORMERS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, and test transformers for power and lighting distribution systems as specified herein, as indicated on the Drawings, and as required to complete the electrical installations.
- B. All equipment specified in this Section shall be furnished by the transformer manufacturer who shall be responsible for the suitability and compatibility of all included equipment.
- C. Reference Section 16000, Basic Electrical Requirements.

##### 1.02 CODES AND STANDARDS

- A. Transformers shall conform to all applicable Federal, UL, and NEMA standards. Materials and components shall be new and conform to grades, qualities and standards as specified herein and shown on the Drawings.
- B. Transformers shall comply with the following standards:
  - 1. UL 1561 – Dry Type General Purpose and Power Transformers
  - 2. U.S. Department of Energy 2016 Efficiency
  - 3. National Electrical Code
  - 4. NEMA ST-20 – Dry Type Transformers for General Applications
  - 5. IEEE C57.12.01 – Standard General Requirements for Dry Type Distribution and Power Transformers

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings.
  - 2. Operation and Maintenance Manuals.
  - 3. Spare Parts List.



4. Reports of Certified Shop Field Tests.

- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein, and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
1. Product data sheets.
  2. Drawings showing clearly marked dimensions and weight for each transformer.
  3. Sample equipment nameplate diagram.
- D. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g. TX-XXXX).
- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- B. Spare parts lists, included with the Shop Drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 IDENTIFICATION

- A. Each transformer shall be identified with the equipment item number indicated on the Contract Drawings and the accepted Shop Drawings. A nameplate shall be securely affixed in a conspicuous place on each transformer. Nameplates shall be as specified in Section 16195, Electrical - Identification.

## PART 2 -- PRODUCTS

### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. Dry type distribution transformers shall be Energy Star compliant and manufactured by the Eaton, Schneider Electric (Square D), General Electric, or Engineer approved Equal.

### 2.02 DRY TYPE TRANSFORMERS

- A. Furnish and install single-phase and three-phase general purpose, dry-type transformers, as specified herein and indicated on the Drawings. The transformers shall be 60 Hz, self-cooled, quiet-design insulated of the two winding type.
- B. The transformers shall be UL 1561 Listed.
- C. The primary windings shall be rated 480 VAC for use on 3-phase systems and connected delta unless indicated otherwise on the Drawings. KVA ratings shall be as shown on the Drawings. Furnish transformers with two 2-1/2% primary taps above, and four 2-1/2% primary taps below rated voltage for transformers 15 KVA and above, and two 2-1/2% primary taps above, and two 2-1/2% primary taps below rated voltage for transformers less than 15 kVA. All taps shall be full capacity rated.
- D. The ratings of the secondary windings shall be as indicated on the Drawings.
- E. Transformers shall be designed for continuous operation at rated KVA, 24 hours a day, 365 days a year, with normal life expectancy as defined in IEEE C57.12.01. This performance shall be obtainable without exceeding 150 degrees Celsius average temperature rise by resistance or 180 degrees Celsius hot spot temperature rise in a 40 degrees Celsius maximum ambient and 30 degrees Celsius average ambient. The maximum coil hot spot temperature shall not exceed 220 degrees Celsius. All insulating materials shall be flame retardant and shall not support combustion as defined in ASTM Standard Test Method D 635. All insulating materials shall be in accordance with NEMA ST 20 Standard for a 220 degrees Celsius UL component recognized insulation system.
- F. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with non-hygroscopic, thermosetting varnish.

- G. All cores are to be constructed of high grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be tightly clamped and compressed with structural steel angles. The completed core and coil shall then be bolted to the base by means of vibration-absorbing mounts to minimize sound transmission. There shall be no metal-to-metal contact between the core and coil assembly and the enclosure.
- H. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees Celsius. Transformers shall be furnished with lugs of the size and quantity required and suitable for termination of the field wiring.
- I. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.
- J. Transformers shall have core and coil assemblies mounted on rubber isolation pads to minimize the sound levels. Transformers shall not exceed the sound levels listed in NEMA ST-20.
- K. Transformers shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION            | ENCLOSURE TYPE AND MATERIAL |
|-----------------------------|-----------------------------|
| Indoor Wet Process Area     | NEMA 3R, Painted Steel      |
| Indoor Dry Process Area     | NEMA 2, Painted Steel       |
| Indoor Dry Non-process Area | NEMA 2, Painted Steel       |
| All Outdoor Areas           | NEMA 3R, Painted Steel      |

- L. The enclosure shall be made of heavy gauge steel and shall be degreased, cleaned, primed, and finished with a baked weather-resistant enamel using the manufacturer's standard painting process. Color shall be ANSI 61.

2.03 NOT USED

2.04 NOT USED

### PART 3 -- EXECUTION

#### 3.01 INSTALLATION

- A. The transformers shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

- B. Conduit routed to and from the transformer shall be arranged for easy removal of the transformer access covers.
- C. Where transformers 50 kVA and smaller are shown to be wall mounted, a transformer manufacturer supplied wall mounting kit shall be used. The lowest point of the wall mounting bracket shall be no lower than 7'-0" above the finished floor. Field fabricated mounting hardware is not acceptable unless reviewed and approved in writing by the Engineer.
- D. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

#### 1. Certified Shop Tests

- a. The transformers shall be given routine factory tests in accordance with the requirements of the ANSI and NEMA standards. Temperature rises may be certified from basic design.
- b. As a minimum, the following tests shall be made on all transformers:
  - i. Ratio tests on the rated voltage connection and on all tap connections.
  - ii. Polarity and phase-relation tests on the rated voltage connection.
  - iii. Applied potential tests.
  - iv. Induced potential tests.
  - v. No-load and excitation current at rated voltage on the rated voltage connection.

#### 2. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.
- b. Insulation between windings shall be tested by 1000 VDC Megaohmmeter for one (1) minute. Resistance value shall be no less than 100 Megaohms.

- END OF SECTION -

## SECTION 16470

### PANELBOARDS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install panelboards of voltage and current ratings as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles and locations conforming to the panelboard schedules on the Drawings.
- B. Reference Section 16000, Basic Electrical Requirements; Section 16195, Electrical Identification.

##### 1.02 CODES AND STANDARDS

- A. Panelboards shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. Underwriters Laboratories
    - a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations
    - b. UL 67 – Standard for Panelboards
    - c. UL 489 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
    - d. UL 943 – Ground Fault Circuit Interrupters
    - e. UL 1449 – Standard for Surge Protective Devices
  - 2. NEMA PB1 - Panelboards
  - 3. National Electrical Contractors Association (NECA) Standard 407 – Standard for Installing and Maintaining Panelboards

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings.

2. Spare Parts List.
3. Operation and Maintenance Manuals.
4. Reports of Field Tests.

B. Each submittal shall be identified by the applicable specification section.

#### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  1. Product data sheets.
  2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.
  3. Complete panelboard schedules indicating circuit designations as shown on the Drawings for each panelboard.
  4. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g. LP-1, PP-2, etc.).

#### 1.05 OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:
  1. Instruction books and/or leaflets.
  2. Recommended spare parts list.
  3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during field installation.

#### 1.06 SPARE PARTS

- A. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. Spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.

- B. Spare parts lists shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

#### 1.07 IDENTIFICATION

- A. Each panelboard shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be as specified in Section 16195, Electrical -Identification.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

#### 2.02 CONDUCTORS (MAIN BUS AND BRANCH CONNECTORS)

- A. All main bus shall be copper sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above a maximum ambient temperature of 40 degrees C.

#### 2.03 LIGHTING PANELBOARDS

##### A. General

1. Lighting panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal-overload, branch circuit breakers. Panelboards shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards. Panelboards shall be service entrance rated where indicated on the Drawings.
2. Lighting panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting.
3. Lighting panelboards shall be fully rated and shall have a minimum short circuit rating of 22,000 amperes symmetrical, unless otherwise indicated on the Drawings.
4. Lighting panelboards shall be manufactured by Eaton, Schneider Electric (Square D), General Electric, or Engineer approved Equal.

## B. Enclosures

1. Enclosures shall be UL 50 listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI #61 light gray. The enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep.
2. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim.
3. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

## C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.
2. Solid neutral bus bars are required and neutral bus ampacity shall be the same as the main bus bars unless otherwise noted. Ratings shall be in accordance with applicable standards.
3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces.

## D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type and UL 489 Listed. All circuit breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation. Tandem or half-size circuit breakers are not acceptable.



2. Where indicated on the Drawings, or where required by Code, circuit breakers shall be equipped with integrally mounted ground fault circuit interrupters complete with "TEST" push button and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Ground fault circuit interrupter circuit breakers shall be UL 943 Listed. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.
3. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating.
4. Main circuit breakers shall be individually mounted. Branch mounted circuit breakers are not acceptable unless specifically indicated on the panel schedules. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location.
5. Where indicated on the Drawings, branch circuit breakers shall be provided with a padlockable hasp or handle padlock attachment for padlocking in the off position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the packlock is removed. Branch circuit breakers shall be provided with a similar lock-on device where indicated on the Drawings.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

## 2.04 POWER DISTRIBUTION PANELBOARDS

A. General

1. Power distribution panelboards shall be of the configuration and rating as specified herein and as indicated on the Drawings. The panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal overload branch circuit breakers. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards. Panelboards shall be service entrance rated where indicated on the Drawings.

2. Power panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting.
3. Power distribution panelboards shall be fully rated and shall have a minimum short circuit rating of 65,000 amperes symmetrical unless otherwise indicated on the Drawings.
4. Power distribution panelboards shall be manufactured by Eaton, Schneider Electric (Square D), General Electric, or Engineer approved Equal.
5. Enclosures
  - a. Enclosures shall be UL 50 listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI #61 light gray. The enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep.
  - b. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim.
  - c. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

B. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1,000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.
2. Solid neutral bus bars, where required, shall be provided. Neutral bus shall have the same ampacity as the main bus, unless otherwise indicated. Ratings shall be in accordance with applicable standards.
3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.

4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces. Panelboards Listed and Labeled as a four-wire panel shall not be used in place of a three-wire panel where a neutral conductor does not exist in the supply conductors to that panel.

#### C. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type and UL 489 Listed. All circuit breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation.
2. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD" where required by Article 440 by the NEC. Circuit breakers installed for air conditioning units shall be HACR type.
3. Circuit breaker voltage rating shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A, unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.
4. Main circuit breakers shall be individually mounted. Branch mounted circuit breakers are not acceptable unless specifically indicated on the panel schedules. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location.
5. Where indicated on the Drawings, branch circuit breakers shall be provided with a padlockable hasp or handle padlock attachment for padlocking in the off position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the padlock is removed. Branch circuit breakers shall be provided with a similar lock-on device where indicated on the Drawings.

#### D. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be provided in each panel. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

2.05 NOT USED

2.06 NOT USED

2.07 SURGE PROTECTIVE DEVICES

- A. The panelboards shall be furnished with integrated Type II surge protective devices (SPD). SPDs shall be provided in the location and quantity as shown on the Drawings. SPD shall be installed within the panelboard enclosure in a location that allows the required quantity and rating of branch circuit breakers to be installed. Reducing the quantity of branch circuit breakers to less than that required by the panel schedules is not acceptable.
- B. The SPD shall be rated, designed, tested, listed, and labeled in accordance with UL-1449, latest edition.
- C. The SPD shall be factory installed by the panelboard manufacturer using a direct bus connection. There shall be no cable connection between the bus bar and the SPD device.
- D. The SPD shall have a fault current rating equal to or greater than that of the fault current rating of the panelboard. The SPD shall employ metal-oxide varistor (MOV) technology. If integral fusing is used, the fuses shall allow the maximum rated surge current to pass without fuse operation.
- E. The SPD shall have a maximum continuous operating voltage (MCOV) of at least 115% of the nominal voltage of the panelboard. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

| SYSTEM VOLTAGE | L-N   | L-G   | L-L   | N-G   |
|----------------|-------|-------|-------|-------|
| 208Y/120       | 700V  | 700V  | 1200V | 700V  |
| 480Y/277       | 1200V | 1200V | 1800V | 1200V |
| 480 DELTA      | N/A   | 1200V | 2000V | N/A   |
| 240 DELTA      | N/A   | 1200V | 1200V | N/A   |
| 120/240        | 700V  | 700V  | 1200V | 700V  |

- F. The Nominal Discharge Current (In) of the SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
- G. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated in panel schedules. Surge current rating indicated is on a per phase basis.
- H. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

| SYSTEM CONFIGURATION | MODES OF PROTECTION | NUMBER OF MODES |
|----------------------|---------------------|-----------------|
| 3-Phase Wye          | L-N, L-G, N-G       | 7               |
| 3-Phase Delta        | L-L, L-G            | 6               |

|                               |               |   |
|-------------------------------|---------------|---|
| 3-Phase Impedance<br>Grounded | L-L, L-G      | 6 |
| Single-Phase                  | L-N, L-G, N-G | 3 |

- I. The SPD shall be furnished with an audible alarm and silence pushbutton, integral SPD status LEDs (one per phase), and a Form C dry contact for remote indication of alarm. A surge counter shall also be provided.
- J. The SPD equipment shall be SPD Series by Eaton, SurgeLogic by the Square D Company, Tranquell by the General Electric Company, Siemens Energy and Automation Inc. equivalent, or equal.

### PART 3 -- EXECUTION

#### 3.01 INSTALLATION

- A. Panelboards shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer, and as required by NECA 407.
- B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six (6) feet above finished floor elevation.
- C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.
- D. The Contractor shall not use factory furnished knockouts with surface mounted back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush mounted back boxes with manufacturer's standard pattern of knockouts.
- E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush mounted enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.
- F. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) KVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practical.
- G. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

#### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field Tests

- a. Prior to termination of any conductors to the circuit breakers , all bus work and circuit breakers shall be tested from phase to phase and phase to ground with a 1000 VDC megaohmmeter for 1 minute in accordance with NECA 407. Resistance values shall be recorded and shall not be less than 100 megohms.
- b. Prior to terminating any wires to the circuit breakers, the resistance of the connection between the bus work and each circuit breaker shall be tested through the use of a low-resistance ohmmeter. Record the resistance values for each circuit breaker.

- END OF SECTION -

## SECTION 16481

### INDIVIDUAL MOTOR CONTROLLERS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install separately mounted, individual motor controllers for 120 volt single phase, and 208 and 480 volt three phase motors as specified herein and indicated on the Drawings. Individual motor controllers specified in this Section include magnetic motor starters, manual motor starters, and reduced voltage solid state starters (RVSS).
- B. Reference Section 16000, Basic Electrical Requirements; Section 16123, Low Voltage Cable; Section 16195, Electrical Identification; and Section 16902, Electric Controls and Relays.

##### 1.02 CODES AND STANDARDS

- A. Individual motor controllers shall be designed, manufactured, and/or listed to the following standards as applicable:
  - 1. UL 508A – Standard for Industrial Control Panels
  - 2. NEMA 250 – Enclosures for Electrical Equipment

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the Specifications, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings.
  - 2. Spare Parts.
  - 3. Reports of Certified Shop and Field Tests.
  - 4. Operation and Maintenance Manuals.
  - 5. Manufacturer's Field Startup Report.
  - 6. Manufacturer's Representatives Installation Certification.
- B. Each submittal shall be identified by the applicable specification section.

##### 1.04 SHOP DRAWINGS

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- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.
  - 2. Product data sheets.
  - 3. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of individual motor controller. For RVSS starters, in free-standing enclosures, show conduit stub-up area locations on the Drawings.
  - 4. Custom wiring diagrams for each individual motor controller. Standard wiring diagrams that are not custom created by the manufacturer for the individual motor controllers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. effluent pump) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.
  - 5. Bill of material list for each individual motor controller.
  - 6. Nameplate schedule for each individual motor controller.
  - 7. Manufacturer's installation instructions.
  - 8. Time-current curves for each type and size protective device if requested by the Engineer.
  - 9. Approximate total shipping weight of each RVSS.



- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.
- E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for individual motor controller. These final drawings shall be plastic laminated and securely placed inside each individual motor controller unit door and included in the O&M manuals.

#### 1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

#### 1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The Contractor shall furnish the following additional spare parts:
  - 1. One (1) solid state overload relay for each type, size, and rating used.
  - 2. One (1) motor circuit protector & motor contactor for each type, size, and rating used.
  - 3. One (1) spare control power transformer for each type and size used.
  - 4. Two (2) spare fuses for each size and type used.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

#### 1.07 IDENTIFICATION

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved with the equipment name and/or number with which it is associated. Equipment identification shall be in accordance with Section 16195, Electrical - Identification.

## PART 2 -- PRODUCTS

### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

### 2.02 INDIVIDUAL MAGNETIC MOTOR STARTERS

- A. Individual magnetic motor starters shall be combination type complete with motor circuit protectors (MCP's). Starters shall be rated 480 VAC, 3-pole, sized for the intended load unless otherwise indicated. In no case shall a starter smaller than a NEMA Size 1 be used. Each starter shall be furnished with a minimum of two spare auxiliary contacts.
- B. In non-hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION            | ENCLOSURE TYPE AND MATERIAL |
|-----------------------------|-----------------------------|
| Indoor Wet Process Area     | NEMA 3R                     |
| Indoor Dry Process Area     | NEMA 12, Painted Steel      |
| Indoor Dry Non-process Area | NEMA 12, Painted Steel      |
| All Outdoor Areas           | NEMA 3R                     |

- C. In hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

| AREA CLASSIFICATION          | ENCLOSURE TYPE AND MATERIAL |
|------------------------------|-----------------------------|
| Class 1, Division 1, Group D | NEMA 7, Die Cast Aluminum   |
| Class 1, Division 2, Group D | NEMA 7, Die Cast Aluminum   |
| Class 2, Division 1, Group F | NEMA 9, Die Cast Aluminum   |
| Class 2, Division 2, Group F | NEMA 9, Die Cast Aluminum   |

- D. Starters shall be provided with all coils and controls for 120 VAC operation, unless otherwise indicated on the Drawings.
- E. The motor controller manufacturer is advised to review the total Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings. Control

power transformers shall be fused on both the primary and secondary sides. The minimum control power transformer VA requirements are as shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.

Size 1-150 VA

Size 2-150 VA

Size 3-200 VA

Size 4-300 VA

Size 5-500 VA

- F. Each starter shall be supplied with a manual reset overload relay. Manual reset shall be accomplished by a door mounted overload reset pushbutton. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy and bi-metallic type overload relays are not acceptable.
- G. Control Devices
  - 1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16902, Electric Controls and Relays:
    - a. Pilot devices (switches, indicating lights, etc.)
    - b. Relays and timers
    - c. Control Terminal blocks
- H. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105°C. Wire color coding shall be as specified in Section 16123, Low Voltage Cable.
- I. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid state equipment (e.g. programmable logic controller) wired as part of the control circuit.
- J. Individual magnetic motor starters shall be manufactured by Eaton, General Electric Company, Schneider Electric (Square D), or Engineer approved Equal.

## 2.03 INDIVIDUAL MANUAL MOTOR STARTERS

- A. Individual manual motor starters in enclosures as specified above shall be furnished and installed for outdoor and indoor exposed work. Furnish and install manual motor starters in outlet boxes with flush wall plates as required for concealed work.
- B. Furnish and install manual motor starters with pilot lights and overload heater elements of correct rating based on motor nameplate data.
- C. Manual motor starters shall be equipped with either a push button or toggle operator with reset device or mechanism accessible without opening the enclosure.
- D. Individual manual motor starters for motors one (1) horsepower and less shall be manufactured by Eaton, General Electric Company, Schneider Electric (Square D), or Engineer approved Equal.
- E. Individual manual motor starters for integral horsepower motors shall be manufactured by Eaton, General Electric Company, Schneider Electric (Square D), or Engineer approved Equal.

## 2.04 REDUCED VOLTAGE SOLID STATE STARTER

- A. The solid-state reduced-voltage starter shall be UL Listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, an integral paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing. The starter shall meet all applicable requirements of this Section and other sections in this Division.
- B. The RVSS shall be suitable for continuous operation at 115% of its continuous ampere rating. The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. This information is available in the applicable mechanical specifications for each piece of equipment (e.g. backwash blower).
- C. The RVSS shall be suitable for the following environmental conditions:
  - 1. Operating Temperature: 0-50 degrees C
  - 2. Humidity: 0-95 percent non-condensing.
  - 3. Altitude: up to 3,300 feet.
- D. The RVSS shall be suitable for operation on a 480 VAC, 3-phase, 60 Hertz system.
- E. The SCR-based power section shall consist of six (6) SCRs connected in a full wave power bridge. Units using triacs or SCR/diode combinations are not acceptable.
- F. The paralleling run bypass contactor shall energize when the motor reaches full speed and close/open under one (1) times motor current.

- G. The starter shall be provided with electronic overload protection as standard and shall be based on an inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 32 to 100% of the maximum continuous ampere rating (frame size) of the starter. The starter shall have selectable overload class setting of 5, 10, 20 or 30 via the device keypad. The starter shall be capable of either an electronic or mechanical reset after a fault. Units using bimetal or eutectic alloy overload relays are not acceptable.
- H. The starter shall provide protection against the following conditions:
1. Improper line-side phase rotation. The starter shall stop the motor load if a line-side phase rotation other than A-B-C exists.
  2. Phase loss or unbalanced conditions. The starter shall stop the motor load if a 50% current differential between any two phases is encountered.
  3. Motor stall conditions.
  4. Motor jam conditions.
  5. Provide metal oxide varistors (MOVs) for protection during transient overvoltage conditions.
- I. The starter shall be provided with a form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. The contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate the type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).
- J. The starter shall be provided with an unpowered internal "Run" contact rated for 24VDC or 120 VAC operation.
- K. The following control function adjustments on the device keypad shall be provided:
1. Selectable Torque Ramp Start or Current Limit Start
  2. Adjustable Kick Start Time, 0-2 seconds
  3. Adjustable Kick Start torque, 0-90%
  4. Adjustable Ramp Start Time; 0.5-180 seconds
  5. Adjustable Initial Starting Ramp Torque; 0-100%
  6. Adjustable Smooth Stop Ramp Time; 0-60 seconds.

- L. Enclosed units shall include a motor circuit protector (MCP) for short-circuit protection and quick disconnect means. If required, the unit shall include a 24 VDC power supply to be used as the primary control voltage source. A 120 VAC control power transformer, fused on both the primary and secondary sides, shall be provided as an additional control power source to power such devices as motor space heaters, solenoid valves, and similar control elements as required. Input and output isolation contactors shall be furnished as indicated on the Drawings.
- M. Unless otherwise specified or indicated on the Drawings, the RVSS enclosure shall be dead-front, with front accessibility. The enclosure shall be designed for both bottom and top entry. The enclosure shall be designed so rear access is not required for operations, maintenance, and repair tasks. The doors shall have full length piano type hinges and shall be braced to prevent sag when fully open. Other enclosure requirements are:
1. Finish exterior of the enclosures in ANSI-61 gray enamel or furnish in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.
- N. In non-hazardous locations, the RVSS shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION            | ENCLOSURE TYPE AND MATERIAL |
|-----------------------------|-----------------------------|
| Indoor Wet Process Area     | NEMA 3R                     |
| Indoor Dry Process Area     | NEMA 12, Painted Steel      |
| Indoor Dry Non-process Area | NEMA 12, Painted Steel      |
| All Outdoor Areas           | NEMA 3R                     |

- O. The complete starter assembly shall be rated per UL 508 for a minimum withstand rating of 65kAIC rms. Starters enclosed in motor control centers shall be by the same manufacturer.
- P. Control Devices
1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16902, Electric Controls and Relays:
    - a. Pilot devices (switches, indicating lights, etc.)
    - b. Relays and timers
    - c. Control Terminal blocks
- Q. The reduced voltage solid state starter shall be SMC-Flex by Allen-Bradley; no substitutions allowed.

### PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. All individual motor starters shall be installed as indicated on the Drawings and as recommended by the equipment manufacturer.
- B. Individual motor starters shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Witnessed Shop Tests
    - a. None required.
  - 2. Field Tests
    - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications, latest edition.

### 3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of the RVSS equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform all startup and field acceptance testing as specified herein.
- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of two (2) hours each. Training shall not take place until after the motor controllers have been installed and tested. Training shall be conducted at times coordinated with the Owner.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
  - 1. One (1) trip of two (2) working days during installation of the motor controllers.

2. One (1) trip of two (2) working days to perform startup and field acceptance testing of the motor controllers.
  3. One (1) trip of one (1) working day two (2) months before the warranty expiration to identify any issues to be corrected under warranty.
  4. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

- END OF SECTION -



## SECTION 16496

### AUTOMATIC TRANSFER SWITCH

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test and place in satisfactory operation automatic transfer switches as specified herein and indicated in Drawings.
- B. All devices and components of the automatic transfer switch shall be NEMA rated. IEC rated devices are unacceptable and shall be cause for rejection of the submittals/equipment.

##### 1.02 CODES AND STANDARDS

- A. All equipment shall be listed by and shall bear the label of Underwriter's Laboratories, Incorporated (UL).
- B. The equipment shall comply with the latest edition of the following codes and standards:
  - 1. UL 1008 - Standard for Transfer Switch Equipment
  - 2. IEC 947-6-1 - Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
  - 3. NFPA 70 - National Electrical Code
  - 4. NFPA 110 - Emergency and Standby Power Systems
  - 5. IEEE 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
  - 6. NEMA ICS 10 – Guide to Application of Low-voltage Automatic Transfer Switch Equipment
  - 7. UL 508 - Industrial Control Equipment

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings

2. Operation and Maintenance Manuals
3. Spare Parts Lists
4. Special Tools List
5. Reports of certified shop tests shall be submitted which indicates a closing and withstand ampere rating as required based on short circuit study requirements. Rating shall be symmetrical, 3 cycles at 480 VAC.
6. Guarantee/Warranty Program

B. Each submittal shall be identified by the applicable specification section.

#### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.
- C. Shop drawings for each automatic transfer switch shall include but not be limited to:
  1. Product data sheets.
  2. Complete assembly, layout, and installation drawings with clearly marked dimensions and conduit entrance locations.
  3. Example equipment nameplate data sheet.
  4. Complete internal schematic and interconnecting wiring diagrams.
  5. Nameplate schedule.
  6. Manufacturer's standard installation instructions.
  7. Manufacturer's standard warranty.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.
- E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each automatic transfer switch. These final drawings

shall be plastic laminated and securely placed inside each transfer switch and included in the O&M manuals.

#### 1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

#### 1.06 TOOLS, SUPPLIES AND SPARE PARTS

- A. The automatic transfer switches shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

#### 1.07 IDENTIFICATION

- A. Each automatic transfer switch shall be identified with the identification number indicated on the Drawings (e.g. ATS-1, ATS-2, etc.). A nameplate shall be securely affixed in a conspicuous place on each switch. Nameplates shall be as specified in Section 16195, Electrical - Identification.

#### 1.08 WARRANTY

- A. The manufacturer shall warrant each automatic transfer switch for a minimum of five (5) years from date of shipment. In addition, the manufacturer shall repair or replace equipment found faulty under the terms of the warranty. The manufacturer shall submit data outlining the guarantee/warranty program.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. The equipment described herein, as a minimum, shall meet all of the requirements specified in this Section and shall be a product of a manufacturer who has produced automatic transfer switches for a period of at least five (5) years. The equipment shall be compatible with the loads to be served. Assembly of the switches by a fabricator is not acceptable.
- C. The manufacturer of the automatic transfer switch shall verify that the switches are listed by Underwriters Laboratories, Inc., standard UL-1008, with 3-cycle withstand and close-in values as indicated on the Drawings or specified herein.
- D. The automatic transfer switches shall be molded case or insulated case circuit breaker design, Type ATV (Open Transition) as manufactured by ASCO, model ASCO 7000, no substitutions allowed.

## 2.02 AUTOMATIC TRANSFER SWITCH

### A. General

- 1. Switches shall have ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation.
- 2. For three phase, four-wire systems where a neutral is required, a true four-pole switch shall be supplied with all four electrically and mechanically identical poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
- 3. The transfer switch shall be housed in a NEMA 12 (gasketed) free-standing enclosure fabricated from 12-gauge steel suitable for floor mounting. The enclosure shall exceed the UL-1008 minimum wire bending space requirements. The enclosure shall be equipped with an internal, welded steel, door-mounted print pocket.
- 4. The transfer switch shall have both top and bottom mounted cable access.
- 5. The switch shall be capable of switching all classes of load and rated for continuous duty when installed in a non-ventilated enclosure.
- 6. The three-cycle closing and withstand current rating of the switch shall be 65,000 amperes RMS (minimum). This rating shall not be restricted by the use of a specific manufacturer's circuit breaker.
- 7. This switch shall be complete with all accessories and listed by UL under Standard UL-1008 for use on emergency systems.

8. All bolted bus connections shall have Belleville compression type washers. Switches for four-wire systems shall be furnished with a fully rated solid neutral bus.
9. The switch shall be equipped with 90°C rated copper/aluminum solderless mechanical type lugs of the proper quantity and size to accommodate the termination of field wiring.
10. Switches shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation.

#### B. Design Requirements

1. Switches shall contain two drawout, mechanically interlocked, insulated case circuit breakers with ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation. A center-off-position shall be provided as a neutral position during switching. Minimum transfer time shall 400 milliseconds. The switches shall be service entrance rated and shall bear the service entrance label as indicated on the Drawings.
2. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
3. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer, allowing the motor and transformer loads to be re-energized after transfer with normal in-rush current.
4. Normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts to be of silver-tungsten alloy, mechanically locked in position in both the normal and standby positions without the use of hooks, latches, or magnets. Provide separate arcing contacts, with magnetic blowouts on each pole. Interlocked molded case circuit breakers switches or contactors are not acceptable.
5. Equip the transfer switch with a permanently attached, safe, manual operator designed to prevent injury to personnel in the event the electrical operator should become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from slowly switching the main contacts.

#### C. Sequence of Operation

1. Should the voltage on any phase of the normal source drop below 80 percent or increase to 120 percent, or frequency drops below 90 percent, or increase to 110 percent, or 20 percent voltage differential between phases occur, after a programmable time delay period of 0-9999 seconds factory set at three (3) seconds to allow for momentary dips, the engine starting contact(s) shall close to connect the standby source.

2. Transfer to the standby power source shall occur when 90 percent of rated voltage and frequency has been reached by the standby power source.
3. After restoration of normal power on all phases to a preset value of 90 percent to 110 percent of rated voltage, at least 95 percent to 105 percent of rated frequency, and voltage differential is below 20 percent between phases, an adjustable time delay period of 0-9999 seconds factory set at 300 seconds shall delay the transfer to allow stabilization of the normal source. Should the standby source fail during this time delay period, the switch shall automatically retransfer to the normal source.
4. After retransfer to the normal power source, standby power source shall operate at no load for a programmable period of 0-9999 seconds factory set at 300 seconds. Should the normal power source fail during this time delay period, the transfer switch shall automatically return to the standby source.

#### D. Controls

1. The transfer switch shall be equipped with a microprocessor-based control system to provide all the operational functions of the automatic transfer switch. The controller shall have a real time clock with Nicad battery back-up.
2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory, I/O, and communication circuits with a watchdog power fail circuit.
3. The transfer switch shall include communication ports that support monitoring of transfer switch. The communication ports shall allow interface to either the manufacturer's or the Owner's furnished remote supervisory control system and use an open protocol. 100 Mbps Ethernet copper RJ-45 ports and serial ports shall be provided. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.
5. The controller shall have password protection to limit access to authorized personnel.
6. The controller shall include a 20 character LCD display with a keypad, which allows access to the system.
7. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection, and phase differential monitoring on both normal and standby sources.
8. The controller shall be capable of storing the following records in memory for access either locally or remotely:
  - a. Number of hours the transfer switch is in the standby position (total since record reset).
  - b. Number of hours standby power source is available (total since record reset).

- c. Total transfer in either direction (total since record reset).
  - d. Date, time, and description of the last four source failures.
  - e. Date of the last exercise period.
  - f. Date of record reset.
9. LED indicating lights shall be mounted on the controller to indicate:
    - a. Switch is in normal position
    - b. Switch is in standby position.
    - c. Controller is running.
  10. A three-phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase-to-phase voltages simultaneously for both the normal and standby source.
  11. A digital LCD frequency readout with 1% accuracy shall display frequency for both the normal and standby source.
  12. An LCD readout shall display both normal source and standby source availability.
  13. The microprocessor controller shall meet the following requirements:
    - Storage conditions - 25°C to 85°C
    - Operation conditions - 20°C to 70°C ambient
    - Humidity 0 to 99% relative humidity, non-condensing
    - Capable of withstanding infinite power interruptions
    - Surge withstand per ANSI/IEEE C-37.90A-1978
  14. All control wiring shall be 18 gauge (minimum), 600 VAC, SIS switchboard type. All control wiring shall be identified at each termination (both ends) using tubular, sleeve-type wire markers.

#### E. Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out

at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

2. Programmable three phase sensing of the standby source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.
3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds.
4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.
5. Time delay on transfer to standby, programmable 0-9999 seconds, factory set at 3 seconds.
6. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.
7. A time delay bypass on retransfer to normal shall be included. Keypad initiated.
8. Contact, rated 5 A at 30 VDC, to close on failure of normal source to initiate engine starting.
9. A plant exerciser shall be provided with (10) 7 day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise the standby plant programmable in one minute increments. Also include a control switch for selection of either "no load" (switch will not transfer) or "load" (switch will transfer) during the exercise period. Keypad initiated.
10. Relay contacts which close when normal source fails wired to a terminal strip.
11. Relay contacts which open when normal source fails wired to a terminal strip.
12. Two auxiliary contacts rated 10 A at 250 VAC on main shaft, closed on normal and wired to a terminal strip.
13. Two auxiliary contacts rated 10 A at 250 VAC on main shaft, closed on standby and wired to a terminal strip.

### PART 3 -- EXECUTION



### 3.01 INSTALLATION

- A. Each automatic transfer switch shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- B. The automatic transfer switch shall be provided with adequate lifting means for installation of wall or floor mounted enclosures.
- C. The Contractor shall tighten all assembled bolted connections to the manufacturer's torque recommendations prior to energizing.
- D. Install each switch to allow complete door swing required for component removal. This is specifically required where a switch is set next to a wall to the left of the switch enclosure.

### 3.02 PAINTING

- A. Painting shall conform with the requirements of Section 09900. Color of finish coat shall be selected by Owner. Color at SLS20 will be camel tan.
- B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

### 3.03 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Witnessed Shop Tests
    - a. Shall be made available at manufacturing facilities if requested.
  - 2. Certified Shop Tests and Reports
    - a. Automatic transfer switches shall be given routine factory tests. The factory tests shall demonstrate that the completed switches function correctly and that the required timing has been set. Certification of these settings shall be submitted to the Engineer upon request.
    - b. Test procedures shall be in accordance with UL-1008. During the 3-cycle withstand tests, there shall be no contact welding or damage.
    - c. The three cycle tests shall be performed without the use of current limiting fuses.
    - d. Oscillograph traces across the main contacts shall verify that contact separation has not occurred and there is contact continuity across all phases after completion of the test.

- e. When conducting temperature rise tests in accordance with UL-1008, include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
- f. Manufacturer shall submit test reports upon request.

### 3. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.
- b. Prior to acceptance of the installation, load test the equipment with all available motor load, but do not exceed the generator's or automatic transfer switch's nameplate rating. Correct defects which become evident during this test.

### 3.04 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1 and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
  - 1. One trip of one (1) working day during installation of the equipment for each automatic transfer switch.
  - 2. One trip of one (1) working day after acceptance of the equipment.
  - 3. One trip of one (1) working day during the warranty period.
- B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Field Representative on each day he is at the project.
- C. The manufacturer shall have an established network of service centers capable of servicing the specified equipment. The manufacturer shall include an 800 telephone number for a field service contact affixed to each enclosure. Service center personnel shall be on call 24 hours a day, 365 days a year. Personnel shall be factory-trained and certified in the maintenance and repair of the specified equipment.
- D. After-warranty service contracts shall be made available to the Owner by the manufacturer, through the service centers, to provide periodic maintenance and/or repair of the specified equipment.

### 3.05 TRAINING

- A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be in accordance with the requirements of Section 11000, Equipment-General Provisions.
- B. Provide the services of an experienced, factory trained technician or service engineer of the switch manufacturer at the jobsite for minimum of three (3) days for training of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner. The technician shall be on duty at the site for at least 8 hours per day and shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

- END OF SECTION -

## SECTION 16500

### LIGHTING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all lighting fixtures, labor, and material, in accordance with the preceding Specifications, the requirements of this Section, and as shown on the Drawings.
- B. Lighting shall be in accordance with the latest requirements of the Illuminating Engineering Society, and all lighting fixtures shall have the Underwriters Laboratories, Inc. label of approval.
- C. All wiring shall be placed in conduit and shall comply with the Specifications for conduit, outlet boxes, pull and junction boxes, wires and cables, grounding, and other Sections as set forth in these Specifications and as noted herein.
- D. Reference Section 16000, Basic Electrical Requirements, and Section 16170, Grounding and Bonding.

##### 1.02 CODES AND STANDARDS

- A. The equipment specified herein shall comply with the following codes and standards, where applicable.
  - 1. Underwriter's Laboratories, Inc. (UL):
    - a. UL 924 – Emergency Lighting and Power Equipment
    - b. UL 935 – Fluorescent Lamp Ballasts
    - c. UL 844 – Luminaires for Use in Hazardous (Classified) Locations
    - d. UL 1029 – High Intensity Discharge Lamp Ballasts
    - e. UL 1598 – Luminaires
  - 2. American National Standards Institute (ANSI):
    - a. ANSI C82.11 – High Frequency Fluorescent Lamp Ballasts
    - b. ANSI C82.77 – Lighting Equipment - Voltage Surge Requirements
  - 3. National Electrical Code (NEC), latest edition.

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### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Operation and Maintenance Manuals
  - 3. Spare Parts Lists
- B. Each submittal shall be identified by the applicable specification section.

### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
  - 2. Catalog cuts for each fixture type showing performance and construction details of standard fixtures, and complete working drawings showing all proposed construction details of special or modified standard fixtures.
  - 3. Photometric curves.
  - 4. Lamp and LED data including efficiency (Efficacy lumens/watt) information.
  - 5. Ballast and LED Driver information
  - 6. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.
  - 7. Manufacturer's warranty information
  - 8. Custom wiring diagrams for each individual lighting contactor. Standard wiring diagrams that are not custom created by the manufacturer for the individual lighting contactors for this project are not acceptable. One wiring diagram which is typical for all lighting contactors is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their

physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

- D. Shop drawings shall be submitted to the Engineer for review and acceptance for all fixtures before fixtures and poles are manufactured. Substitutions will be permitted only if acceptable to the Engineer.
- E. Manufacturer's catalog number and description in the fixture schedule on the Contract Documents establishes a level of quality, style, finish, etc. The use of a catalog number describing the various types of fixtures shall be used as a guide only, and does not exclude all the required accessories or hardware that may be required for a complete installation.

#### 1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit Operation and Maintenance Manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

#### 1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The following minimum spare parts shall be furnished:
  - 1. A minimum of one (1) ballast for every ten (10) ballasts (of the same model) installed.
  - 2. A minimum of one (1) LED driver for every ten (10) drivers (of the same type) installed.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

#### 1.07 LIGHTING CONTROLS

- A. The lighting systems shall be controlled as specified herein and indicated on the Drawings.

- B. Lighting contactors shall be furnished and installed for specific lighting control applications as specified herein and indicated on the Drawings.

#### 1.08 WARRANTY

- A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of delivery of fixtures to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, shipping costs, expendables used during the course of repair, or complete replacement of the failed lighting unit.
- B. Warranty for LED fixtures shall be provided for the entire fixture and shall include all parts and accessories. Warranty for non-LED fixtures shall be provided for the entire fixture and shall include all parts and accessories except the replaceable bulb. Submittals received without written warranties as specified shall be rejected in their entirety.

### PART 2 -- PRODUCTS

#### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

#### 2.02 FIXTURES

- A. Each fixture shall bear the Underwriters Laboratories, Inc. label. All lighting fixtures shall be furnished complete with lamps of the size and type as indicated on the Drawings and all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all parts and fittings necessary to completely and properly install the fixtures.
- B. Fixture leads shall be as required by NEC and shall be grounded by the equipment grounding conductor in the conduit.
- C. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.
- D. HID fixture housings shall be finished with a seven-stage phosphate pretreatment and thermal-set, electrostatically applied polyester paint. Color shall be as indicated in the fixture schedule or as selected by the Engineer.
- E. Indoor metal halide fixtures shown in non-hazardous locations shall be furnished with a tungsten/halogen lamp and time delay relay as specified in the fixture schedule or indicated on the Drawings. For hazardous locations where this feature is not available, emergency fixtures shall be provided with a time delay feature.

- F. Emergency fixtures shall be UL 924 listed and have a minimum 90 minutes battery back-up.
- G. Fixtures for use in hazardous locations shall be UL 844 Listed.
- H. Fixtures specified to be damp or wet locations rated shall be UL 1598 listed.
- I. Fluorescent fixtures shall be complete with housing, louvers (if required), and accessories of the types and quantities specified herein and indicated on the Drawings.
- J. Fixtures shall be as specified in the Drawings per the fixture schedule below.

| <b>FIXTURE TYPE</b> | <b>WATTAGE</b> | <b>DESCRIPTION</b>                                                                                                                                                                                                                                                                                                                                                           | <b>MFR AND MODEL</b>                                                               |
|---------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| EW1                 | 10 W           | Wall mounted, emergency fixture, 120-277 VAC with 6 or 12 VDC nickel cadmium battery, gray corrosion and impact resistant molded fiberglass housing, time delay shutoff, surge and brown-out protection, and low voltage battery cut-off. Battery shall be suitable for 90 minutes (including all remote heads as shown on Drawings). Two 5W LED heads. Wet location Listed. | Holophane Desoto M90X, Philips Rhyno Series, or Lithonia INDX Series.              |
| EW3                 | LED 10.8W      | Wall mounted emergency fixture. Wet location Listed, 120 VAC, partial lens, completely self-contained battery back-up for emergency only. Black die cast aluminum housing, with a clear prismatic lens. Battery shall be sealed nickel cadmium, with solid state battery charger, provide 90 minutes illumination time.                                                      | Holophane Cortez CZA9A Series, Chloride Patron Series, or Lithonia AFN Series.     |
| XW1                 | 1.5 W          | Wall-mounted, red LED exit sign, 120-277VAC, brushed aluminum faceplate, die cast aluminum housing, single/double face as indicated on the drawings, nickel cadmium battery, brownout and surge protected, damp location Listed.                                                                                                                                             | Holophane Magellan MEX Series, Lithonia LE Series, or Duallite Sempra Series.      |
| LC1                 | 45 W (max)     | Ceiling-mounted, 120 VAC, LED light fixture, color temperature of 5000K, lineal ribbed frosted acrylic lens, wide distribution, gasketed fiberglass housing, stainless steel latches, 4ft, 60000 lumen minimum, and wet location Listed.                                                                                                                                     | Holophane EMS LED Series, Cooper Vaportite LED Series, or Lithonia FEM LED Series. |



| <b>FIXTURE TYPE</b> | <b>WATTAGE</b> | <b>DESCRIPTION</b>                                                                                                                                                                                                                                                                                                                                                          | <b>MFR AND MODEL</b>                                                                 |
|---------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| LL1                 | 126W (max)     | Pole-mounted, 120-277VAC, LED light fixture, universal mount, color temperature of 4000K, prismatic borosilicate glass lens, IESNA Type 5 distribution, 19,000 lumen minimum, bronze die cast aluminum housing, integral photocell with pole mounted weatherproof switch, wet location Listed.<br><br>Square, bronze, base mounted, straight, 16ft. anodized aluminum pole. | Holophane Mongoose LED Series, Kim Archetype LED Series, or AEL Autobahn LED Series. |
| LW1                 | 39 W (max)     | Wall-mounted, 120 VAC, LED light fixture, color temperature of 4000K, prismatic borosilicate glass lens, LEDs, IESNA Type III medium distribution, black die-cast aluminum housing, 1000mA driver, 3300 lumen minimum, integral photocell, and wet location Listed.                                                                                                         | Holophane W4G LED, Hubbell LED PGM3 Series, or GE EWS1 Series.                       |

2.03 NOT USED

2.04 NOT USED

#### 2.05 LED DRIVERS

- A. Drivers shall have a voltage range of (120-277) +/- 10% at a frequency 60Hz.
- B. All drivers shall be designed to a power factor >90% with a total harmonic distortion THD <20% at full load.
- C. Case temperature shall be rated for -40°C through +80°C.
- D. Drivers shall have overheat protection, self-limited short circuit protection and overload protected.
- E. Drivers shall be furnished with a fused primary.
- F. Drivers shall have an output current ripple <30%
- G. Drivers shall be manufactured by Advance, Universal or equal.
- H. Drivers shall be UL Listed for damp location, UL1012, UL935, ROHS.
- I. Drivers shall meet FCC 47 Sub Part 15.

- J. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

## 2.06 NOT USED

## 2.07 LEDs

- A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.
- B. Color Temperature: as specified in fixture schedule.
- C. Junction point shall be designed and manufactured to allow adequate heat dissipation.
- D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70).

## 2.08 POLES

- A. Poles shall be designed to withstand calculated wind force based on wind velocity in accordance with the provisions of the California Building Code.
- B. Pole mounted fixtures shall be mounted on poles as designated in the fixture schedule or as indicated on the Drawings. Poles shall have adequate handholes and weatherproof receptacles where indicated. All anchor bolts and nuts shall be stainless steel.

## 2.09 LIGHTING CONTROLS

- A. Lighting contactors shall be as manufactured by Eaton or Square D Company, no substitutions allowed. Lighting contactors shall be heavy duty industrial type with 30A minimum rating and shall have the number of contacts required. Contactor ampere rating shall be increased as required to suit the application. Contactor coil voltage shall be as indicated on the Drawings. Contactors shall be the electrically or mechanically held type as indicated on the Drawings. Contactors shall include fused integral control power transformers. Any auxiliary relays, or other devices required for proper operation shall be included.
- B. In non-hazardous locations, lighting contactors shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION                             | ENCLOSURE TYPE AND MATERIAL       |
|----------------------------------------------|-----------------------------------|
| Indoor Wet Process Area                      | NEMA 4X, Type 304 Stainless Steel |
| Indoor Dry Process Area                      | NEMA 12, Painted Steel            |
| Indoor Dry Non-process Area                  | NEMA 1, Painted Steel             |
| Indoor Type 1 Chemical Storage/Transfer Area | NEMA 4X, Fiberglass               |

|                                              |                                   |
|----------------------------------------------|-----------------------------------|
| Indoor Type 2 Chemical Storage/Transfer Area | NEMA 4X, Type 304 Stainless Steel |
| All Outdoor Areas                            | NEMA 4X, Type 304 Stainless Steel |

- C. In hazardous locations, lighting contactors shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

| AREA CLASSIFICATION          | ENCLOSURE TYPE AND MATERIAL |
|------------------------------|-----------------------------|
| Class 1, Division 1, Group D | NEMA 7, Die Cast Aluminum   |
| Class 1, Division 2, Group D | NEMA 7, Die Cast Aluminum   |
| Class 2, Division 1, Group F | NEMA 9, Die Cast Aluminum   |
| Class 2, Division 2, Group F | NEMA 9, Die Cast Aluminum   |

- D. Photocells shown on the Drawings that are not integral to a fixture provided by the (lighting manufacturer) shall be provided by the Contractor. Photocells shall be rated for 120 VAC, 1800W, and be provided with 1/2" or 3/4" threads for box mounting. Photocells shall be Model K4121C by Intermatic, or equal.

### PART 3 -- EXECUTION

#### 3.01 INSTALLATION

- A. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance such as cleaning, relamping, and other activities. The fixtures shall be installed to be accessed by a 12 ft. (max.) ladder. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.
- B. The Contractor shall provide and install all inserts, conduit, structural supports as required, lamps, ballasts, poles, wiring, and any other items required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system. The Contractor shall provide pigtails and flexible conduit connected to an outlet box where necessary or required resulting in a neat and complete installation.
- C. The Contractor shall protect all fixtures at all times from damage, dirt, dust, and the like. Before final acceptance, all fixtures and devices shall be cleaned of all dust, dirt or other material, be fully re-lamped (except LED fixtures) and in operating condition to the satisfaction of the Engineer.
- D. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal fixture motion and self-alignment. Fixture pendants shall be Appleton Type UNJ ball type flexible hanger at the fixture and supports from an Appleton JBLX junction box with JBLX hub cover, or equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation

heights above the reference datum. Stems shall be one-piece, with matching canopies and fittings.

- E. Fixtures located on the exterior of the building shall be provided with neoprene gasket and non-ferrous metal screws finished to match the fixtures.
- F. The finish or exposed metal parts of lighting fixtures and finish trims of all recessed lighting fixtures shall be as directed by the Engineer.
- G. The Contractor shall furnish and install recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.
- H. The Contractor shall furnish and install all boxes for lighting fixtures such that the box is not the sole support of the fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting (holding) the fixture.
- I. All lighting units, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.
- J. The Contractor shall install fixtures at mounting heights indicated on the Drawings or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer.
- K. The Contractor shall support each lighting fixture securely. Each fixture shall be secured to the building structure. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures from plaster. The Contractor shall furnish and install all steel members and supports as required to fasten and suspend fixtures from the structure.
- L. In all mechanical equipment areas, the Contractor shall install lighting fixtures on the ceiling after all piping and equipment therein has been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.
- M. Upon completion of work, and after the building area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, and lamps.
- N. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures and/or lamps, as directed.
- O. Lamp replacement for all fixtures shall require no special tools. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of special tools.

No fixture part that may be removed, for maintenance, shall be held in place by metal tabs that must be bent to remove said part.

- P. The Contractor shall furnish and install time switches and photocells as specified herein or indicated on the Drawings. Time switches shall be provided with a manual bypass switch controlling the lights locally and remotely. Time switches shall control contactors, relays, or direct controlling of one, two, or three lighting circuits, as indicated. The Contractor shall furnish and install photocells as specified herein or indicated on the Drawings for automatic "ON/OFF" switching of outdoor lighting.
- Q. Lighting contactors shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- R. The Contractor shall furnish and install a concrete foundation for the pole mounted fixtures as indicated on the Drawings and as required. This applies to foundations for pole mounted fixtures located in the yard (i.e. site lighting) and foundations that are part of a structure (e.g. filters). Foundation shall be approved by a professional structural engineer currently registered in the State of California. The wind and seismic design shall be in accordance with ASCE 7, the California Building Code, and Section 01350. Provide calculations signed and sealed by a Professional Structural Engineer for review.
- S. One (1),  $\frac{3}{4}$ " diameter, 10'-0" long ground rod, furnish in accordance with Section 16170, shall be driven adjacent to each pole. The pole, anchor bolts, steel reinforcement bar in the base, and equipment grounding conductor shall all be bonded to the ground rod as indicated in the standard details.

### 3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
  - 1. Certified Shop Tests
    - a. The lighting fixtures shall be given routine factory tests in accordance with the requirement of ANSI, NEMA and Underwriters Laboratories standards.
  - 2. Field Tests
    - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

## SECTION 16620

### PACKAGED ENGINE GENERATOR SYSTEMS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install a standby power engine generator set complete with base-mounted fuel storage tank, leak detection systems, piping, exhaust silencer, batteries, charger, enclosure, and engine control panel.
- B. It is the intent under this Contract to require an installation complete in every detail whether or not indicated on the Drawings or specified. Consequently, the Contractor is responsible for all details, devices, accessories and special construction necessary to properly install, adjust, test, and place in successful and continuous operation the engine-generator set.
- C. Use materials which are new, unused, and as specified, or, if not specifically indicated, the best and most suitable of their kinds for the purpose intended, and for the design and expected conditions of service, subject to the approval of the Engineer.
- D. All materials used must bear the inspection labels of the Underwriter's Laboratories, if the material is of a class inspected by the Laboratory.
- E. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- F. The engine generator sets shall fully comply with all current Environmental Protection Agency (EPA) emission regulations including, but not limited to, the New Source Performance Standards (NSPS) for stationary and non-road generator sets. The engine generator set(s) must meet the EPA new source performance requirements required at the time the engine generator set(s) submittal is approved by the engineer. Engines manufactured previous to the submittal approval date that do not meet the current regulated emissions levels are not acceptable.
- G. Reference Section 16000, Basic Electrical Requirements and Section 16426, Low Voltage Switchboard.

##### 1.02 CODES AND STANDARDS

- A. The packaged engine-generator system shall comply with the following Codes and Standards as a minimum:

1. NEMA MG1, Motors and Generators.
2. NEMA MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.
3. ISO STD 8528, Reciprocating Internal Combustion Engines.
4. ISO STD 3046, Performance Standard for Reciprocating Internal Combustion Engines.
5. NFPA 30, Flammable and Combustible Liquids Code.
6. NFPA 37, Standard for Installation and use of Stationary Combustible Engine and Gas Turbines.
7. NFPA 70, National Electrical Code
8. NFPA 70E, Standard for Electrical Safety in the Workplace
9. NFPA 110, Standard for Emergency and Standby Power Systems.
10. UL 508, Industrial Control Equipment.
11. EGSA, Electrical Generating Systems Association.
12. UL 2200 – Stationary Engine Generator Assemblies
13. ANSI C57, Dry-Type Transformers.
14. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
15. UL 1236 – Standard for Battery Chargers for Charging Engine Starter Batteries.

#### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  1. Shop Drawings
  2. Spare Parts List
  3. Reports of Certified Shop and Field Tests
  4. Operation and Maintenance Manuals
  5. Manufacturer's Field Start-up Report

6. Manufacturer's Representative's Installation Certification

- B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings for each engine-generator set shall include but not be limited to:
1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this specification section.
  2. Manufacturers printed specification sheets showing critical engine and generator set specifications including the following:
    - Dimensions, and weights
    - Guaranteed fuel consumption at 25%, 50%, 75% and 100% of full rated load
    - Engine bhp available
    - Brake Mean Effective Pressure (BMEP)
    - Engine jacket water heat rejection
    - Exhaust flow rate and temperature at 100% of rated load
    - Ventilation and combustion air requirements
    - Exhaust backpressure limitation
    - Liquid refill capacities
    - Voltage regulation characteristics
    - Guaranteed noise levels
  3. Alternator technical electrical data, including, but not limited to:



- Alternator efficiency at 50%, 75%, and 100% load
  - Telephone Interference Factor (TIF)
  - Harmonic waveform distortion
  - Type of winding insulation and generator temperature rise
  - Per unit subtransient impedance  $X''$  and X/R ratios for positive, negative, and zero sequences
  - Transient reactance ( $X_d'$ )
  - Synchronous reactance ( $X_d$ )
  - Sub transient time constant ( $T_d''$ )
  - Transient time constant ( $T_d$ )
  - DC time constant ( $T_{dc}$ )
  - Decrement curve
4. Manufacturer's printed warranty statement of the engine and generator set showing single source responsibility by the engine manufacturer.
  5. Generator control panel equipment and features. Include a written explanation of the auto start/stop logic and operation.
  6. Engine-generator set and accessory product data sheets including, but not limited to, the following (if applicable):
    - Alternator strip heater
    - Radiator
    - Seismically rated vibration isolators
    - Flexible exhaust coupling
    - Exhaust silencer
    - Batteries
    - Battery charger
    - Engine manufacturers shutdown contactors
    - Jacket coolant heater
    - Fuel cooler
    - Fuel tank(s) and pump(s)
    - Fuel level devices
    - Output circuit breaker and trip unit
    - Conduit
    - Wire and Cable

7. Standard dealer preventative maintenance contract for review and possible adoption under a separate contract. Dealer must have existing contracts and personnel and contractual detailed performance information available.
8. Normal operating ranges for systems temperature, pressure and speed.
9. Manufacturer's part number for the engine and generator operation guide, parts book, service manual, warranty policy, and installation guide.
10. Location of other similar units showing compliance with the experience requirements specified herein.
11. Phone numbers of twenty-four (24) hour products support contacts and locations.
12. Drawing showing right hand, left hand, and top views of proposed assembly; battery rack, isolators, exhaust silencer, conduit stub up locations, and flexible fittings; wiring schematics, interconnection diagrams (point to point), and written description of engine generator controls and alarm circuits.
13. Control panel layout drawings and wiring diagrams.
14. Drawings and specifications for base-mounted fuel storage tank with accessories and leak detection system.
15. EPA Certificate of Conformity for Exhaust Emissions
16. Detailed drawings showing plan, front, and side views as well as appropriate section views of the weatherproof, engine-generator enclosure. Include product data sheets for all appurtenances (e.g. exhaust fan, thermostat, lighting, switches, receptacles, combination power unit, etc.) to be furnished and installed in the enclosure. Drawings shall be of sufficient detail to assure proper installation by the Contractor.

- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

#### 1.05 REPORTS OF CERTIFIED SHOP AND FIELD TESTS

- A. Submit two (2) certified copies of all test reports. This includes all shop tests and field tests. Certified shop test reports for prototype engine-generator sets are unacceptable. The manufacturer's serial number for the actual engine-generator set furnished for this project shall appear on all test reports.

#### 1.06 OPERATION AND MAINTENANCE MANUALS

- A. Two (2) preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not more than 10 days after the equipment arrives on the project site.
- B. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner. Following review of the preliminary copies of the Operation and Maintenance Manuals, one (1) copy will be returned to the Contractor with required revisions noted, or the acceptance of the Engineer noted.
- C. Manuals shall contain complete information in connection with assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts. Manuals shall contain all information submitted as part of the shop drawing review process.
- D. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contract information.
- E. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.
- F. Following the Engineer's review of the preliminary manuals, the Contractor shall submit five (5) paper copies and two (2) electronic copies of the final Operation and Maintenance Manuals to the Owner. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents, as well as any changes made during installation. Failure of the final manuals to reflect the required revisions noted by the Engineer as well as changes made during installation will result in the manuals being returned to the Contractor. Acceptable final Operation and Maintenance Manuals shall be provided not more than one (1) month after receipt of the Engineer's comments.

#### 1.07 SPARE PARTS

- A. Routine maintenance and adjustments shall be performed without the use of special tools or instruments. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts for each engine-generator set:

| <u>No. Required</u> | <u>Description</u>                  |
|---------------------|-------------------------------------|
| 1                   | Set of Fuel Oil Particulate Filters |

|   |                                         |
|---|-----------------------------------------|
| 1 | Set of Air Filters                      |
| 1 | Set of Lube Oil Filters                 |
| 1 | Set of Fuel Oil/Water Separator Filters |
| 1 | Set of Coolant Filters                  |

- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts list, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.
- F. The dealer shall have sufficient parts inventory to maintain over-the-counter availability of at least 90% of any required part and 100% availability within 48 hours.

#### 1.08 IDENTIFICATION

- A. Each engine-generator set shall be identified with the identification name/number indicated on the Drawings (e.g., Generator No. 1, Generator No. 2, etc.). A nameplate shall be securely affixed in a conspicuous place on the generator main circuit breaker or output termination box enclosure. Nameplates shall be as specified in Section 16195, Electrical - Identification.

#### 1.09 WARRANTY TERMS

- A. The manufacturer's and Dealer's warranty shall in no event be for a period of less than two (2) years or two-thousand (2,000) hours of operation, whichever comes first, from date of delivery of equipment to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, coolant, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified shall be rejected in their entirety.
- B. Provided warranty shall cover all equipment included in the scope of supply. This warranty shall include, but is not limited to, the following:
  - Engine-generator set and respective auxiliary equipment
  - All controls for the engine-generator set

- C. Batteries shall be provided with two (2) year full replacement guarantee, and a pro-rated replacement schedule thereafter.

#### 1.10 OIL SAMPLING KIT

- A. The generator set supplier shall provide an oil sampling analysis kit which operating personnel shall utilize for scheduled oil sampling. All equipment needed to take oil samples shall be provided in a kit and shall include the following:

- 1 Sample extraction gun
- 10 Bottles
- 10 Postage-paid mailers
- 1 Written instructions

An additional oil sampling kit shall be made available to the Owner to continue the sampling when the above specified kit has been depleted. All kits in addition to that specified above shall be at an additional cost to the Owner, if the Owner desires to continue the sampling service.

#### 1.11 NOT USED

#### 1.12 PREVENTIVE MAINTENANCE AGREEMENT

- A. The engine/generator set supplier shall provide a preventive maintenance agreement using qualified factory trained service personnel, for a period of 2-year minimum. Provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance as defined in the manufacturer's Operation and Maintenance Manual and as listed below. All parts shall be new and provided by the generator manufacturer. The maintenance agreement shall include the following as a minimum:

1. Check oil level, check oil pressure safety shutdown switches, complete an oil sample analysis, check oil pressure and gauges, and inspect the system for leaks. Change oil and oil filter if required.
2. Check coolant level, inspect/replace cooling system hoses, check high/low temperature alarms and shutdowns, inspect radiator, inspect fan and fan belts (tighten or replace as required). Flush coolant system and replace coolant if required.
3. Inspect the fuel system including fuel pumps and tank(s), check fuel pressure, inspect fuel filters and replace if required, and check for water in fuel storage tank.
4. Check the battery and battery charging system including a voltage test, check and clean battery terminals, check and inspect engine starting system.
5. Inspect and test the generator, check bearing grease and add grease if required, check terminations, and complete a generator winding insulation resistance (i.e.

megger test).

6. Check engine control system including overspeed alarms and shutdowns, overcrank alarm, engine starter, circuit breaker and fuses, and test and adjust engine governor.
7. Check and the engine air intake and exhaust systems for leaks and damage. Check air filter and replace if required.
8. Inspect all components of the generator enclosure including, but not limited to, lights, louvers, fans, doors, etc.

## PART 2 -- PRODUCTS

### 2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. Consideration will be given only to the equipment of those manufacturers who have furnished comparable size diesel engine-generator sets for at least two similar installations that have been in regular successful operation for not less than five (5) years.
- C. The engine-generator set manufacturers shall be Caterpillar. No substitutions allowed. The engine-generator set manufacturer and/or dealer shall be responsible for the entire engine-generator package including the engine-generator set with all accessories and equipment specified herein and all other devices required for a complete and operable system.

### 2.02 GENERAL DESCRIPTION

- A. The engine-generator set shall be rated as specified herein and as indicated on the Drawings. It shall have the capability to operate at its standby rating for the duration of any power outage with all accessories including engine running devices, silencer, radiator, cooling fans, fuel system, and all appurtenances complete as it would be installed in the field. The Contractor shall note and take appropriate action regarding the intended operation of the engine-generator sets while connected to motor driven loads controlled by variable frequency drives (VFDs).

### 2.03 ENGINE

- A. The engine shall be diesel, 4 cycle, radiator cooled, and shall be turbocharged having an operating speed of 1800 RPM. Engine shall operate on ASTM D-975 Grade No. 2D S15 ultra-low sulfur diesel fuel. Engines requiring any other fuel type are not acceptable.
- B. The engine will not be acceptable if the design is a conversion of a naturally aspirated engine to which a turbo-blower has been attached, unless the engine is certified by the

manufacturer as having been analyzed and redesigned with ample provisions for increased stresses and bearing or heat loads due to increased pressures and rate of heat liberation.

- C. Break mean effective pressure (BMEP) shall not exceed 320 psi at rated load. Brake Horsepower (BHP), and Engine-Generator efficiency shall conform with ASME, IEEE and NEMA standards that electrical energy delivered by the machine is within the minimum certified guaranteed fuel oil consumption rate and evidence that these parameters have been met shall be furnished.
- D. Only engine manufacturers' standard ratings shall be acceptable. No dealer special ratings will be acceptable.
- E. The specified standby kW rating shall be for continuous electrical service during interruption of the normal utility source, per NEMA standards.
- F. Engine speeds shall be governed by an electronic isochronous governor that will sense generator speed and provide accurate load transient correction capability at less than 0.5 percent regulation, from no load to full load generator output.

#### 2.04 ALTERNATOR

- A. The alternator shall conform with NEMA and IEEE standards and be rated as indicated on the Drawings. The alternator shall have a UL 2200 listing. The alternator shall be brushless, salient pole, 2/3 pole pitch and synchronous for operation at 240 VAC or 480 VAC, wye connected, as indicated on the Drawings. The generator shall be capable of delivering peak transient load at 125 SkVA (minimum) for a 240 VAC generator, or 200 SkVA for a 480 VAC generator, with an instantaneous voltage dip of no more than 20% voltage drop.
- B. Laminations and windings shall be designed for minimum reactance, low voltage waveform distortion and maximum efficiency.
- C. The main stator coils shall be random wound. Insulation shall be Class H, 125 degrees C rise according to NEMA standards. The insulation system shall be made of epoxies and polyesters which are inorganic compounds and shall prevent fungus growth.
- D. The rotor shall be dynamically balanced and include amortisseur windings to minimize voltage deviations and heating effects under unbalanced load conditions.
- E. Radio interference suppression (both directions) shall be provided in accordance with NEMA and IEEE Standards.
- F. The alternator shall have a brushless, permanent magnet generator (PMG) excitation support system to provide input to the automatic voltage regulator to enable the alternator to support 300% of rated current for 10 seconds to allow fault clearing.
- G. Waveform deviation shall not exceed 5% from true sine wave. The transient response from no load to full load in one step of the engine-generator set shall not exceed a voltage dip of 35%, a frequency dip of 20%, and shall recover to complete steady state performance within

12 seconds for both voltage and frequency. The transient response from full load to no load in one step shall not exceed a voltage overshoot of 7% and shall recover to steady state performance within 3 seconds. Transient performance shall be in accordance with ISO 8528.

- H. The Telephone Influence Factor (TIF) shall be less than 50.
- I. The voltage regulator shall be an adjustable, solid-state, three-phase RMS sensing, volts/hertz type. Voltage regulation shall be a minimum of  $\pm 0.25\%$  from no load to continuous rating. The voltage regulator shall provide  $\pm 10\%$  voltage adjustment. The voltage regulator shall be located within the engine control panel.
- J. An alternator mounted strip heater shall be furnished and installed as part of the system. The strip heater shall be energized to prevent condensation when the engine generator set is not running.

## 2.05 CONTROLS

- A. Engine-generator monitoring and controls shall be mounted in a single NEMA 1 (gasketed) dust-tight enclosure. A suitable accessible terminal strip having all wires properly identified shall be furnished within the enclosure. The control panel shall be mounted at a height of 4'-8" measured from the center of the panel to the equipment pad or enclosure floor.
- B. The control panel shall accept a dry contact input for engine starting from remote locations. The starting and stopping of the engine-generator set shall be initiated through the control panel only. When the engine starts, starting control shall automatically disconnect cranking controls. Four (4) cranking cycles of 10 seconds "ON", 10 seconds "OFF" shall be provided. The starting controls shall prevent re-cranking for a definite time after source voltage has been reduced to a low value, or the four (4) cranking cycles have been reached without a successful start. The automatic engine starting controls shall use industrial rated control type elements throughout, and controls shall have the capability to operate at 50% battery voltage.
- C. Speed sensing shall be provided to protect against accidental starter engagement with a moving flywheel. Battery charging alternation output voltage is not acceptable for this purpose.
- D. A generator/exciter field circuit breaker with shunt trip device shall be furnished and installed as part of the engine generator set. Shunt trip shall be activated upon engine-generator fault conditions.
- E. A main line circuit breaker as specified herein and sized as indicated on the Drawings shall be installed as a load circuit interrupting and protection device in a NEMA 4X (gasketed) dust-tight enclosure. The circuit breaker shall be provided with adjustable long-time, short-time, and instantaneous settings. The circuit breaker shall contain an electronic trip unit with ground fault. It shall operate both manually for normal operation and automatically for protection against overload or short circuits. Generator/exciter field circuit breakers are not acceptable for this service.



The circuit-breakers described above shall be manufactured and tested in accordance with U.L. and NEMA AB1 standards. Their interrupting rating shall be suitable for the available fault current. All electrical ratings shall be suitable for the application.

- F. Engine-generator monitoring and control shall be provided using a microprocessor based control panel complete with an LCD display. The devices necessary for automatic starting shall be on the engine and in the engine control panel. The following hardware (minimum) shall be provided on the front of the control panel; the use of the LCD display and keypad to accomplish the same function is not acceptable:
  - 1. Keyed engine control mode switch (Run-Off-Auto)
  - 2. Large, red emergency stop pushbutton
  - 3. Generator voltage adjust potentiometer
  - 4. Generator frequency adjust potentiometer
- G. The following parameters (minimum) shall be shown on the LCD display or otherwise be indicated at the control panel:
  - 1. Engine oil pressure
  - 2. Coolant temperature
  - 3. Generator output voltage
  - 4. Generator output current
  - 5. Generator elapsed run time
  - 6. Generator output frequency
  - 7. Engine run
  - 8. Engine fail
  - 9. Low coolant temperature
  - 10. Pre-high engine temperature
  - 11. Pre-low fuel level
  - 12. Engine speed (RPM)
  - 13. Battery voltage
- H. The following events (minimum) shall cause an immediate shutdown of the engine-generator set if it operating, or prevent starting if it is not operating. The specific event that

causes the shutdown/prevents starting shall be shown on the LCD display or otherwise be indicated at the control panel. A reset shall be required to clear the fault and allow the unit to operate:

1. Engine coolant high temperature
  2. Engine low oil pressure
  3. Low fuel level
  4. Engine overspeed
  5. Engine overcrank
  6. Engine tried to start but failed
  7. Low coolant level
- I. The generator control panel shall have a communication port capable of transmitting all available engine-generator set data via Modbus RTU protocol.
- J. The generator control panel shall have Form C dry contacts rated 5A (minimum) at 120VAC/24VDC for the following signals:
1. Engine coolant high temperature
  2. Engine low oil pressure
  3. Pre-low fuel level
  4. Low fuel level
  5. Engine overspeed
  6. Engine overcrank
  7. Engine tried to start but failed
  8. Low coolant level
  9. Engine fail
  10. Engine run

The normally closed (NC) contacts for all of the above signals (except engine run and Pre-low fuel level) shall be wired in series to provide a common "Generator System Failure" alarm for remote indication. Other contacts shall also be wired as a part of this alarm as specified elsewhere herein.

## 2.06 ENGINE ACCESSORIES

- A. Furnish and install the engine with all accessory equipment and appurtenances which are required for proper operation, including the following:
  - 1. Heavy duty dry type air filler with restriction indicator
  - 2. Heavy duty lubricating oil filter, bypass type, with replaceable absorbent-type elements
  - 3. Lubricating oil cooler, water cooled
  - 4. Heavy duty fuel oil filter, spin-on, with non-replaceable absorbent-type elements
  - 5. Fuel oil fuel/water separator
  - 6. Heavy duty crankcase vapor coalescer
  - 7. Radiator mounted fuel cooler to cool recirculated fuel before it is re-deposited into the fuel tank as recommended by the manufacturer.

## 2.07 MOUNTING

- A. Couple the engine and generator together through a flexible, non-backlash type, all metal coupling which overcomes all normal misalignment stresses and transmits full engine torque with ample safety factor. Also provide flexible connections for piping connections.

## 2.08 COOLING SYSTEM

- A. Provide a radiator manufactured of a non-corrosive material mounted on the engine. The radiator core shall be coated with a corrosion resistant coating. Corrosion resistant coating shall be a corrosion resistant baked phenolic coating or similar.
- B. Connect the radiator to the engine internal cooling system with flexible piping. Furnish appropriately sized coolant expansion tank for the cooling system.
- C. The engine shall be cooled through a radiator sized to continuously maintain safe operation at full load and at 105°F outside ambient air with 50% ethylene glycol coolant. A blower type fan and low noise fan drive and controls shall be furnished. The fan and all rotating members and drive belts shall be guarded and meet OSHA standards. Proof of 105°F ambient temperature capability shall be required.
- D. Coolant
  - 1. After the cooling system is flushed and cleaned, provide an initial fill of coolant consisting of 50% ethylene glycol. An anti-corrosion treatment shall be added during the initial fill.

2. The coolant shall meet the requirements of the generator manufacturer including corrosion inhibitors provided in the coolant to protect the engine cooling system.

## 2.09 ENGINE STARTING AND CHARGING SYSTEM

- A. Engine starting batteries shall be sealed, lead-acid type, rated 12 volts. Starting batteries shall have adequate capacity for rolling the engine for five (5), ten (10) second cycles without starting, and then operating the control devices in the local generator controls for two (2) hours. The batteries shall be mounted on a suitable non-corrosive rack. Batteries shall have battery cables with lugs and shall be provided with lugs for connection to the battery charger.
- B. Battery charger shall be a U.L. 1236 listed, automatic, solid-state battery charger, 20 A (min.) current limited,  $\pm 2\%$  voltage regulation,  $\pm 10\%$  line voltage variation, automatic float equalizing system, DC voltmeter, and DC ammeter. Provide a Form C unpowered (dry) contact to indicate a low battery alarm condition.
- C. In addition, the engine shall be provided with an engine battery charging alternator that automatically changes the starting batteries during engine operation.

## 2.10 EXHAUST SILENCER

- A. Furnish and install an exhaust silencer. Silencers shall be of critical type and sized to produce a high degree of silencing. Reference the sound attenuation requirements specified herein.
- B. Connect the silencer to the engine exhaust manifold with a high corrosion and temperature resistant stainless steel flexible convoluted exhaust pipe. Use flange-type connections. Provide a taper-cut tail pipe complete with rain cap to exhaust the gases to the atmosphere.
- C. The silencer (if installed inside), exhaust piping, and expansion fittings, including collector box, shall be completely covered with a removable insulation blanket in order to protect operating personnel and to reduce noise. Insulation shall be of composite fiberglass and stainless steel construction capable of withstanding 1200°F continuously. The insulation blankets shall be tailored and custom fabricated to fit the contours of the manifolds. Average weight of the insulating blanket shall be 1.5 psf. Insulation shall conform to MIL-1-16411D, Type II and shall be custom fabricated to fit the contours of the components.
- D. The silencer system shall be designed, furnished, and installed to prevent moisture and condensation from corroding the silencer. All exterior components of the exhaust system shall be of 316 stainless steel.
- E. Silencer shall be mounted within or exterior to the generator enclosure dependent on generator size and manufacturers standards. Silencers mounted on the outside of the enclosure shall be 316 stainless steel construction on its interior and exterior. Silencers mounted within the generator enclosure shall be painted steel and insulated using a calcium silicate material covered by a brushed aluminum skin.

## 2.11 WIRING

- A. Furnish and install internal wiring in the engine-generator set. All internal wiring between the generator and engine-generator control panel, and all accessories shall be provided.

## 2.12 NOT USED

## 2.13 BASE MOUNTED FUEL TANK

- A. The generator set shall be supplied with a U.L.-142 listed base mounted fuel tank of sufficient capacity to operate the engine-generator set at full load for a minimum of 24 hours. The tank, painted in a color as selected by the Owner, shall be fabricated from steel with a rupture basin and leak detector system. The alarm and indicator for the leak detection shall be mounted adjacent to the generator control panel and a contact for remote indication of a fuel leak condition shall be provided. This contact shall be wired as part of a common "Generator System Failure" alarm.
- B. A level device shall also be furnished and installed to provide a local (generator control panel) and remote indication of pre-low fuel tank level and low fuel tank level. The pre-low fuel tank level shall activate a set of dry contacts for remote alarm indication. The low fuel tank level alarm shall shut down the engine to prevent the fuel level from dropping below the fuel pickup piping in the fuel tank. The pre-low fuel level alarm shall activate when only 6 hours of fuel for full load operation remains in the fuel tank. The remote low fuel tank level alarm shall be wired separate from the "Generator System Failure" alarm.
- C. The tank shall be supplied with all necessary fuel supply, return, vent, and fill fittings and a fuel level gauge. The lockable fill port and level gauge shall be easily accessible from outside the enclosure. Provide a valve that automatically closes the fuel fill inlet when the tank level reaches 95% of its capacity. The vent line shall be piped to the outside and be equipped with a fill whistle.
- D. The underside of the tank shall not be in contact with the mounting surface (concrete pad).

## 2.14 WEATHERPROOF ENGINE - GENERATOR ENCLOSURE

- A. Furnish and install an outdoor, weather-protective housing. The housing shall be furnished complete with a full sub-base floor resulting in complete enclosure. The enclosure shall be factory-assembled to the engine-generator set base and radiator cowling. Lifting eyes shall be provided. Housing shall provide ample airflow for generator set operation. The housing shall be constructed of 12 gauge (minimum) aluminum or 14 gauge (minimum) galvanized steel, reinforced to be vibration free in the operating mode. The housing shall have hinged side-access doors and rear control panel access door. Each door shall have at least two latch-bearing points. All doors shall be lockable. All steel sheet metal shall be primed for corrosion protection and finish painted in a color as selected by the Owner. Roof shall be peaked to allow drainage of rain water. Unit shall have sufficient guards to prevent entrance by small animals. Batteries shall fit inside enclosure and alongside the engine (batteries under the generator are not acceptable). Unit shall have engine coolant and oil drains piped to outside the unit to facilitate maintenance. Each drain line shall have a valve located near the fluid source.

- B. A "Skin-tight" housing shall be provided. No walk-around access is required within the enclosure; however, adequate working clearance shall be provided as required by the NEC. Alternatively, access doors may be provided so that when opened, adequate working clearance is achieved in front of electrical equipment.
- C. Enclosure shall be sound attenuated to provide sound level as specified herein.
- D. Not Used.
- E. All hardware (nuts, bolts, screws, washers, etc.) that is installed on the exterior of the generator enclosure shall be stainless steel. Galvanized steel hardware is not acceptable.
- F. Not Used
- G. Not Used
- H. Not Used
- I. Conduit and wire shall be in accordance with Sections 16111 and 16123, respectively.
- J. All air intake louvers shall be furnished with rain guards or designed to eliminate water intrusion to the interior of the enclosure when the generator is operating at full load (maximum airflow) during rain events.

#### 2.15 SOUND ATTENUATION

- A. Extreme care shall be exercised in providing equipment for and setting the engine-generator in place to guard against excessive noise transmission and vibrations. Fasten to the underside of the skids seismically-rated spring type isolators.
- B. The engine-generator enclosure shall be designed, furnished, and installed to reduce source noise to 78 dB(A) as measured at seven (7) meters from the enclosure.

#### 2.16 NOT USED

#### 2.17 NOT USED

#### 2.18 NOT USED

#### 2.19 NOT USED

#### 2.20 NOT USED

#### 2.21 NOT USED

#### 2.22 NOT USED

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

- A. The standby generator system shall be furnished and installed as indicated on the Drawings and as recommended by the equipment manufacturer.
- B. The initial filling of the fuel storage tank shall be provided by the Contractor. Fuel tank shall be filled to its full capacity. At the conclusion of all field testing, the Contractor shall fill the fuel storage tank back to its full capacity. Fuel shall be ultra-low sulfur diesel Grade No. 2D S15 in accordance with ASTM D-975. Fuel shall be new and free from contaminants and water.

### 3.02 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified generator manufacturer's factory-trained technical representative who shall adequately supervise the installation and of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform all startup and field testing of the generator assembly as specified herein.
- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of four (4) hours each. Training shall not take place until after the generator has been installed and tested. Training shall be conducted at times coordinated with the Owner and shall occur during the same week as the training specified in Section 16426 – Low Voltage Switchboard.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
  - 1. One (1) trip of two (2) working days during installation of the engine-generator set.
  - 2. One (1) trip of one (1) working day to perform startup of the engine-generator set.
  - 3. One (1) trip of two (2) working days to perform the field testing of the engine-generator set.
  - 4. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

### 3.03 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

- a. The engine-generator set(s) specified in this Section shall be witness shop tested and inspected in accordance with the equipment manufacturer's standard procedures and the certified shop testing described below. The testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to such tests and inspection dates.

2. Certified Shop Tests

- a. Fully test the engine-generator set with all accessories in the manufacturer's plant before shipment. Tests shall be conducted through the use of balanced, three-phase, dry-type, resistive load banks.
- b. Record complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, and oil pressure.
- c. The manufacturer shall conduct a shop test run of at least six (6) consecutive hours for the set under the following conditions of load, in the following order:
- 3 hours - full load
  - 1 hour - 3/4 load
  - 1 hour - 1/2 load
  - 1 hour - 1/4 load
- d. Fuel, lubricants, and other fluids as required for the shop tests shall be furnished by the manufacturer.

2. Field Tests

- a. Field tests shall be performed by the generator manufacturer's technical representative. The Contractor shall obtain from the manufacturer and submit a detailed field test plan and procedures documenting the intended field test program.
- b. In the presence of the Engineer and Owner, the representative shall inspect, adjust, and test the entire system after installation and leave in good working order. Field tests specific to each generator shall be conducted after the entire engine-generator system is installed including, but not limited to, the following: diesel fuel tanks including leak detection, exhaust silencer, radiators, enclosures, batteries, and all other equipment included in the



complete system.

- c. Field test the generator enclosure to ensure the enclosure performs as specified herein. The generator enclosure field tests shall include water tests to confirm the enclosure does not leak and that the air intake louvers eliminate water intrusion to the interior of the generator enclosure when the generator is operating at its full load capacity (maximum airflow). A garden hose shall be used to simulate falling rain for this test. Water supply and garden hose will be provided by the Owner for this test.
- d. Field test, as far as practicable, all control, shutdown, and alarm circuits. Document the successful completion of these tests as witnessed by the Owner and the Engineer.
- e. Generator load tests shall be conducted through the use of balanced, three-phase, dry-type, reactive (0.8 power factor) load banks. Conduct a continuous run test using the load bank without shutdown for the engine-generator set under the following load conditions (in this specific order) and in the presence of the Owner and Engineer:
  - 5 hours, full load
  - 1 hour, 3/4 load
  - 1 hour, 1/2 load
  - 1 hour, 1/4 load

Record complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, and oil pressure every 15 minutes during the continuous run test. If any failures, malfunctions, and/or shutdowns occur during this test, the problems shall be fixed and the test shall be restarted. The test shall not be considered complete until the generator has operated for eight (8) consecutive hours without any shutdowns under the conditions listed above.

- f. After successful completion of the load bank tests, the generator system shall then be operated for a minimum of four (4) hours with plant loads during a time period when the plant is operating at average demand. The same data shall be recorded at 15 minute intervals for this load test as for the load bank test.
- h. Demonstrate the system will transfer properly with generator operating.
- i. The Contractor shall collect a sample of engine oil from each engine for analysis after the start-up and testing has been completed. The sampling method shall be of the atomic absorption spectrophotometry method and be accurate to within a fraction of one part per million for the following elements:
  - Iron
  - Chromium

- Copper
- Aluminum
- Silicon
- Lead

The sample shall also be tested for the presence of water, fuel dilution, and coolant.

The oil samples shall be analyzed at an independent laboratory that is not a part of the engine supplier's facility. Immediate notification of critical results shall be provided to the Owner when the analysis shows any critical reading.

- j. All fuel, lubricants, and other fluids required to complete all field tests shall be paid for by the Contractor.

### 3.04 PAINTING

- A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

- END OF SECTION -

## SECTION 16902

### ELECTRIC CONTROLS AND RELAYS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.
- B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.
- C. Reference Section 16000, Basic Electrical Requirements and Section 16195, Electrical Identification.

##### 1.02 CODES AND STANDARDS

- A. Products specified herein shall be in conformance with or listed to the following standards as applicable:
  - 1. NEMA 250 – Enclosures for Electrical Equipment
  - 2. UL 508A – Standard for Industrial Control Panels
  - 3. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
  - 4. ANSI/ISA 12.12.01-2013 – Nonincendive Electrical Equipment for use in Class I and II, Division II Hazardous (Classified) locations.

##### 1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
  - 1. Shop Drawings
  - 2. Spare Parts List
- B. Each submittal shall be identified by the applicable specification section.

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#### 1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
  - 1. Product data sheets.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

#### 1.05 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

### PART 2 -- PRODUCTS

#### 2.01 CONTROL COMPONENTS

- A. Manufacturers
  - 1. Unless otherwise specified, control components shall be manufactured by Eaton, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

## B. Pilot Devices

### 1. General

- a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (i.e. HAND-OFF-AUTO, RUN, FAULT, etc).
- b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.
- c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.
- d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.
- e. In Class 1 Division 2 hazardous locations, pilot devices shall be the hermetically-sealed type, constructed in accordance with ANSI/ISA 12.12.01.

### 2. Pushbuttons

- a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.
- b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
- c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.

### 3. Selector Switches

- a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as required. Handles shall be the extended type that provide a greater surface area for operation.

- b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
  - c. Where indicated in the Drawings or Specifications, provide spring return positions.
  - d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.
4. Indicating Lights
- a. Indicating lights shall LED type, with the proper voltage rating to suit the application, and push-to-test feature.
  - b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:
    - i. Blue - "Auto"
    - ii. Green - "Run", "On", "Open"
    - iii. Red - "Alarm", "Fail"
    - iv. White - "Control Power On"
5. Emergency Stop and Tagline Switches
- a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.
  - b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.
  - c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

C. Relays and Timers

1. General

- a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.
- b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.
- c. Relays shall be single pole, double throw (SPDT) and manufactured by IDEC, Potter Brumfield, or Allen Bradley; no substitutions allowed.

2. Control and Pilot Relays

- a. Miniature or "ice-cube" type relays are not acceptable.
- b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
- c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC.

3. Time Delay Relays

- a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.
- b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
- c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC.
- d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.

4. Elapsed Time Meters

- a. Elapsed time meters shall be non-resettable type with no less than a 4 digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.

D. Control Terminal Blocks

- 1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size

range of #22 - #8 AWG.

2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (i.e. 120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.
3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.
4. Terminal Blocks shall be manufactured by M-Systems, Wago, Wilkerson, or Allen Bradley; no substitutions allowed.

## 2.02 LOCAL CONTROL STATIONS

- A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.
- B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.
- C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

| AREA DESIGNATION                             | ENCLOSURE TYPE AND MATERIAL                    |
|----------------------------------------------|------------------------------------------------|
| Indoor Wet Process Area                      | NEMA 4X, Type 304 Stainless Steel              |
| Indoor Dry Process Area                      | NEMA 12, Die Cast Zinc                         |
| Indoor Dry Non-process Area                  | NEMA 12, Die Cast Zinc                         |
| Indoor Type 1 Chemical Storage/Transfer Area | NEMA 4X, Fiberglass or Thermoplastic Polyester |
| Indoor Type 2 Chemical Storage/Transfer Area | NEMA 4X, Type 304 Stainless Steel              |
| All Outdoor Areas                            | NEMA 4X, Type 304 Stainless Steel              |

- D. In hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.



| AREA CLASSIFICATION          | ENCLOSURE TYPE AND MATERIAL       |
|------------------------------|-----------------------------------|
| Class 1, Division 1, Group D | NEMA 7, Die Cast Aluminum         |
| Class 1, Division 2, Group D | NEMA 4X, Type 304 Stainless Steel |
| Class 2, Division 1, Group F | NEMA 9, Die Cast Aluminum         |
| Class 2, Division 2, Group F | NEMA 9, Die Cast Aluminum         |

- E. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure.
- F. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class 1 Division 1 and Class 2 Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class 1 Division 2 hazardous locations shall be in accordance with ANSI/ISA 12.12.01-2013.
- G. Provide a nameplate on each local control station in accordance with Section 16195, Electrical Identification. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words "LOCAL CONTROL STATION".

### PART 3 -- EXECUTION

#### 3.01 INSTALLATION

- A. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- B. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.
- C. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The bonding screw shall be bonded to the equipment enclosure through the use of an insulated green bonding conductor.
- D. Local control station covers shall be bonded to the local control station enclosure through the use of an insulated green bonding conductor.
- E. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.

Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors.

- END OF SECTION -

## SECTION 17000

### CONTROL AND INFORMATION SYSTEM SCOPE AND GENERAL REQUIREMENTS

#### PART 1 – GENERAL

##### 1.01 SCOPE

- A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, components, system installation services, as well as required and specified ancillary services in connection with the Instrumentation, Control and Information System.
- B. The System includes materials, labor, tools, fees, charges, and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system.
- C. The system shall include measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, remote telemetry units, signal and data transmission systems, interconnecting wiring, and pertinent accessories.
- D. The scope of the work to be performed under this Division includes but is not limited to the following:
  - 1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
  - 2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
  - 3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17.
  - 4. Furnish and install digital control system hardware and software as specified in Division 17.
  - 5. Final termination and testing of instrumentation and control system signal wiring and power supply wiring at equipment furnished under Division 17.
  - 6. Furnish, install and terminate special cables for devices (e.g., instruments, printers, radios). Furnish and terminate control system communication network cables.
  - 7. Furnish and install surge protection devices for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16.

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8. Coordinate grounding requirements with the electrical subcontractor for digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division. Terminate grounding system cables at equipment provided under this Division.
  9. Provide system testing, calibration, training and startup services as specified herein and as required to make systems fully operational.
- E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

#### 1.02 RELATED ITEMS

- A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls, and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested, and calibrated as specified under other Divisions unless otherwise indicated.
- B. Additional and related work performed under Division 16 includes the following:
1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for equipment, control panels and accessories furnished under Division 17.
  2. Conduit and raceways for instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.
  3. Instrumentation and control system signal wiring.
  4. Install control system communication network cables.
  5. Furnish and install grounding systems for digital equipment, local control panels, remote telemetry units, and instrumentation provided under Division 17. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.
  6. Termination of instrumentation and control system signal wiring at equipment furnished under other divisions of the Specifications.
  7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g., panelboards, motor control centers, and other sources of electrical power).

#### 1.03 GENERAL INFORMATION AND DESCRIPTION

- A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.

- B. In order to centralize responsibility, it is required that equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating signals, and furnishing appurtenant equipment.
- C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment/systems and shall provide for the services of a qualified installation engineer to supervise activities required to place the completed facility in stable operation under full digital control.
- D. The instrumentation and control system shall be capable of simultaneously implementing all real time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of other system components.
- E. Control system inputs and outputs are listed in Section 17920 – Control System Input/Output Schedule. This information, together with the functional control descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.
- F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect equipment, panels, instrumentation, controls, and appurtenances, either existing or furnished on the Project to determine requirements for interfacing with the control and information system. The Contractor shall coordinate the completion of required modifications with the associated supplier of the item furnished.
- G. The instrumentation subcontractor shall review and approve the size and routing of instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.
- H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.

- I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.
- J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to observe materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records, and certifications during all stages of design, fabrication, and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies, and services required for these observation activities.
- K. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as equipment, labor, services, and documents necessary to meet the intent of the Specifications.

#### 1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

- A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater treatment facilities and remote telemetry systems for wastewater collection systems. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers/models of major hardware or software products (PLC, HMI software, network, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.
- B. Acceptable instrumentation and control system subcontractors shall be Tesco Inc., or equal.

#### 1.05 DEFINITIONS

- A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.
- B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.

- C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
- D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.
- E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.
- F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (\text{MTBF} / (\text{MTBF} + \text{MTTR})) \text{ Percent}$$

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A2 + 1 - ((1 - A1) * (1 - A1))$$

where:

A1 = availability of non-redundant device or system

A2 = availability of device or system provided with an automatically switched backup device or system

- G. Abbreviations: Specification abbreviations include the following:
  - 1. A - Availability
  - 2. ADC - Analog to Digital Converter
  - 3. AI - Analog Input
  - 4. AO - Analog Output
  - 5. AVAIL - Available
  - 6. BCD - Binary Coded Decimal
  - 7. CSMA/CD - Carrier Sense Multiple Access/Collision Detect
  - 8. CPU - Central Processing Unit
  - 9. CRC - Cyclic Redundancy Check
  - 10. CS - Control Strategy

11. DAC - Digital to Analog Converter
12. DBMS - Data Base Management System
13. DI - Discrete Input
14. DMA - Direct Memory Access
15. DO - Discrete Output
16. DPDT - Double Pole, Double Throw
17. DVE - Digital to Video Electronics
18. EPROM - Erasable, Programmable Read Only Memory
19. FDM - Frequency Division Multiplexing
20. FSK - Frequency Shift Keyed
21. HMI - Human Machine Interface (Software)
22. I/O - Input/Output
23. LAN - Local Area Network
24. LCD – Liquid Crystal Display
25. LDFW - Lead Follow
26. MCC - Motor Control Center
27. MTBF - Mean Time Between Failures
28. MTTR - Mean Time To Repair
29. OS - Operating System
30. PAC - Programmable Automation Controller
31. PCB - Printed Circuit Board
32. PID - Proportional Integral and Derivative Control
33. PLC - Programmable Logic Controller or Programmable Controller
34. PROM - Programmable Read Only Memory
35. RAM - Random Access Memory
36. RDY - Ready



- 37. RMSS - Root Mean Square Summation
- 38. RNG - Running
- 39. ROM - Read Only Memory
- 40. RTU - Remote Telemetry Unit
- 41. SPDT - Single Pole, Double Throw
- 42. ST/SP - Start/Stop
- 43. TDM - Time Division Multiplexing
- 44. UPS - Uninterruptible Power Supply
- 45. VFD – Variable Frequency Drive

- H. To minimize the number of characters in words used in textual descriptions on displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

#### 1.06 ENVIRONMENTAL CONDITIONS

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (e.g., dust).
- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

## PART 2 – PRODUCTS

(NOT USED)

## PART 3 – EXECUTION

### 3.01 SCHEDULE OF PAYMENT

- A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System.
- B. The following payment schedule defines project milestones that will be used for establishing maximum partial payment amounts for the Control and Information System. Payment for field instruments, field wiring, fiber optic network cable and similar items will be made in addition to the payment for the scopes of services incorporated into the schedule below.
  - 1. Task Completed - Maximum Cumulative % Request for Payment
    - a. Mobilization - 3%
    - b. Preliminary Design Review - 5%
    - c. Approved Submittals - 20%
    - d. Hardware Purchase (excludes field instruments) - 40%
    - e. Factory Acceptance Test - 60%
    - f. Loop Checkout - 70%
    - g. Control System Start-up and Test - 80%
    - h. Plant Start-up - 90%
    - i. Final System Acceptance Test - 95%
    - j. Final Acceptance - 100%
- C. Requests for payment for materials and equipment that are not installed on site, but are required for system construction and the factory acceptance test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.
- D. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

### 3.02 CLEANING

- A. The Contractor shall thoroughly clean soiled surfaces of installed equipment and materials.
- B. Upon completion of the instrumentation and control work, the Contractor shall remove surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

### 3.03 FINAL ACCEPTANCE

- A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:
  - 1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.
  - 2. Completion of the Availability Demonstration.
  - 3. Completion of control system training requirements.
  - 4. Completion of punch-list items that are significant in the opinion of the Engineer.
- B. Final acceptance of the System shall mark the beginning of the warranty period.

- END OF SECTION -

## SECTION 17030

### CONTROL AND INFORMATION SYSTEM SUBMITTALS

#### PART 1 – GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall submit for review complete Shop Drawings for all equipment in accordance with the General Conditions and Division 1 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.
- B. All submittal materials shall be tailored to this project by highlighting relevant items or crossing out non-applicable items. Generic submittals without identified options will be returned the Contractor without review.
- C. Compliance, Deviations, and Exceptions (CD&E) Letter:
  - 1. Where a named manufacturer and product is specified and a substitution or an “or equal” product is submitted, the submittal shall be accompanied by a “Compliance, Deviations, and Exceptions (CD&E) letter.” If the required submittal is submitted without the letter, the submittal will be rejected.
  - 2. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor, subcontractor (if applicable), and the equipment Manufacturer/Supplier. This letter shall include a copy of the Specification Section to which the submittal pertains. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in.
    - a. The letter "C" shall be for full compliance with the requirement.
    - b. The letter "D" shall be for a deviation from the requirement.
    - c. The letter "E" shall be for taking exception to a requirement.
  - 3. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions shall not be acceptable.
  - 4. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals
- B. Section 17000 – Control and Information System Scope and General Requirements

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### 1.03 DIGITAL HARDWARE SUBMITTALS

- A. Submit system block diagram(s) showing:
  - 1. All equipment to be provided.
  - 2. All interconnecting cable.
  - 3. Equipment names, manufacturer, and model numbers.
  - 4. Equipment locations.
- B. Submit information for all digital equipment including, but not limited to, the following:
  - 1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
  - 2. Catalog cuts, including complete part number breakdown information.
  - 3. Complete technical, material and environmental specifications.
  - 4. Assembly drawings.
  - 5. Mounting requirements.
  - 6. Color samples.
  - 7. Nameplates.
  - 8. Environmental requirements during storage and operation.

### 1.04 SOFTWARE SUBMITTALS

- A. Software submittals shall include the following as a minimum:
  - 1. Bill of materials with software names, vendors, and complete listings of included software modules.
  - 2. Standard manufacturer's literature describing the products.
  - 3. Description of function of software in Control and Information System.
  - 4. Limitations or constraints of software.
  - 5. Minimum system (processor and memory) requirements.
  - 6. Operation and maintenance requirements.
- B. Submit information on the following software:
  - 1. Third-party software, including:

- a. Operating system.
  - b. Operator workstation (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).
  - c. Office-type products, such as spreadsheets, word processors, etc.
  - d. Database management software.
  - e. Communication software, including all applicable local and wide area network software.
  - f. Programmable controller programming software (where applicable).
2. Software configuration, including:
- a. Graphic display organization.
  - b. Database configuration for operator workstations and database management system.
  - c. Trends.
  - d. System security.
  - e. Formats for all reports, including all required calculations.
  - f. Intercommunications between software products required to implement system functions.
  - g. Equipment backup configuration and requirements.

C. Programming Methodology Submittal

- 1. Standard PLC programming logic, with comments, for
  - a. “Across-the-line” motor
  - b. Variable speed motor
  - c. Open/close valve
  - d. Modulating valve
  - e. Lead/lag sequencing
  - f. Operator mode/stage selection with auto alternate
- 2. Internal PLC task/routine layout, per PLC if not standardized

3. Standard PLC tag name structure

D. Control Strategies

1. Description of automatic logic and all non-standard manual logic using plain English, for non-technical persons, and written in Contractor's own words. The write-up shall include references to associated I/O, tag/loop numbers, alarming/interlocks.
2. Submitting language verbatim to Section 17950, Functional Control Descriptions, shall not be acceptable.

E. Application Software

1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

F. Graphic Displays

1. Submit all graphic displays required to perform the control and operator interface functions specified herein. Submitted graphic displays shall be for both new and modified graphics.
2. Submit the complete set of graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.
3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters, and is intended to allow the Contractor to obtain preliminary approval of these features and parameters prior to beginning main graphic display production.
4. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.
5. The required submittals in each revision cycle shall be full color prints of the entire set of displays.
6. Displays shall be printouts of actual process graphics implemented in the system.

7. The Contractor shall coordinate workshops to review graphical displays with the Engineer and Owner per Section 17240.

#### 1.05 CONTROL PANEL SUBMITTALS

- A. Submittals shall be provided for all control panels, and shall include:
  1. Exterior panel drawings with front and side views, to scale.
  2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.
  3. Panel area reserved for cable access and conduit entry.
  4. Location plans showing each panel in its assigned location.
- B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:
  1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
  2. Catalog cuts, including complete part number breakdown information.
  3. Complete technical, material and environmental specifications.
  4. Assembly drawings.
  5. Mounting requirements.
  6. Color samples.
  7. Nameplates.
  8. Environmental requirements during storage and operation.
- C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

#### 1.06 INSTRUMENT SUBMITTALS

- A. Submit information on all field instruments, including but not limited to the following:
  1. Relevant Specification Section and Contract Drawing numbers.
  2. Product (item) name and tag number used herein and on the Contract Drawings.
  3. Catalog cuts, including complete part number breakdown information.
  4. Manufacturer's complete model number.



5. Location of the device.
6. Input output characteristics.
7. Range, size, and graduations.
8. Physical size with dimensions, NEMA enclosure classification, and mounting details.
9. Materials of construction of all enclosures, wetted parts and major components.
10. Instrument or control device sizing calculations where applicable.
11. Certified calibration data on all flow metering devices.
12. Environmental requirements during storage and operation.
13. Associated surge protection devices.
14. Installation drawings/details.

#### 1.07 WIRING AND LOOP DIAGRAMS

- A. Submit as-built drawings showing the location of all equipment.
- B. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.
- C. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.
- D. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3, Minimum Required Items.
- E. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.
- F. Loop drawings shall be submitted as hardcopies (3) and AutoCAD electric copies.

#### 1.08 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01300, Submittals. Operation and maintenance (O&M) manuals shall consist of two basic parts:

1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.
  2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
- B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.
- C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.
1. A comprehensive index.
  2. A functional description of the entire system, with references to drawings and instructions.
  3. A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
  4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
  5. Full specifications on each item.
  6. Detailed service, maintenance, and operation instructions for each item supplied.
  7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
  8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
  9. References to manufacturers' standard literature where applicable.
  10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

- D. The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.
- E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.
- F. The hardware maintenance documentation shall include, as a minimum, the following information:
  - 1. Operation Information: This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.
  - 2. Preventive Maintenance Instructions: These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.
  - 3. Corrective Maintenance Instructions: These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
  - 4. Parts Information: This information shall include the identification of each replaceable or field repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross references between equipment numbers and manufacturer's part numbers shall be provided.
- G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:
  - 1. A program abstract that includes:
    - a. Program Name The symbolic alphanumeric program name.
    - b. Program Title English text identification.
    - c. Program Synopsis A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by non-programming-oriented readers.

2. A program description that shall include, but not be limited to, the following:
  - a. Applicable Documents List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.
  - b. Input Output Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.
  - c. Processing This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.
  - d. System Configuration Describe in detail the system configuration or status required for program implementation, if appropriate.
  - e. Limitations and Constraints Summarize all known or anticipated limitations of the program, if appropriate.
  - f. Storage Define program storage requirements in terms of disk or RAM memory allocation.
  - g. Verification Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.
  - h. Diagnostics Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.
  - i. Malfunction Procedures Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.
3. The O&M manuals shall be structured to develop increasing levels of detail.
4. O&M manuals shall include the complete documentation and annotation of every PLC program.

#### 1.09 FINAL SYSTEM DOCUMENTATION

- A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.
- B. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected to describe final "as built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.
- C. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built software configurations.
- D. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- E. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.
- F. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.
- G. The Owner recognizes the fact that not all possible problems related to real time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

#### 1.10 PROGRAMS AND SOURCE LISTINGS

- A. Provide one copy of all standard, off-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.
- B. Provide one copy of source listings on digital media, acceptable to Engineer, for all custom software/logic written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

- C. All software/logic shall be in both its native format and in Adobe Portable Document Format.

#### 1.11 SUBMITTAL/DOCUMENTATION FORMAT

- A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.
- B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in searchable Adobe Portable Document Format (PDF). Raster scans will not be accepted.

#### 1.12 ELECTRONIC O&M MANUALS

- A. The Contractor shall submit six (6) hardcopies and three (3) electric copies or all finalized O&M materials. Subject to acceptance by the Engineer, draft the O&M information may be submitted in part or in whole in an electronic format on digital media.
- B. Electronic O&M manuals shall contain information in standard formats (searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible using standard, "off-the-shelf" software such as an Internet browser. Raster scans will not be accepted.

### PART 2 – PRODUCTS (NOT USED)

### PART 3 – EXECUTION (NOT USED)

- END OF SECTION -

## SECTION 17040

### CONTROL AND INFORMATION SYSTEM TRAINING REQUIREMENTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements

##### 1.03 SUBMITTALS

- A. A minimum of 60 days prior to beginning training, submit a detailed training plan describing the following:
  - 1. A listing of all courses to be conducted.
  - 2. Course content.
  - 3. Applicability of each course to management, operations, maintenance, laboratory, etc., personnel.
  - 4. Course schedules.
  - 5. Qualifications and experience of individual(s) providing training.
- B. A minimum of 14 days prior to beginning each training course, submit documentation for use by the Owner's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:
  - 1. A listing of all subjects to be covered.
  - 2. Course schedule.
  - 3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

##### 1.04 GENERAL REQUIREMENTS

- A. All costs of providing the training courses shall be borne by the Contractor.

- B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five-day, 40-hour week.
  - C. Training courses, especially those for operator training, may be required to be scheduled during non-standard business hours (i.e., not between the hours of 8:00 am and 5:00 pm) to accommodate the working schedule of the Owner's personnel. No additional compensation will be awarded to the Contractor for training at non-standard hours.
  - D. All training courses shall complement the experience and skill levels of the Owner's personnel.
  - E. Training courses shall be structured in order of increasing capability. The purpose of this requirement is to allow personnel with lesser training requirements drop out of the training at certain times while the training continues for personnel with greater requirements.
  - F. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Contractor shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor demonstrates system functions shall not be acceptable.
  - G. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.
  - H. All training shall be completed prior to system acceptance.
  - I. Standard manufacturer training courses are acceptable pending approval by the Engineer and Owner.
- 1.05 SYSTEM SUPERVISOR/ENGINEER TRAINING
- A. Provide manufacturer standard training in the use and configuration of the specified operator workstation (HMI or SCADA) software.
  - B. System supervisor/engineer training shall be performed a minimum of 30 days prior to system startup.
  - C. Training shall be provided in the following subjects:
    - 1. System overview and capabilities.
    - 2. Database configuration.
    - 3. Graphic display configuration, including linking of data to displays.
    - 4. Historical data configuration (collection, manipulation, and display).
    - 5. Real-time and historical trending.



6. Report configuration, generation, printing, and customization.
7. Alarm configuration and management.
8. System security.
9. I/O driver use and configuration.
10. System backup and recovery.
11. DDE linking, where applicable.
12. System command language.
13. Troubleshooting.
14. System optimization.
15. System startup and shutdown procedures.
16. LAN and WAN communications, as appropriate.

D. The course shall be structured as follows:

1. Fundamentals - Two one-day courses (minimum) shall be provided which shall serve as a digital control system familiarization course for project management personnel, engineers, and key operating/maintenance personnel. This course shall be a prerequisite for the advanced course described below in Item 2.
2. Advanced - Two one-day (minimum) digital system configuration and operating course shall be provided. The level of training shall be sufficient to familiarize the Owner's personnel with the configuration and application of all system programs. All essential system operating procedures shall be described as required to enable the Owner's personnel to operate the system via the various workstations and local control panels.
3. Historical – Two one-day courses to instruct in the use and configuration of the historical data archival system. Training shall include creation, viewing, and printing of trends, charts, and reports. Training shall include all database maintenance and archival functions necessary to maintain the facility's data on both short and long term basis, including periodic archival to optical media.

#### 1.06 OPERATOR TRAINING

- A. Two two-day courses comprised of daily half-day (four-hour) sessions for up to ten persons each shall be conducted to provide instruction in the use of the Control and Information System to monitor and control the facility.

- B. Operator training shall include familiarization training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.
- C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.
- D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

#### 1.07 MAINTENANCE TRAINING

- A. A one-day course shall be conducted prior to the start-up of digital equipment at the Owner's plant. Instruction shall be provided in the following:
  - 1. Operating all digital equipment, including system start-up and shutdown procedures.
  - 2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules.
  - 3. Calibration and routine maintenance procedures for all analog and digital equipment.
- B. Step by step written procedures shall be provided for all preventive maintenance tasks and for identifying hardware faults to the circuit board or module level for all items of digital equipment.
- C. All digital equipment preventive and corrective maintenance training activities shall be limited to the use of commercially available off-the-shelf test equipment and to the use of diagnostic routines and hardware items which are the same as those to be provided as part of the system.

#### 1.08 INSTRUMENT TRAINING

- A. A one-day course shall be provided at the Owner's facilities no more than three months prior to system start-up to in the calibration and preventive maintenance of the field instruments provided under this Contract.

#### 1.09 GENERAL REFRESHER TRAINING

- A. A one-week general refresher training course shall be provided for up to ten persons 3-6 months after final system acceptance. Instruction shall be given in all aspects of the complete instrumentation and control system. Instructor(s) shall be capable of answering questions related to all aspects and details of the complete system.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 17050

### TOOLS, SUPPLIES AND SPARE PARTS - GENERAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall provide tools, supplies, and spare parts as specified herein for the operation and maintenance of the Control and Information System.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 – Submittals
- B. Section 17000 – Control and Information System Scope and General Requirements

#### PART 2 -- PRODUCTS

##### 2.01 TOOLS

- A. Provide special tools, other than those normally found in an electronic technician's tool box, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance. This shall include, but not be limited to, the following: connector pin insertion and removal tools, wire crimping tools, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.
- B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Division.

##### 2.02 SUPPLIES

- A. The Contractor shall provide supplies as specifically required in other Sections of Division 17

##### 2.03 SPARE PARTS

- A. Provide spare parts for items of control and instrumentation equipment as recommended by the manufacturer and in accordance with the Contract Documents.
- B. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.

- C. The Contractor shall replace all spare parts consumed during installation, testing, start-up, the system availability demonstration, and the guarantee period.
- D. Refer to individual digital hardware and instrument sections for additional requirements specific to those devices.

### PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 17060

### SIGNAL COORDINATION REQUIREMENTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall conform to the signal coordination requirements specified herein.
- B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor and the instrumentation subcontractor.
- C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLCs and Control System PLCs.
- D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLCs, the Control System, etc.

##### 1.02 ANALOG SIGNAL TRANSMISSION

- A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 12/24 VDC.
- B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
- C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.
- D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.
- E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliamperes signal.
- F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.

- G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.
- H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

#### 1.03 DISCRETE INPUTS

- A. All discrete inputs to equipment and Control and Information System PLCs, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLCs, unless specified otherwise.
- B. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.

#### 1.04 DISCRETE OUTPUTS

- A. All discrete outputs from local control panels and Control and Information System PLCs to field devices, starters, panels, etc., shall be 12/24 VDC powered (sourced) from PLC's.
- B. PLC powered discrete outputs shall energize 24 VDC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The 24 VDC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.
- C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.
- D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

#### 1.05 OTHER DISCRETE SIGNALS

- A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.
- B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

- C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.
- D. The above requirements shall apply to all starters and panels, regardless of supplier.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -



## SECTION 17070

### CONTROL AND INFORMATION SYSTEM TESTING - GENERAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17071 – Factory Acceptance Test
- C. Section 17072 – Field Testing
- D. Section 17073 – Final Acceptance Test

##### 1.03 SUBMITTALS

- A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:
  - 1. A schedule of all testing to be conducted.
  - 2. A brief description of the testing to be performed
  - 3. Test objectives.
  - 4. Testing criteria per the Specifications.
  - 5. Check lists and procedures for performing each of the specified tests.
  - 6. Sample test result documentation.
  - 7. Requirements for other parties.

##### 1.04 GENERAL REQUIREMENTS

- A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

- B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.
- C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.
- D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.
- E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17071  
FACTORY ACCEPTANCE TEST

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall perform a Factory Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17070 – Control and Information System Testing, General
- C. Section 17072 – Field Testing
- D. Section 17073 – Final Acceptance Test

1.03 FACTORY ACCEPTANCE TEST

- A. The Control and Information System equipment shall not be shipped until the Contractor receives notice of acceptability of the factory tests.
- B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.
- C. Each subsystem shall be fully factory tested for function and operation.
- D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.
- E. All hardware and software required to perform the specified testing shall be furnished by the Contractor at no additional cost to the Owner.
- F. The instrumentation subcontractor shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.
- G. The factory testing shall demonstrate all aspects of system sizing and timing including:

1. Monitoring and control scan times at the PLC level.
  2. Response times at the operator workstation level.
- H. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.
- I. Operator Workstation Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:
1. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.
  2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.
  3. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.
  4. The system shall be operated with data input/output with the PLC's and associated panels to prove operation of all workstation functions.
  5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).
- J. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLC's. This shall include the following:
1. On-line and off-line diagnostics.
  2. For redundant units, fail-over operation and reconfiguration.
  3. System initialization and restart.
  4. Network communications, including fieldbus communications where required.
  5. Non-volatility of memory.

6. Operation of all control logic shall be demonstrated as described herein.
- K. Process I/O Simulation - Process input/output simulation for PLC's shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to approval by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:
1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLC's and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.
  2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.
  3. To provide data for use at all levels of the control system at the time of system integration.
- L. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 17072

### FIELD TESTING

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17070 – Control and Information System Testing, General
- C. Section 17071 – Factory Acceptance Test
- D. Section 17073 – Final Acceptance Test

##### 1.03 GENERAL REQUIREMENTS

- A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
  - 1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Sections 17600, 17700, and 17800.
  - 2. Each final control element shall be individually tested as specified hereinafter.
  - 3. Each control loop shall be tested as specified hereinafter.
  - 4. Each control strategy shall be tested under automatic digital control as specified hereinafter.
  - 5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.
- B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.
- C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific

exceptions are allowed if written approval has been obtained in advance from the Engineer.

#### 1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
- B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.
- C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.
- D. The Contractor shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

#### 1.05 FINAL CONTROL ELEMENT TESTING

- A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
- B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD's, that require turndown limits shall be initially set during this test.
- C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

#### 1.06 LOOP CHECKOUT

- A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the

operator workstation or loop controller level, for continuity and for proper operation and calibration.

- B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.
- C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
- D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.
- E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

#### 1.07 CONTROL SYSTEM STARTUP AND TESTING

- A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.
- B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
- C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
- D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.
- E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.
- F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions



that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

- G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
- H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

#### 1.08 FACILITY STARTUP COORDINATION

- A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.
- B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.
- C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.
- D. At least one qualified control systems technician shall be provided for control system startup and test activities (at least two when loop checkout is being performed).

#### PART 2 -- PRODUCTS

(NOT USED)

#### PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 17073

### FINAL ACCEPTANCE TEST

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17070 – Control and Information System Testing, General
- C. Section 17071 – Factory Acceptance Test
- D. Section 17072 – Field Testing

##### 1.03 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE

- A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 90-day availability test period. The Owner shall be given two (2) weeks' notice of the starting date of the 90-day availability test.
- B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.
  - 1. Downtime of any network-connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.
  - 2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.
  - 3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.
  - 4. Downtime of the following devices shall not be considered a system failure provided the failed device is repaired within the specified time:

- a. Hard disc (one day)
  - b. Workstations (one day)
  - c. Communication interfaces (eight hours)
  - d. Printer (three days)
  - e. Process control system networks (eight hours)
  - f. Off-line (optical, etc.) storage units (one day)
  - g. UPS unit (one day)
- 5. Total shutdown of a single PLC resulting from a software fault shall be considered a system failure.
  - 6. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.
  - 7. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.
  - 8. The failure of the same component more than one time during the 30-day test shall be considered a system failure.
- C. If the system fails the 90-day availability test, the 90-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored. The system shall be demonstrated for the full 90-day period following the restart.
  - D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

## SECTION 17080

### QUALITY ASSURANCE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. It is the intent of these Specifications and Drawings to secure high quality in all materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

##### 1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State, local and other applicable codes.

##### 1.03 QUALITY ASSURANCE - GENERAL

- A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.
- B. For uniformity, only one manufacturer will be accepted for each type of product.
- C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.
- E. Electronic components shall be de-rated to assure dependability and long-term stability.
- F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.
- G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.
- H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

## 1.05 OPTIONAL EQUIPMENT

- A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

## 1.06 GUARANTEE

- A. The instrumentation subcontractor through the Contractor shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 1 of the Specifications. Maintenance personnel provided by the instrumentation subcontractor shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed and list materials used. A copy of all service reports shall be delivered to the Owner on the day the work is performed.
- B. The instrumentation subcontractor shall provide the services of factory-trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.
- C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 1 and, in addition, shall meet the following requirements:
  - 1. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on all other equipment. The hardware service technician(s) shall be available on-site within 24 working hours after notification by the Owner.
  - 2. Corrective software maintenance shall be performed for software provided by the instrumentation subcontractor and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on-site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of all application software upgrades released during the guarantee period.
  - 3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.

4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.
  5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.
- D. The instrumentation subcontractor shall submit to the Owner a proposed maintenance agreement incorporating the following features:
1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.
  2. Provisions for corrective hardware and/or software maintenance work on a will-call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance work shall be performed by properly trained personnel as described above.
- E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

#### 1.07 SHIPPING HANDLING AND STORAGE

- A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of all field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

#### 1.08 FABRICATION

- A. Fabrication of all equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.
- B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Contractor shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.
- C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Contractor shall provide for the proper storage, installation and satisfactory

start-up and operation of the equipment to the satisfaction of the equipment manufacturer, the instrumentation subcontractor, and the Engineer.

#### 1.09 INSTALLATION

- A. All instrumentation and control system installation work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.
- B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of all on-site instrumentation and control system construction work from commencement of construction through completion and final acceptance.
- C. All labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.
- D. All equipment and materials shall fit properly in their installations. Any required work to correct improperly fit installations shall be performed at no additional expense to the Owner.
- E. All work shall be performed in a neat and workmanlike manner. All hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers' recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. All wiring shall be neatly bundled, run in wireway, and terminated. All spare wiring shall be neatly coiled and clearly labeled at both ends for future use by the Owner. Any work not meeting these requirements shall be corrected at no expense to the Owner.
- F. Sufficient common-mode and differential-mode noise rejection shall be provided to insure operation of the plant process control system to meet all specification requirements. General practice shall include:
  - 1. Maintaining crossings between noisy wires and signal wires at right angles.
  - 2. Maintaining separation between noisy wires and signal wires as wide as practical.
  - 3. Grounding all signals, shields and power supplies at the process control unit or local control panel.
  - 4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.
  - 5. Eliminating cable splices. All splices in instrumentation and control system signal and network cables shall be approved in advance by the Engineer.

6. Providing a floating output for transmitters that have their own power sources.
- G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.
- H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.
- I. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:

| <u>CIRCUIT<br/>VOLTAGE (VAC)</u> | <u>MINIMUM<br/>SPACING (IN.)</u> |
|----------------------------------|----------------------------------|
| 120                              | 12                               |
| 240                              | 18                               |
| 480                              | 18                               |
| 2000 and above                   | 24                               |

- J. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.
- K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical work has been completed in the equipment rooms, MCC's, control rooms and all structural and/or mechanical work has been completed within 50 feet of equipment locations.
- L. Upon completion of the above construction work, the Contractor shall request an inspection of the above-named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

## PART 2 -- PRODUCTS

(NOT USED)

## PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -



## SECTION 17100

### CONTROL AND INFORMATION SYSTEM HARDWARE, GENERAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The process control system is physically and functionally distributed between PLC equipped control panels, motor control panels, field panels, operator workstations and appurtenances.
- B. Although manual control facilities shall be provided adjacent to each final control element or in local control panels, such facilities are for testing, maintenance and local monitoring purposes only and shall not be regarded as backup to the PLC-based control system.
- C. PLCs may be categorized as either "process PLCs" that are provided by the instrumentation subcontractor or "equipment control PLCs" provided by equipment manufacturers for the operation of their equipment (blowers, centrifuges, chemical systems, filters, etc.). Unless otherwise specified, all PLCs provided under this Contract shall conform to the requirements specified in this Division.
- D. Major plant control system digital equipment items are described in the Specifications and shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17120 – Programmable Logic Controllers
- B. Section 17180 – Process Control System Networks

##### 1.03 DIGITAL HARDWARE CONFIGURATIONS

- A. The digital hardware configuration shown on the Control System Architecture Drawing depicts overall system configuration requirements. System design shall be based upon this concept and shall provide an overall digital system availability of 99.8 percent under the conditions specified in Section 17073. Unless otherwise specified, designs that vary from this concept will be rejected.
- B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. Run time and flow accumulations shall be performed at the PLC level. Except for minimal calculations related to report-specific functions such as minimum, maximum, average, etc., operator workstations shall not be used to perform calculation for the process control system. Operator workstations shall be fully independent devices, individually connected to the plant control system networks.

- C. No other exceptions will be considered.

## PART 2 -- PRODUCTS

### 2.01 GENERAL SYSTEM HARDWARE REQUIREMENTS

- A. Unless otherwise specified, all hardware shall be rated for industrial use, resistant to shock, vibration, electromagnetic interference, static discharge, and suitable for the environmental conditions described elsewhere in this Division. Commercial or office grade equipment shall not be accepted.
- B. Unless otherwise specified, modular construction shall be employed to simplify maintenance and to provide for future hardware expansion. Plug-in, modular PCB's or modules shall be employed for easy removal to permit exposure of circuit wiring, components and test points. Extender boards shall be provided if necessary to permit PCB's to be completely exposed for testing purposes.
- C. Keying schemes shall be used to prevent PCB misplacement.
- D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.

### 2.02 DIGITAL SYSTEM FAILURE DETECTION AND FAIL-OVER REQUIREMENTS

- A. No degradation in control system performance shall occur when the system is operating in a partial failure or an equipment fail-over mode. Likewise, no degradation of system performance shall occur while a backed up system component is undergoing preventive or corrective maintenance.
- B. All devices connected to the plant control system network shall be self-checking and shall report their operational status to the operator workstations as either "normal" or "failed". A graphic display based on the system architecture drawing shall be furnished with the control and information system showing this information along with current communication status of each device.

## PART 3 -- EXECUTION

### 3.01 REQUIREMENTS

- A. Refer to Section 17000, Part 3.

- END OF SECTION -

## SECTION 17120

### PROGRAMMABLE LOGIC CONTROLLERS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all programmable logic controllers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17060 – Signal Coordination Requirements
- C. Section 17100 – Control and Information System Hardware - General
- D. Section 17125 – Operator Interface Units
- E. Section 17180 – Process Control System Networks
- F. Section 17190 – Uninterruptible Power Systems
- G. Section 17500 – Enclosures, General

##### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies, and Spare Parts. In addition, the following specific spare parts items shall be provided:
  - 1. One of each type and size of module for PLC equipment furnished under this Contract.
  - 2. One of each type and size of PLC and equipment power supply furnished under this Contract.

#### PART 2 -- PRODUCTS

##### 2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL

- A. The instrumentation subcontractor shall furnish programmable controllers (PLC's) as specified herein and as shown on the Drawings. PLC's shall be provided complete with backplane, power supply, I/O cards, special function cards, instructions, memory,

input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions will be permitted.

- B. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.
- C. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.
- D. Where applicable, the minimum PLC backplane size shall be 7 slots, not including power supply slots.
- E. System configuration shall be as shown on the Control System Architecture Drawing. PLC types shall be designated on the Control System Architecture Drawing and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. **Memory and processor shall be adequate for all control functions specified.** PLCs shall be as manufactured to the following with no substitutions accepted:
  - 1. Tesco L3000e Series PLC

## 2.02 PROCESSORS

- A. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire current program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low.

- B. The instruction set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 languages simultaneously. These five languages shall be:
  - 1. Ladder Diagram
  - 2. Structured Text
  - 3. Instruction List
  - 4. Function Block Diagram
  - 5. Sequential Function Chart
- C. **Additional co-processors or modules may be necessary and shall be furnished as required to meet the functions specified herein and in Section 17950 – Functional Control Descriptions.**
- D. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.

## 2.03 COMMUNICATIONS

- A. PLC communications shall be provided as specified in Section 17180 – Process Control System Networks and as shown on the Control System Architecture Drawing.
- B. In addition to a communications port for the control system network, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.
- C. The PLC shall be able to support various types of fieldbus communication systems for data links to field instruments (where specified) in addition to connected equipment such as power monitors, VFDs, motor protection monitors, etc. As a minimum, Profibus DP, Foundation Fieldbus, Modbus RTU Master and Slave, TCP/IP Ethernet shall be supported. The Contractor shall coordinate the efforts of the necessary parties (instrumentation subcontractor and equipment suppliers) to accomplish the required device and data table addressing between each PLC and the associated connected equipment.
- D. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract, and shall be supplied at no extra cost to the Owner.

## 2.04 INPUT/OUTPUT SUBSYSTEMS

- A. Input/output hardware shall be plug-in modules in associated I/O backplane/chassis or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 10 percent spare I/O module space for the addition of future circuit cards or modules.

- B. Discrete inputs shall be 12/24 VDC or 120 VAC signals (integral to the PLC) from dry field contacts. Discrete outputs shall be 24 VDC or 120 VAC outputs sourced from the PLC, or dry relay contacts (2A minimum) as required. Refer to Section 17060 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 17550. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.
- C. Analog input circuits shall be isolated, minimum 16-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTD's. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 17560 - Surge Protection Devices. Maximum density for analog I/O modules shall be 8 per module.
- D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.
- E. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

## 2.05 REMOTE I/O SUBSYSTEMS

- A. Remote I/O shall be provided as designated on the Control System Architecture Drawing. Remote I/O shall be either PLC backplane type I/O or field modules as manufactured by the PLC manufacturer. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems. Remote I/O processor or communication modules shall be modular and individually replaceable.

- B. Remote I/O shall communicate with the PLC using the PLC manufacturer's standard protocol or an open standard network such as DeviceNet, Ethernet IP, ProfiNet, Foundation Fieldbus, Modbus TCP/IP, or equal.

## 2.06 INPUT/OUTPUT CIRCUIT ARRANGEMENT

- A. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

## 2.07 PROGRAMMING SOFTWARE

- A. The PLC programming and configuration software shall be the manufacturer's latest, full-featured version, Windows-based, and shall be fully compliant with IEC 61131-3 standards. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. PLC programming software shall include documentation on optical media.
- B. A minimum of one copy of the PLC programming software shall be purchased by the instrumentation subcontractor and registered to the Owner.
- C. All configuration and programming software necessary shall be provided for connection to the PLC processor via a communications port. All necessary hardware required to allow the notebook computer to perform PLC configuration and programming shall be provided.
- D. If available, the configuration and programming software shall support communication over the network specified in Section 17180 – Process Control System Networks to implement its functions remotely from an operator workstation. All necessary hardware required to have the operator workstation perform PLC configuration and programming shall be provided.

## PART 3 - EXECUTION

### 3.01 REQUIREMENTS

- A. PLC programming shall be furnished to perform all functions described in Section 17950 – Functional Control Descriptions, including global functions. In addition, PLCs shall be programmed to provide additional functions described in other sections of this Division.
- B. PLC programming shall make use of the various IEC languages as appropriate to the specific task, and shall be performed in a modular style making extensive use of program blocks (subroutines) and program variables to be passed to the program blocks for specific equipment. It is the intent of this requirement to allow for enhanced readability and ease

of modification of the program code through the elimination of multiple instances of repeated code for the same function in a “hard-coded” style.

- C. Extensive comments shall be placed in the program code to describe the functions of all elements of the program code. PLC code that does not contain comments shall be rejected.
- D. Refer to Section 17000, Part 3 for additional requirements.

### 3.02 REQUIREMENTS FOR MANUFACTURER-SUPPLIED PLCs

- A. PLCs that are supplied for equipment local control panels by individual equipment manufacturers or suppliers shall, where so indicated on the Control System Architecture Drawing, be integrated into the plant control system. The manufacturer-supplied PLC shall be furnished, installed and programmed by the manufacturer. The PLC shall continuously monitor and control the associated system and at the same time shall provide all the required alarms, indications of system parameters, equipment status, etc. to the main control system at the plant.
- B. Where required as described above, each manufacturer-supplied PLC shall be connected to the Ethernet process control network for access from the plant control system HMI servers, as specified in Section 17180, and shall contain a fiber optic Ethernet switch identical to those provided for the rest of the network-connected PLCs.
- C. Each equipment manufacturer shall provide all monitoring and control data to be transferred between the PLC and the plant control system in contiguous blocks of PLC registers to facilitate block read and write commands for efficient scanning by the control system SCADA servers. These contiguous registers shall be arranged in a single data transfer area, which shall be divided into eight distinct areas with an emphasis on flexibility and future expansion. The distinct areas shall be arranged by data type (analog or discrete), transfer direction (server to PLC or PLC to server), and, where applicable, implementation schedule (current or future). Where required, peer-to-peer communication between PLCs shall likewise be accomplished using separate blocks of contiguous registers. Where individual equipment PLCs are not required to be connected to the plant control system via the data highway network, they shall provide the individual hardwired signals as specified in the Contract Documents. Data and commands for connection to the control system are described in the Drawings, the Input/Output Schedule, the individual equipment specification sections, and in Section 17950 – Functional Control Descriptions.
- D. The operator interface for control of each individual system shall be performed by local operator interface units as specified in Section 17125 or individual pilot devices on the equipment local control panel, as specified in the associated equipment specification section. Additional operator interface functions shall be provided through the plant control system as specified in the respective equipment specifications and in Section 17950.
- E. Where operator interface and control functions are required to be provided through the plant control system, the individual system supplier shall be responsible for coordination with the instrumentation subcontractor to provide a complete and working equipment



control system. The individual equipment supplier shall also be responsible for limiting the access of the plant control system to the equipment PLC code so as to prevent malfunctions of the equipment and any failure to continuously perform its intended functions. The equipment supplier shall be responsible for ensuring that no actions by the plant control system can damage or otherwise adversely affect the operation of the associated equipment or the safety of personnel working on or near that equipment. The equipment supplier shall also provide direction in the configuration of the SCADA software's security system by the instrumentation subcontractor to limit access to the control functions of the equipment control system to authorized personnel only. The equipment supplier shall coordinate testing of the completed system with the instrumentation subcontractor, which shall conform to the requirements of Section 17072 – Field Testing.

- F. The Contractor, equipment supplier and instrumentation subcontractor shall coordinate testing and startup of the equipment provided by the equipment supplier with the plant control system, including but not limited to the following tasks:
1. Provide assistance with control system testing of inputs, outputs, and control strategies as needed.
  2. Provide support or interface work necessary to perform physical checkout and field testing to the final field devices. The schedule may require the instrumentation subcontractor and equipment manufacturer personnel to perform loop checks simultaneously, as directed by the Engineer.
  3. Coordinate and assist as needed to maintain I/O connectivity throughout the system.
  4. Ensure personnel safety while equipment is exercised via the plant control system.
  5. Ensure that process, instrumentation, and control equipment are not damaged while equipment is exercised via the plant control system.
  6. Provide temporary modifications to field devices and their terminations, if needed.
  7. Providing labor and supervision, which may include, but is not limited to, the following: electricians, instrument technicians, manufacturer's representatives, and individual(s) knowledgeable about process startup and operation.
  8. Operation of process equipment for verification of each plant control system input and output.

- END OF SECTION -

## SECTION 17125

### OPERATOR INTERFACE TERMINALS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all operator interface units, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware Configuration
- C. Section 17120 – Programmable Logic Controllers

#### PART 2 -- PRODUCTS

##### 2.01 OPERATOR INTERFACE TERMINAL – LARGE

- A. The operator interface shall be rated for temperatures up to 185 F.
- B. The operator interface unit shall be C-more 12-inch Touch Panel, Model EA9-T10WCL with no substitutions accepted.

##### 2.02 DATA LOGGER INTERFACE

- A. A data logger interface shall be furnished and installed in each control panel as shown on the SCADA Architecture diagram. The data logger shall facilitate simplified viewing of historical data trends and alarms. The Contract shall configure the data logger to poll all pertinent information from the respective pump station PLC.
  - 1. The data logger shall be model DX1012 or DX2020 per the SCADA Architecture Contract Drawing with no substitutions accepted.

#### PART 3 -- EXECUTION

##### 3.01 REQUIREMENTS

- A. The OIT shall be configured to display all PLC I/O, setpoints, and parameters. All equipment failures shall be alarmed. PLC I/O values and operator-entered setpoints shall

be displayed with associated units and service descriptions. Menus shall be provided to navigate between screens of different equipment items. Displays shall be arranged in a hierarchical structure with displays for specific equipment items grouped together. Additional functionality shall be as specified elsewhere in this Division.

- B. All necessary configuration and programming software shall be provided on optical media and turned over to the Owner.
- C. Unless otherwise noted, each OIT shall be mounted between 60 inches above the floor or work platform.
- D. Refer to Section 17000 for additional requirements.

- END OF SECTION -

SECTION 17135  
RADIO TELEMETRY SYSTEM (LICENSED)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the licensed radio telemetry system, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.
- B. The Contractor shall perform a radio path/propagation analysis as soon as possible following initiation of the Contract to determine the quality of all required paths. Any radio path transmission problems shall be brought to the Engineer's and Owner's attention immediately.
- C. The Contractor shall provide complete assistance to the Owner to obtain necessary FCC licensing. The Contractor shall retain a suitable firm to perform a radio frequency search and coordination following acceptance of the radio path analysis by the Engineer. The Contractor shall complete all applications and acquire all necessary licenses in accordance with all applicable rules and regulations including, but not limited to, FCC Part 90. The Owner will pay all licensing fees and the cost of the frequency coordination.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware Configuration
- C. Section 17120 – Programmable Logic Controllers
- D. Section 17500 – Enclosures, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. Where equipment is furnished under other Sections of the Specifications, spares requirements shall be as specified in those Sections. In addition, the following specific spare parts items shall be provided:
  - 1. One of each type of printed circuit board used in telemetry equipment furnished under this Contract. Complete devices shall be provided where individual circuit boards are impractical (e.g., radios).
  - 2. One of each type of miscellaneous hardware device for telemetry equipment furnished under this Contract (lightning arresters, set of N type connectors, etc.).

3. One hand-held diagnostic terminal or software and accessories for the notebook computer specified in Section 17170 shall be provided for diagnostic and programming functions.
4. One spare radio.

#### 1.04 SUBMITTALS

- A. In addition to submittals required under Section 17030 – Control and Information System Submittals, a radio path/propagation study shall be submitted to the Engineer prior to system assembly. This submittal shall clearly define required radio equipment, antenna orientation, antenna mounting height, expected radiated power and standing wave ratio (SWR). An equipment list shall be included listing the antenna, accessories (i.e., polyphaser lightning arresters, vapor trap kits, etc.), radios, and antenna support structures.

### PART 2 -- PRODUCTS

#### 2.01 GENERAL

- A. The Contractor shall provide a licensed radio telemetry system that operates and is fully functional within the confines of the Owner's FCC license.
- B. All communications equipment shall be installed in accordance with the manufacturer's recommendations, FCC rules and regulations, and details on the Contract Drawings.
- C. Radio telemetry equipment shall have a minimum of 30 minutes back-up power.
- D. All radio telemetry equipment power and signal lines that extend or are located outside of an enclosed structure shall be protected from lightning and voltage surges in accordance with the requirements of Section 17560 – Surge Protection Devices.
- E. Although system configuration may be shown on the Control System Block Diagram, the radio telemetry system shall be implemented in conjunction with the radio path survey and actual installation conditions to provide a trouble-free and reliable transmission system.

#### 2.02 ANTENNAS AND APPURTENANCES

- A. Directional antennas shall be yagi type, rated for a minimum of 10 dB gain with an N-type connector. Directional antennas shall be as manufactured by Yokogawa with no substitutions allowed. Directional antennas shall utilize a low-loss coaxial transmission line of 1/2-inch heliax w/foam dielectric for distances less than or equal to 50 ft. Cable for distances greater than 50 ft shall be 7/8-inch heliax w/foam dielectric.
- B. Installations shall include grounding kit and polyphaser coaxial protection.
- C. Antennas shall be rated for 100 mph wind velocity.

- D. Support structures shall be designed to withstand earthquake, wind and ice loads in accordance with the Electronic Industries Association (EIA) Structural Standards for Steel Antenna Towers and Antenna Supporting Structures. Wind loads shall also be calculated in accordance with the State Building Code, except the basic wind speed used for calculating wind loads shall be 100 mph. The worst case loads from the EIA standards and the State Building Code shall be used for design. The shop drawing submittals shall include details of proposed antenna supporting systems.
- E. Antenna masts shall be supported from structures such as buildings and tanks, or otherwise by polyester powder coated steel or anodized aluminum with 2 – 3/8" diameter tenon rated for 80 MPH winds. Antenna masts shall be Valmont DS2000 or equal. No welded supports shall be used on storage tanks. Only bolted stainless steel mountings shall be used, as manufactured by Tesco, Decibel Products, or equal.

## 2.03 LICENSED REMOTE RADIO TRANSCEIVERS/MODEMS

- A. Licensed radio transceivers shall use frequency modulation to transmit and receive telemetry data. The transceivers shall be completely compatible with the control and information system's hardware and communication protocols.
- B. Licensed radio transceivers shall be Integra-TR 242-4018-551, with no substitutions accepted. Used radio transceivers shall be acceptable with calibration report. Licensed radios shall have the following operation and performance specifications:
  - 1. Environmental
    - a. Temperature Range: -30°C to +60°C
    - b. Humidity: 95% at 40°C; non condensing
  - 2. Power Supplies
    - a. Input Power: 10 - 16 VDC
    - b. Transceiver Primary Power: Voltage 13.8 VDC nominal (10.5 to 16 VDC operating range)
    - c. Tx Current: < 2.6A @ 13.3V
    - d. Rx Current: < 270mA @ 13.3V
  - 3. Transmitter Specifications
    - a. Frequency Stability: +/- 0.00015% (1.5 PPM) 12.5kHz and 25 kHz
    - b. Carrier Power: 1 to 5 Watts Programmable
    - c. Carrier Power Accuracy: Normal +/- 1.5 dB
    - d. Duty Cycle: 50% max, 30 seconds (extended Tx time with cooling fan option)
    - e. Output Impedance: 50 Ohms
    - f. Spurious and Harmonics: -20 dBm
  - 4. Receiver Specifications

- a. Type: Double Conversion Superheterodyne
  - b. Sensitivity: 0.35  $\mu$ V for 12 dB SINAD
  - c. Alternate Channel: 6.25 kHz @ > 60 dB min
  - d. Adjacent Channel: 12.5 kHz @ > 55 dB min and 25 kHz @ > 65 dB min
  - e. Intermodulation: > 70 dB
  - f. Spurious Rejection: >70 dB min
  - g. Conducted Spurious: < 57 dBm
5. Modem and Diagnostics
- a. Local diagnostics included
  - b. Data Rate: 19200 bps error-free data

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. After the radios have been installed, the instrumentation subcontractor shall test the following items and make all necessary adjustments:
  - 1. Supply voltage (In keyed and de-keyed positions)
  - 2. Regulated voltage (In keyed and de-keyed positions)
  - 3. Lock voltage
  - 4. Signal strength
  - 5. Forward power
  - 6. Reverse power
  - 7. Standing wave ratio (SWR)
  - 8. Radio temperature
  - 9. Loop back code (if applicable)
  - 10. Software revision
  - 11. Hardware revision
  - 12. Time out timer setting
  - 13. Squelch tail eliminator
  - 14. Soft carrier de-key setting
  - 15. Push to test delay testing
- A. The instrumentation subcontractor shall test the integrity of the radio cable after installation to ensure that the insertion losses are not excessive. The lock voltage, regulated voltage, etc. shall be checked by keying and then de-keying the radio to ensure proper functioning of the radio hardware.

- END OF SECTION -

## SECTION 17138

### AUTOMATIC ALARM DIALER

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the automatic alarm dialers with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirement
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17120 – Programmable Logic Controllers

#### PART 2 – PRODUCTS

##### 2.01 AUTOMATIC ALARM DIALER

- A. An automatic alarm dialer shall be a completely automatic alarm reporting unit utilizing digitally recorded and stored human voice messages to notify personnel over standard dial-up, subscriber type telephone lines. The unit shall be suitable for a 120 volt, single phase, 60 Hz power supply. The dialer shall be provided in a NEMA 4X enclosure.
- B. The dialer shall be a microprocessor-based system having a modular design capable of accepting field-installable expansion modules. The dialer shall have the following minimum input/output capacities:
  - 1. Discrete Inputs: Up to 32, dry contact
  - 2. Analog Inputs: Up to 16, 4-20 mA
  - 3. Relay Outputs: Up to 8
- C. Upon detection of any of the alarm conditions, the unit shall, after a programmable time delay, begin dialing the first of at least 16 user-programmable telephone numbers. It shall then deliver a message describing the alarm condition in a digitally recorded human voice. The dialer shall be capable of being programmed to dial groups of telephone numbers, selectable based on the specific active alarm. The dialer shall be capable of monitoring the following types of alarms:
  - 1. Loss of power (internal alarm)
  - 2. Field contact closure

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3. Pulse totalization
  4. Run time limits
  5. User-specified high and low limits for any analog input
- D. The unit shall continue to call the phone numbers programmed in succession until an acknowledgement is received, either locally from the front panel, or in the form of a specific touch-tone key or calling the unit back. Once acknowledged, the unit shall enter a programmable delay period to allow correction of the alarm condition before beginning notification again. If a new alarm occurs in this delay period, the unit shall abort the delay and begin its calling sequence.
- E. The dialer shall have the ability to issue a formatted report detailing the current status of all system and input/output channels to a local printer. The dialer shall also have the ability to log all alarms, dial in/out, programming changes, and alarm acknowledgement activities with individual time/date stamps to a local printer.
- F. The alarm dialing unit shall be provided with the following physical and functional characteristics.
- Integral battery back-up, at least 20 hours.
  - Tone and pulse-dialing capabilities.
  - Visual indications of the following conditions:
    - Power Status
    - Time and Date
    - Alarm Conditions
    - Battery Condition
    - Operating Mode
  - Integral surge protection on all power, phone, and signal inputs.
  - Remote programming capability.
  - Built-in microphone to allow audio monitoring of the site and two-way conversations.
  - Programmable time-of-day operation and alarm prioritization.
  - Independent programmable time delay for each alarm condition.
- F. The dialing alarm unit shall be FCC registered for direct connection to a standard dial-up, subscriber type line and shall be furnished complete with all necessary power and telephone connection cords.
- G. The automatic alarm dialer shall be Model No. B1285-M1 with Module Model B1285-T1 with no substitutions accepted.

### PART 3 – EXECUTION

### 3.01 REQUIREMENTS

- A. The Automatic Alarm Dialer shall be installed at the location(s) shown on the Drawings.
- B. Following is a list of alarms and initiating sources for the dialer at each location:

| <b>Alarm</b>          | <b>Signal Source</b> |
|-----------------------|----------------------|
| PLC Heartbeat         | PLC                  |
| Common system Failure | PLC                  |
| Hi wet well level     | PLC                  |
| Normal Power Lost     | Internal to dialer   |

- END OF SECTION -

## SECTION 17190

### UNINTERRUPTIBLE POWER SYSTEMS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.
- B. One UPS shall be provided for each operator workstation and its peripherals (i.e. printer, network equipment, radio, etc.) provided under this Contract.
- C. One UPS shall be provided for each programmable logic controller (PLC) or remote telemetry unit (RTU) and its appurtenant equipment provided under this Contract. However, courtesy receptacles in PLC and RTU cabinets shall not be powered by the UPS.
- D. UPS's shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:
  - 1. UPS's for operator's consoles shall be mounted within the consoles.
  - 2. UPS's for control panels containing PLCs shall be mounted either within the cabinet or in an adjacent cabinet of suitable environmental rating.
  - 3. UPS's for RTUs shall be mounted within the RTU cabinet.
  - 4. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 17500 and its subordinate Sections.
  - 5. Where the UPS is mounted within the PLC or RTU cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17120 – Programmable Logic Controllers

### 1.03 SUBMITTALS

- A. The Contractor shall submit UPS sizing calculations for all UPS's furnished under this Contract in accordance with Section 17030 - Control and Information System Submittals.

## PART 2 -- EQUIPMENT

### 2.01 UNINTERRUPTIBLE POWER SYSTEMS

- A. Each UPS shall consist of a freestanding UPS module and battery modules as required to meet backup run time requirements.
- B. UPS's shall be true on-line type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.
- C. An automatic bypass switch shall be provided on UPS's of greater than 2 kVA capacity. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.
- D. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.
- E. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.
- F. Each UPS shall meet the following requirements:
  - 1. Input voltage shall be 117 VAC, single phase, 60 Hz.
  - 2. Voltage regulation shall be +/-5 percent for line and load changes.
  - 3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.
  - 4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.

5. A status monitoring and control panel shall be provided and shall include the following:
    - a. Status indicating lights for both normal and abnormal conditions.
    - b. Individual alarm contacts that shall close upon loss of the AC line, low battery level or operation of the static transfer switch. Contacts shall be wired to the closest discrete input subsystem. Alternatively, an RS-232 or USB port shall provide UPS status to an operator workstation. All required interface software and hardware shall be provided.
    - c. Circuit breaker for the AC input.
  6. Sound absorbing enclosure.
  7. EMI/RF noise filtering.
  8. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
- G. UPS systems shall be Model GXT2 as manufactured by Liebert, equivalent by Powerware, MGE UPS Systems, GE Digital Energy, or equal.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17000, Part 3 of the Specifications.

- END OF SECTION -

## SECTION 17200

### CONTROL AND INFORMATION SYSTEM SOFTWARE REQUIREMENTS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17920 – Control System Input/Output Schedule
- C. Section 17950 – Functional Control Descriptions

#### PART 2 -- PRODUCTS

##### 2.01 SOFTWARE REQUIREMENTS

- A. The Owner's existing SCADA (Human-Machine Interface or HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.
- B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.

##### 2.02 OVERALL SYSTEM CONFIGURATION

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel" of the Owner's existing system. Major HMI software scope of work shall include but shall not be limited to the following:
  - 1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.
  - 2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment, and create links to the new screens.
  - 3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.

4. Modify existing reports to include the additional monitoring points specified under this Contract.
  5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.
  6. Update the system status display to include new hardware provided under this Contract.
- B. Ladder logic resident in existing PLCs shall be configured to perform the functions described as specified herein and in Specification Section 17950. Specifically, the existing PLCs shall be programmed to accept the inputs specified in the Input/Output Schedule and to make this data readily available to the plant network, and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.
- C. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

## PART 3 -- EXECUTION

### 3.01 REQUIREMENTS

- A. Software design, implementation and checkout shall satisfy the requirements specified in the various Sections of Division 17.

- END OF SECTION -

## SECTION 17303

### AIR BUBBLER LEVEL SYSTEMS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the air bubbler level systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17700 - Powered Instruments, General

#### PART 2 -- PRODUCTS

##### 2.01 AIR BUBBLER LEVEL SYSTEMS

- A. The air bubbler level measurement system shall include the following:
  - 1. All components shall be installed within the main pump station industrial control panel. The schematic of the air bubbler level system is provided in the Contract Drawings. Contractor shall submit materials and schematic of bubbler system for Engineer and Owner approval prior to fabrication and installation.
  - 2. Two air compressors.
  - 3. Check valve snubbers installed after each air compressor.
  - 4. Adjustable rotameter with low flow switch (discrete output).
  - 5. Rosemont pressure transducer and transmitter (4-20 mA output).
  - 6. Cleanouts and valves as shown on Contract Drawing schematic.
  - 7. ¼-inch and 3/8-inch polyethylene tubing as shown on Contract Drawing schematic.
  - 8. 1-inch schedule 80 PVC pipe with no couplings and pipe supports every 36-inches. Bottom of pipe in wet well shall be cut with two 3/8-inch notches.
  - 9. Appurtenances as necessary.



B. The system shall include all components required to comprise a complete air bubbler level control/measurement system to perform the functions indicated herein and in the respective associated Drawings and Specifications.

C. System Operation and Control

1. Power to the system shall be controlled by a fused disconnect switch shall control power to all components within the cabinet. All components requiring power shall operate on a single 120V, 60Hz, single phase power supply.
2. A low pressure switch shall produce a contact closure for local control of the compressors.
3. Flow shall be indicated by a rotameter manufactured by King with no substitutions accepted. The rotameter shall have a low flow contact switch that is integrated with the PLC.
4. The compressed air shall flow through a pressure regulator to produce a constant discharge pressure and then flow through respective control valves, constant differential pressure regulator, and rotameters to the bubbler tube.

D. Installation

The following components shall be housed in the pump station industrial control panel cabinet and mounted securely within the cabinet in the following order, bottom to top:

1. Disconnect switch, compressor controls, pressure switch, pressure indicating transmitter and alternator.
2. Air filter, pressure regulator, and auxiliary compressed air connection.
3. Bubbler air control valves, pressure regulators, and rotameters.
4. Direct-reading level gage.

E. NOT USED

F. Air Compressors

1. The duplex air compressors shall be model WISA 26813-007 as manufactured by Gorman-Rupp with no substitutions accepted.

G. NOT USED

H. NOT USED

I. NOT USED

J. NOT USED

K. Branch Air Control/Pressure Devices

1. The rotameter shall be a King Instruments model 74C-111G082-5-2-1-5-1-4 or equal for loss of flow alarm.
2. Other valves shall be of the plug type and shall be brass construction.

L. NOT USED

M. NOT USED

N. Pressure Indicating Transmitter

A Rosemount model 3051CG4A22AIAM5B41151 smart gauge pressure transmitter shall be furnished by the Contractor. See Section 17760 of this Division for additional details.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 17700, Part 3 of the specifications.

- END OF SECTION -

SECTION 17500  
ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.
- B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17510 – Cabinets and Panels
- D. Section 17520 – Field Panels
- E. Section 17550 – Panel Instruments and Accessories
- F. Section 17560 – Surge Protection Devices
- G. Section 17600 – Instruments, General (Combined)
- H. Section 17900 – Schedules and Control Descriptions, General
- I. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, etc.

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.

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- B. Either manufacturer-standard or custom cabinetry may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.
- C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements, and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

#### 1.04 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the spare parts items shall be provided as specified in the individual cabinet and panel specification sections (175XX).

### PART 2 -- PRODUCTS

#### 2.01 TERMINAL BLOCKS

- A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by M-Systems, Wage, Wilkerson, or Allen-Bradley.
- B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.
- C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

#### 2.02 NAMEPLATES

- A. Items of equipment installed in control panels shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include, as necessary, the equipment identification number, description, calibrated range, and set point(s). Abbreviations of the description shall be subject to the Engineer's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background. Nameplates attached to instruments may be black laser etched 1/8-inch high text on stainless steel with sharp edges made smooth. Stamped text shall not be acceptable.
- C. Nameplates shall be attached to metal equipment by NEMA rated stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and

attached to the associated device by means of a braided stainless steel wire affixed with a permanent crimp.

- D. Submit sample nameplate of each type.

### PART 3 -- EXECUTION

#### 3.01 FABRICATION

- A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.
- B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:
  - 1. Louvered openings near the bottom and top (NEMA 12 cabinets only).
  - 2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.
  - 3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.
  - 4. All openings in cabinets and panels shall be fitted with dust filters.
- C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.
- D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure interior temperature alarm shall be displayed on the HMI.
- E. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door or building door is opened.
- F. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of

the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.

- G. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.
- H. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.
- I. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.
- J. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.
- K. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet. Where space for spare I/O modules has been provided with the PLC backplane or DIN-rail mounting system, corresponding space for wiring, surge protection, and terminations shall be furnished within the cabinet.
- L. A copper ground bus shall be installed in each cabinet, and shall be connected to the building power ground.
- M. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 16123 - Building Wire and Cable. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 16123. Where applicable, the wire number shall be the ID number listed in the input/output schedules.
- N. Wires shall be color coded as follows:

Equipment Ground - GREEN

120 VAC Power - BLACK

120 VAC Power Neutral - WHITE

120 VAC Control (Internally Powered) - RED

120 VAC Control (Externally Powered) - YELLOW

24 VAC Control - ORANGE

DC Power (+) - RED

DC Power (-) - BLACK

DC Control - BLUE

Analog Signal – BLACK/WHITE or BLACK/RED

- O. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.
- P. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.
- Q. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power". Letters in the word "WARNING" shall be 0.75 inch high, white.
- R. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.
- S. Panels and enclosures installed outdoors shall be rated NEMA 3R/12 and shall include custom gasketed doors and sun/rain shield.
- T. Heating and cooling shall be provided to each outdoor cabinet section to maintain internal components within operating tolerances and to avoid condensation per Section 17512.

### 3.02 PAINTING/FINISHING

- A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9 for additional requirements.
- B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.
- C. Panels fabricated from stainless steel shall not be painted.
- D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be painted.

### 3.03 INSTALLATION

- A. Refer to Section 17000 for additional requirements.

- END OF SECTION -



SECTION 17510  
CABINETS AND PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the cabinets and panels, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17500 – Enclosures, General
- D. Section 17900 – Schedules and Control Descriptions, General

PART 2 -- PRODUCTS

2.01 CABINETS AND PANELS

- A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.
- B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
- C. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in storage/feed areas for chlorine or other applicable corrosive chemicals shall be of non-metallic construction, rated NEMA 4X, and fully compatible with the associated chemical. Cabinets located

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outside shall be rated NEMA 3R/12 with 304 stainless steel construction and include custom gasketed doors and sun/rain shield.

- D. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.
- E. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with three-point latches. Door hardware on NEMA 4X cabinets located in chemical storage/feed areas shall be non-corrosive in that environment.
- F. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits.
- G. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
- H. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door. When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.
- I. Unless otherwise noted, panel-mounted control devices (OIUs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform.
- J. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17512  
CABINET AIR CONDITIONING UNITS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the cabinet air conditioning units, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 - Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17500 - Enclosures, General
- D. Section 17510 - Cabinets and Panels
- E. Section 17900 - Schedules and Control Descriptions, General

PART 2 -- PRODUCTS

2.01 CABINET AIR CONDITIONING UNITS

- A. Where specified or shown on the Drawings, cabinets shall be of insulated 304 stainless steel NEMA 3R/12 construction, and shall be provided with side mounted closed loop air conditioning units and thermostatically controlled space heaters. Power supply shall be 115 VAC, 60 Hz.
- B. Air conditioning units shall both cool and dehumidify the cabinet's internal air. Each air conditioner shall be sized to handle current and future (with specified spare capacity filled) heat loadings from all equipment mounted inside the cabinet.
- C. Air conditioners shall be provided with thermostats which operate the centrifugal evaporator blowers continuously to prevent stratification of air within the cabinet. Compressors shall operate as needed to maintain the temperature set at the thermostat. Compressors shall be provided with space heaters to maintain the compressor at a minimum temperature during cold ambient temperatures.
- D. Ambient air shall be completely separated from the air inside the cabinet. All air conditioner components exposed to the atmosphere outside the cabinets shall be coated to prevent corrosion.

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- E. Units shall be provided with EMI/RFI noise suppressors.
- F. Air conditioner enclosures shall be constructed of cold rolled steel which is phosphatized and finished in baked enamel.
- G. Cabinet air conditioners shall be ProAir CR Series as manufactured by McLean Midwest of Brooklyn Park, MN, or equal.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

## SECTION 17520

### FIELD PANELS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the field panels, with all spare parts, accessories, and appurtenances as specified or shown.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17500 – Enclosures, General
- C. Section 17900 – Schedules and Control Descriptions, General

#### PART 2 -- PRODUCTS

##### 2.01 FIELD PANELS

- A. Field panels for outdoor service shall be suitable for wall or pipe mounting. Panels shall have the following features:
  - 1. Type 316L stainless steel NEMA 3R/12 construction unless located in chlorine environments. Chlorine environment shall be nonmetallic NEMA 4X construction.
  - 2. Hinged and foamed-in-place continuous gasketed door(s). Door material shall match enclosure and shall have piano hinge(s) and three-point latches.
  - 3. Field panels located outside fence-secured areas shall be fitted with staple and hasp. Provide padlock and coordinate keying with Owner.
  - 4. Thermal insulation and thermostatically controlled space heaters where required to prevent condensation or maintain environmental conditions for installed components.
  - 5. External sun shields or shades constructed of the same materials as the associated enclosure, unless otherwise specified. Sun shield or shade shall be fitted to enclosure supports and not to enclosure. Sun shield or shade shall have a slightly sloped top to shed water and shall extend past the front of the enclosure by at least 6 inches and extend down the side and back of enclosure.

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- B. All external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to the temperature of the lines. Heat tape shall be powered from a GFCI circuit from within panel, unless otherwise shown or specified.
- C. Field panels shall be adequately sized to house instruments, power supplies, surge protection, and appurtenant equipment required for operation. Sufficient space shall be provided for servicing instruments without removal of equipment from the enclosure.
- D. Field panels shall be as manufactured by Hoffman, Saginaw Control and Engineering (SCE), or equal.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17521  
INDUSTRIAL CONTROL PANELS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies the requirements for industrial control panels.
2. This section specifies requirements for power supply and conditioning equipment required to support the instrumentation and communication systems specified.
3. Provide the instrument, control, and monitoring features indicated on the P&ID and electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring, in accordance with NEC Article 409. It shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label. Panels shall be labeled in accordance with Article 409 of the National Electrical Code.
4. Transmitters, Analyzers, signal conditioning modules and other equipment or devices as specified in other Division 17 sections.
5. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
6. Vendor and Manufacturer panels specification Sections are referenced in the Panel Schedule and specify specific requirement for these panel. CONTRACTOR custom panels are specified herein and shown on the drawings.
7. The Vendor / Manufacturer package equipment and CONTRACTOR custom field panels shall adhere to the requirements in specifications Section 16481 for motor starters, controllers, and devices and the circuits shall be arranged for Fail-Safe wiring and electrical operation, as defined hereinafter.

B. Panel Design:

1. Control Power Distribution:
  - a. Panel containing 120-volt and/or 24 volt powered equipment shall use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.
2. Panels containing voltages greater than 208 Vac shall be separated from the control section by physical barrier.

3. Power Supplies:
  - a. Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified herein.
4. Air Supplies:
  - a. Each panel containing pneumatically operated instruments shall be provided with a dual service regulator and distribution manifold, and all other devices necessary to perform the functions specified. Air distribution and control devices shall be provided as specified in Section 40 79 00.
5. Electrical Control Devices:
  - a. Pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section shall comply with the requirements of Section 16902.
6. Uninterruptible Power Supplies:
  - a. Panel mounted 120 Vac input and 120 Vac output are specified herein.

## 1.02 QUALITY ASSURANCE

### A. References:

1. This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.
  - a. EIA RS-310C Racks, Panels, And Associated Equipment
  - b. NEMA 250 Tests For Flammability Of Plastic Materials For Parts In Devices And Appliances



- c. UI 94 Tests For Flammability Of Plastic Materials For Parts In Devices And Appliances
  - d. UI 508A Industrial Control Panels
  - e. UI 698 Industrial Control Panels Relating To Hazardous (Classified) Locations
  - f. NFPA 79 Electrical Standard For Industrial Machinery
  - g. NFPA 70 National Electrical Code (Nec)
  - h. NEMA ICS 6 Industrial Control And Systems: Enclosures
  - i. ANSI/UL 497-1995 Standard For Protectors For Paired Conductor Communications Circuits
  - j. UI 1012 Power Supplies
  - k. EIA RS-310C Racks, Panels, And Associated Equipment
  - l. UI 1449 UI Standard For Safety For Surge Protective Devices
4. This Section references other sections with associated work specified therein:
- a. Section 16000 Basic Electrical Requirements
  - b. Section 16123 Low Voltage Wire and Cable.
  - c. Section 16130 Boxes
  - d. Section 16141 Wiring Devices.
  - e. Section 16195 Electrical Identification
  - f. Section 16461 Dry Type Distribution Transformers
  - g. Section 16470 Panelboards
  - h. Section 16481 Individual Motor Controllers
  - i. Section 16496 Automatic Transfer Switch
  - j. Section 16902 Electrical Controls and Relays.
  - k. Section 40 61 21 specifies process control system testing.
  - l. Section 40 63 43 specifies programmable logic controllers.
  - m. Section 40 91 01 specifies process control strategies.

B. Listed Products:

1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.
2. The control panels shall have factory applied UL 508A labels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.
3. All panels shall be labeled in accordance with NEC Article 409.

C. Factory Testing:

1. Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in the control strategies Section 40 91 01.

D. Shipment, Protection and Storage:

1. Equipment shipment, protection and storage shall conform to the requirements specified in the Specifications.

### 1.03 SUBMITTALS

A. General:

1. Submittals and transmittal procedures for submittals are defined in the Specifications . Submit In accordance with the procedures set forth in the General Conditions of the Contract Documents and the Specifications that include drawings, information and technical data for equipment and as required in in the Specifications. Submittal information shall be included in one complete submittal.
  - a. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
    - 1) A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
    - 2) The CITY shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications.
    - 3) Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

- b. A marked copy of specification Section 40 61 13.
- c. A marked copy of specification Section 40 61 21.
- d. A marked copy of specification Section 40 91 01.
- e. A marked copy of specification Section 01 45 20.
- f. A marked copy of specification Section 16461.
- g. A marked copy of specification Section 16470.
- h. A marked copy of specification Section 16481.
- i. A marked copy of specification Section 16496.
- j. A marked copy of specification Section 16902.
- k. A copy of the contract document Process and Instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- l. Marked contract document Control Schematic diagrams related to the submitted equipment.
- m. Marked contract document of Single Line and One Line diagrams related to the submitted equipment.
- n. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.
- o. List of miscellaneous items, cables, spare and replenishment parts, and chemicals to be provided, including MSDS information.
- p. Dimensioned drawings:
  - 1) Exterior panel and layout
  - 2) Interior devices and layout
  - 3) Door-in-door construction devices, where required
- q. Panel assembly drawings including sections showing clearances between face and rear mounted equipment.
- r. Nameplate engraving schedule:
  - 1) Indicate engraving by line

- 2) Character size
- 3) Nameplate size
- 4) Panel and equipment tag number and description
- s. Heat load calculations for each cabinet based on the highest ambient temperature listed in Section 40 61 13 for the area in which the subject panel will be located.
- t. Wiring drawings:
  - 1) Schematic diagrams
  - 2) internal wiring diagrams
  - 3) Connection diagrams
  - 4) Power and control single line diagrams to comply with NEC Article 409.

#### 1.04 ENVIRONMENTAL CONDITIONS

- A. Refer to Section 40 61 13.

### PART 2 – PRODUCTS

#### 2.01 FABRICATION

- A. General:

1. Panels shall be designed for the seismic requirements of Section 40 61 13. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.
2. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.
3. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
4. Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.
5. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

B. Panel Layout:

1. Provide 20 percent spare contiguous sub-panel area for future expansion.
2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.
3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.
4. Separation between the power components (over 120Vac) and the control / instrument components (120Vac and less) by locating the power components and the control / instrument components in separate sections of the cabinet enclosure.
5. Power cabinet section and the control / instrument cabinet section with separate door handles.
6. Separation between the power components and the control / instrument components using barriers.
7. External lockable circuit breaker handle for the main panel disconnect.
8. Individual power and control components with internal circuit breakers, as required.
9. Motor controllers, as required by the equipment specifications.
10. Displays with door-in-door construction accessible by opening the cabinet outer door.
11. Face-mounted equipment flush or semi-flush with flat-black escutcheons.
12. Panel tops of wall-mounted panels: mounted at the same elevation.
13. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.
14. Panel inner door contains a drawing holder.
15. Panel drawings enclosed in a transparent, protective jacket.
16. Panel functions as specified.
17. Panels with floor stands, to raise the top of the panel to 60 inches above the floor or work platform.
18. Wall mounting of panel weighs less than 100 pounds, where wall space is available,

C. Enclosures:

1. Panel enclosures shall comply with the requirements of NEC Article 409 and NEMA 250.

2. Manufacturer:
  - a. Hoffmann Enclosures, Inc.
  - b. Rittal.
  - c. or equal.

## 2.02 HEATING, VENTILATING AND COOLING

- A. Forced air ventilation shall be provided for panels where indicated in the Panel Schedule and if the cabinet's heat load calculations indicate that the interior temperature of the cabinet will exceed 115 degrees-F, under worst case conditions.
- B. Ventilation for panel racks shall be venturi fans provided on 5-1/2-inch high-notched panel. Ventilation for consoles shall be similar to that for panel racks except EIA RS-310 mounting is not required. Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.
- C. Outdoor panels shall also be provided with thermostatically controlled space heaters. Space heater surface temperature that exceeds 120 degrees F requires an expanded metal guard. Thermostats shall be Honeywell T631 series, Penn Controls A28AA 4, or equal.
- D. Air conditioners shall be provided for panels where indicated in the Panel Schedule or if the forced air ventilation is not adequate to keep the panel interior temperature under 90 degrees fahrenheit. Air conditioning cooling requirements shall be a cooling system that does not exchange cabinet interior air with ambient air. The cooling system shall be either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for the specified equipment and instrument complement and ambient temperature conditions.
- E. Panel air conditioner shall be NEMA rated based on the installed area environment and the coils shall be Heresite, or equal coated and protected from corrosion.

## 2.03 PROTECTION COATING AND FINISH

- A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

## 2.04 NAMEPLATES

- A. External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

- B. The machine engraved laminated white phenolic nameplates with black text shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.
- C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- D. The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.
- E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

## 2.05 PANEL FEATURES

### A. Interconnection Wiring: Panel Interconnecting Wiring:

- 1. Panel control wiring: All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Single conductor stranded copper NEC rated Type MTW No. 14 AWG minimum (rated 10 A per NFPA 79, Table 12.5.1), with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
- 2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.
- 3. Power wiring shall be rated per NEC; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105°C. Wire color coding shall be red for control and black for power. Conductors specified shall meet the NEC requirements for power including phase, grounded, and grounding conductors.
- 4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.
- 5. Wiring channels shall comply with UL 94, Type V.
- 6. Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 50% maximum fill.
- 7. Plastic spiral wrap shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap.

### B. Wire Markers:

- 1. Wire marker shall comply with the requirements specified in Division 16.

### C. Conductor Installation And Protection:

- 1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.

2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
3. No more than two connections shall be made to one terminal.
4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.
5. Terminal blocks shall be;
  - a. Buchanan 0621-1
  - b. Allen-Bradley 1492-HM1 600 V 30-amperes, finger-safe terminal block.
  - c. Allen-Bradley 1492-CD3 600 V 35-amperes with #8 screw terminal block for ring or spade terminals.
  - d. Phoenix Contact or Weidmuller, or equal products.

D. Field Wiring:

1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only.

E. Fuse And Fuse Holders:

1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.
2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.
3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.
4. Fuse holders shall be tip-out or draw-out type.
5. Provide Phoenix Contact or equal products.

F. Control Power:

1. 120 Vac control power source: Single power source for all control and DC power. Dual power sources, one for control power and one for DC power. Dual power sources, one for PLC and DC power and one for DCS output control power.
  - a. Provide control power transformers, as required for the load.
  - b. Provide direct current power supplies, as required for the load.



- c. Provide UPS for PLC and derived loop power as defined above, as required for the load.
- G. Panel Power: Panel power source:
  - 1. Provide a 120 Vac circuit for the panel light, receptacle, heating, fan, heat exchanger, or air conditioner cooling load as required.
- H. Accessories:
  - 1. Panels greater than 24" high x 24" wide shall include GFCI convenience receptacles and LED utility lights.
  - 2. Receptacles and utility lights shall not be powered by the UPS, where included.
  - 3. Print pocket.
- I. Fail-Safe Wiring:
  - 1. Fail-safe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.

## 2.06 ALARM AND TROUBLE DETECTION

- A. The equipment control system shall incorporate a non-energized, open-state, output contact to activate on an alarm or trouble condition or on loss-of-power. Detection of a critical alarm or trouble condition shall cause the control system to initiate the shutdown or the operation of the equipment's controlled components to achieve a "Fail-Safe" condition.
- B. Devices that signal an alarm or a trouble conditions shall latch in the alarm position and require a manual reset at the equipment control panel.
- C. Alarm and trouble output shall:
  - 1. Open an output dry-contact.
  - 2. Remain open until manually reset.
  - 3. Not indicate abnormal condition when the equipment shutdown manually or automatically.
  - 4. Indicate the alarm at the equipment control panel.
- D. Fail-Safe Design and Operation:
  - 1. Failure of part of a system shall not result in the failure of the rest of the system.
  - 2. Failure of equipment or process shall not propagate beyond the failing device or equipment component.

3. Control design and operation shall prevent improper system functioning due to a circuit malfunction or operator error.
4. Control system design shall cause the controlled equipment to operate in a safe mode in the event of loss-of-power or the failure of a control system component.

## 2.07 CONTROL DEVICES

- A. Control devices and relays shall comply with Section 16902.

## 2.08 INDICATING LIGHTS

- A. Indicating lights shall be as specified in Section 16902.

## 2.09 MOTOR CONTROLLERS

- A. Motor controllers installed inside industrial control panels shall comply with the requirements listed in Section 16481.

## 2.10 POWER DISTRIBUTION EQUIPMENT

- A. Wiring devices installed inside industrial control panels shall comply with the requirements listed in Section 16141.
- B. Dry type transformers installed inside industrial control panels shall comply with the requirements listed in Section 16461.
- C. Panelboards installed inside industrial control panels shall comply with the requirements listed in Section 16470
- D. Automatic transfer switches installed inside industrial control panels shall comply with the requirements listed in Section 16496.

## 2.11 POWER SUPPLY AND CONDITIONING EQUIPMENT

- A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded.
- B. Alternating Current (AC) Voltage Regulators:
  1. Regulators shall be of the solid-state tap-changing type, insensitive to line frequency variations between 47 and 63 hertz. Ferroresonant units are not acceptable. Output regulation for input voltage variation from 85 to 125 volts shall not exceed 3.3 percent. Output regulation for load variation from 0 to 100 percent shall not exceed 1.0 percent. Response time shall be 1.0 cycles or less. Voltage regulators serving

panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Voltage regulators serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the regulator shall not exceed 2 percent of the regulator capacity, and harmonic distortion introduced by the regulator shall not exceed 0.1 percent. Regulator output shall be fully protected against internal faults, external overloads and short circuits. Three- phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Regulators shall be Topaz 73000 series, or equal.

C. Noise-Suppression Isolation Transformers:

1. Isolation transformers shall be provided for AC powered instrumentation loads containing solid state circuitry where such is not included within the instrument. Isolation transformers shall be of the triple box shield type. Each coil shall be completely enclosed in a grounded conductive faraday shield, and the overall transformer enclosed in a faraday shield. Common mode noise attenuation between primary and secondary shall exceed 140 dB at 1.0 kHz. Isolation transformer dielectric strength shall be 2500 volts minimum. Isolation transformers serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Isolation transformers serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the isolation transformer shall not exceed 2.0 percent of the maximum load rating. Harmonic distortion introduced by the isolation transformer shall not exceed 0.1 percent. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Isolation transformers shall be Topaz series or equal.

D. Direct-Current Power Supplies:

1. Nominal 24-volt direct-current instrumentation and control power supply:
  - a. Convection-cooled linear type or switching type.
  - b. Line regulation: 0.4 percent for line variations from 105 to 132 volts
  - c. Load regulation: 0.4 percent for load variations from 0 to full load.
  - d. Ripple and noise: Not exceed 100 mV peak-to-peak.
  - e. Hold-up time at maximum load: Not less than 16 milliseconds.
  - f. Continuous duty from 0 to 50 degrees C at rated load.
  - g. Output electronically current limited.
  - h. Over-voltage crowbar shutdown.
  - i. Output voltage:
    - 1) Rated 28 Vdc

- 2) Adjustable plus or minus 5 percent
- 3) Set to provide 26.4 volts to the panel direct current bus.
- j. Power Supply: TDK-Lambda LZSA series, or equal.
- k. Provide dry contact for failure alarm. Dry contact to be wired to input in nearest DCS I/O location.

E. Uninterruptible Power System (UPS):

- 1. The UPS shall be on-line, computer-grade, double conversion type, with electrical isolation including output neutral. UPS shall be packaged for panel enclosure mounting using a back-panel bracket or holder:
  - a. Nominal input voltage: 120Vac.
  - b. Nominal output voltage: 120Vac.
- 2. The online UPS system shall be provided with integral sealed no maintenance batteries, sized to provide full capacity backup power for 60 minutes minimum at connected load with integral battery charger.
- 3. The panel supplier shall calculate the required kVA rating at 150 percent of connected load. Submit load calculations, schematic diagrams, and wiring connection diagrams. Provide battery cabling and other required cabling for a complete system.
- 4. The UPS shall be mounted within the panel on a pedestal or tray with stainless-steel legs to provide space for wire entry and passage.
- 5. The UPS shall be configured with a maintenance bypass switch to allow ease of removal from the panel; to allow the panel to operate on utility power.
- 6. The UPS shall be provided with a relay contact for external alarm and shall be a hardwired discrete input to the DCS.
- 7. Uninterruptible power supply systems shall be as manufactured by Eaton Powerware 9155-8 with PDM outlet, or equal.

## 2.12 POWER MONITORING

- A. Power meters shall be provided at the Hansford Court and Skyfarm A Pump Stations in compliance with the Contract Documents.
  - 1. The meter shall be UL listed, CE marked, and ANSI C12.20 certified.
  - 2. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The meter shall perform to spec in harsh electrical applications in high and low voltage power systems.
  - 3. The meter shall support 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.

4. The meter's surge withstand shall conform to IEEE C37.90.1.
5. The meter shall be user programmable for voltage range to any PT ratio.
6. The meter shall accept a burden up to 0.36VA per phase, Max at 600 V, and 0.014 VA at 120 volts.
7. The meter shall accept a voltage input range of up to 576 volts Line to Neutral, and up to 721 volts Line to Line.
8. The meter shall accept a current reading of up to 11 Amps continuous.
9. The meter shall have color-coordinated voltage and current inputs.
10. The meter shall have a phasor diagram, through software, that clearly shows wiring status.
11. The meter shall have an accuracy of +/- 0.1% or better for voltage and current, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC 62053-22 (Class 0.2%) and ANSI C12.20 (Class 0.2%). ANSI C12.20 shall have a third party certification. The meter shall have a Frequency measurement accuracy of not less than 0.007 Hz.
12. The meter shall support a power supply of (90 to 265) volts AC and (100 to 370) volts DC. Universal AC/DC Supply shall be available and shall have a burden of less than 11 VA. An optional power supply of (18-60) volts DC shall be available.
13. The meter shall have data logging capability with the 2, 3, and 4 Megabyte memory options.
14. The meter shall come equipped with the following data output cards installed: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card.
15. The power meter shall be the Shark 200 with no substitutions accepted.

## 2.13 SURGE PROTECTION

- A. Provide primary surge protectors, per NEC Article 800.90 on all signal conductors entering the panel. Surge protectors shall be multi-stage, plug-in type selected to protect the equipment, and listed per ANSI/UL497. Surge protectors shall be removable without changing the impedance of the circuit. Surge protectors product manufactures shall be:
  1. Circuit Components Inc: Din Rail SDD-400 Series for Data or Analog Signals.
  2. Joslyn Model 1663-08
  3. Taylor 1020FA
  4. Phoenix Contact

5. Telematic
  6. Edco
  7. Or equal.
- B. Power distribution system SPDs shall be Type II and provided in locations as indicated on the Drawings.
1. The SPD shall be rated, designed, tested, listed, and labeled in accordance with UL-1449, latest edition.
  2. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.
  3. Each Type II SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
  4. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Drawings for short circuit current rating of each piece of equipment.
  5. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

| SYSTEM VOLTAGE | L-N   | L-G   | L-L   | N-G   |
|----------------|-------|-------|-------|-------|
| 208Y/120       | 700V  | 700V  | 1200V | 700V  |
| 480Y/277       | 1200V | 1200V | 1800V | 1200V |
| 480 DELTA      | N/A   | 1200V | 2000V | N/A   |
| 240 DELTA      | N/A   | 1200V | 1200V | N/A   |
| 120/240        | 700V  | 700V  | 1200V | 700V  |

6. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.
7. The Nominal Discharge Current (In) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
8. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

| SYSTEM VOLTAGE | L-N   | L-G   | L-L   | N-G   |
|----------------|-------|-------|-------|-------|
| 208Y/120       | 800V  | 800V  | 1200V | 800V  |
| 480Y/277       | 1200V | 1200V | 2000V | 1200V |
| 480 DELTA      | N/A   | 1800V | 2000V | N/A   |
| 240 DELTA      | N/A   | 1200V | 1200V | N/A   |
| 120/240        | 800V  | 800V  | 1200V | 800V  |

9. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated on single line diagrams and in panel schedules. Surge current rating indicated is on a per phase basis.

10. Each SPD shall be provided in an enclosure to match or exceed the NEMA rating of the equipment enclosure that it is serving (i.e. NEMA1, NEMA 12, NEMA4X, etc).
11. Each SPD shall be provided with the following accessories:
  - a. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.
  - b. Surge counter and audible alarm with reset/silence switch.
  - c. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.
12. SPDs shall be as manufactured by Eaton, Thor Systems, ASCO/Emerson Network Power, General Electric, or Square D.

#### 2.14 PANEL GROUNDING

- A. Each panel shall be provided with two copper ground bars.
  1. One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.
  2. Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.
- B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.
- C. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.
- D. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.
- E. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1 inch copper bars extending the entire length of the panel interior at the bottom of the panel.

#### 2.15 PANEL DRAWING PROTECTION

- A. Provide wiring diagrams in accordance with the Specifications. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

#### 2.16 SPARE PARTS

1. NOT USED.

## 2.17 PRODUCT DATA

A. The following data shall be provided in accordance with the Specifications:

1. Manufacturer's operation and maintenance information as specified in the Specifications. Manual shall include final reviewed submittal and separate record of all final configuration, jumper, and switch settings.
2. Test results as specified in in the Specifications.
3. Manufacturer's certification for the performance of features of the specified equipment that cannot be readily inspected.
4. Special requirements for delivery of the information such as time, manner, place, or quantity.
5. Installation and training forms specified in Part 3.

## PART 3 – EXECUTION

### 3.01 GENERAL

- A. Floor mounted cabinets shall be mounted and shimmed to precise alignment so doors operate without binding. Sealant shall be provided for conduit entering the panels.
- B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with Section 40 61 13-3.01 Field Equipment.
- C. Terminals and terminal blocks shall be sprayed after all terminations have been completed with a silicone resin conformal coating, Fine-L-Coat Type SR, Dow Corning, or equal.
- D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind plexiglass holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.
- E. Verify that all panels have been labeled with Arc Flash warning labels per NEC 110.16.

### 3.02 MOUNTING

- A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair its operation.
- B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.



- C. Steel used for support of equipment shall be 316 stainless steel. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.
- D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.
- E. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.
- F. Center-line of wall-mounted panels shall be 48 inches above the floor.
- G. Panel tops of wall-mounted panels shall be mounted at the same elevation.

### 3.03 OUTDOOR PANEL SHADE COVERS

- A. Fabricate the custom aluminum panel shade cover and mount the panels facing away from the prevailing sun or wind.
- B. Provide Sun/Rain covers per Instrumentation Detail for outdoor vendor, manufacture, and custom panels. Fabricate based upon known panel dimensions or accepted submittal drawing dimensions.

### 3.04 PANEL POWER SUPPLY

- A. Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions.
- B. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70.
- C. Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.
- D. Power supply and conditioning equipment larger than 5 kVA load capacity supported from surfaces other than concrete shall be provided with sound isolators.
- E. Final raceway connections shall be a flexible conduit in compliance with Division 16.

### 3.05 FACTORY TESTING

- A. Testing shall be provided per Section 40 61 21.
- B. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The CITY shall have the option of witnessing the Factory Acceptance Test. The CONTRACTOR shall notify the CITY at least two (2) weeks in advance prior of the scheduled functional shop test.

### 3.06 FIELD TESTING

#### A. Field verify the following for Instrument and Control Panels:

1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.
2. Control contacts installed in the ungrounded side of the circuit.
3. Panel signal and control wiring separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.
4. Barriers between the power wiring and the signal and control wiring.
5. Connected to the plant grounding system, as specified.
6. Inner door contains a copy of the Record elementary and wiring diagrams, in a protected drawing holder. Drawings shall be enclosed in a transparent, protective jacket.
7. Panel Functions as specified.
8. Mounted with stainless steel unistrut, fittings, and fasteners.
9. Tested in accordance with Section 16000 and Section 40 61 21.

- END OF SECTION -

## SECTION 17550

### PANEL INSTRUMENTS AND ACCESSORIES

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the panel instruments and accessories, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17500 – Enclosures, General
- D. Section 17900 – Schedules and Control Descriptions

##### 1.03 GENERAL INFORMATION AND DESCRIPTION

- A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

##### 1.04 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts.

#### PART 2 -- PRODUCTS

##### 2.01 ELECTRONIC INDICATORS

- A. NOT USED

##### 2.02 SIGNAL CONVERTERS

- A. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.
- B. General Requirements – Converters shall be of the miniature type, utilizing all solid-state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet

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space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.

- C. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by M-Systems, Wago or Wilkerson.
- D. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- E. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5100 as manufactured by AGM, or equivalent by Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- F. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5016 as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- G. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be  $\pm 0.1\%$  of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- H. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be  $\pm 0.1\%$  per degree F. The repeatability shall be  $\pm 0.1\%$  of span. The units shall be furnished

with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

- I. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20 mA DC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.
- J. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be small format type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.
- K. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.
- L. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

## 2.03 TOTALIZERS

- A. NOT USED

## 2.04 ACCESSORIES

- A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be manufactured by Allen-Bradley with no substitutions accepted. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.
- B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard and shall be manufactured by Allen-Bradley with no substitutions accepted.

Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, corrosion-resistant, maintained contact type. Pilot lights shall be of the proper control voltage, push-to-test LED type with light lens colors as specified below.

| <u>Color</u> | <u>Function</u>      |
|--------------|----------------------|
| Red          | Fault (Closed)       |
| Green        | Running or On (Open) |
| Blue         | Auto                 |
| White        | Other                |

- C. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
- D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17560  
SURGE PROTECTION DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install and place in satisfactory operation the surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17100 – Control and Information System Hardware, General
- C. Section 17500 – Enclosures, General
- D. Section 17900 – Schedules and Control Descriptions, General

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the following specific spare parts items shall be provided:
  - 1. Five of each type of surge protection device provided under this Contract.

PART 2 -- PRODUCTS

2.01 SURGE PROTECTION, GENERAL

- A. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.
- B. Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, Edco, Transtector, Weidmuller, or equal.

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- C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.
- D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.
- E. Device Locations: As a minimum, provide surge protection devices at the following locations:
  - 1. At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.
  - 2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.
  - 3. At both ends of all copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.
  - 4. On all external telephone communication lines.

## 2.02 AC POWER PROTECTION

- A. Surge protection device assemblies for connections to AC power supply circuits shall:
  - 1. Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.
  - 2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.
  - 3. Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.
  - 4. Comply with all requirements of UL 1449, latest edition.
  - 5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
  - 6. Have the following characteristics:
    - a. Maximum Continuous Operating Voltage: 150VAC



- b. Maximum Operating Current: 20 amps
- c. Ambient Temperature Range: -20 degrees C to +65 degrees C
- d. Response Time: 5 nanoseconds

## 2.03 ANALOG SIGNAL CIRCUIT PROTECTION

### A. Surge protection device assemblies for analog signal circuits shall:

1. Have four lead devices with DIN Rail mounting.
2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
3. Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.
4. Comply with all requirements of UL 497B.
5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
6. Limit line-to-line voltage to 40 volts on 24VDC circuits.
7. Have the following characteristics:
  - a. Maximum Continuous Operating Voltage: 28VDC
  - b. Ambient Temperature Range: -20 degrees C to +65 degrees C
  - c. Response Time (Line-to-Line): 5 ns

## 2.04 COMMUNICATION CIRCUIT PROTECTION

### A. Surge protection devices for copper-based data communication circuits shall:

1. Be designed for the specific data communication media and protocol to be protected (i.e. telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF, etc.).
2. Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards:
  - a. IEC 60-1 / DIN VDE 0432 part 2
  - b. CCITT K17 / DIN VDE 0845 part 2
  - c. IEEE C62.31
3. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

4. Provide automatic recovery.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

## SECTION 17600

### INSTRUMENTS, GENERAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test and place in operation process instrumentation as scheduled herein, as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.
- B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract, except where noted otherwise.
- C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 –Control and Information System Scope and General Requirements
- B. Section 17698 – Instrumentation and Control System Accessories
- C. Instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

#### PART 2 -- PRODUCTS

##### 2.01 GENERAL

- A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.
- B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

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- C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:
1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.
  2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.
- D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.
- E. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Floating outputs shall be provided for all transmitters.
- F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper free cast aluminum NEMA 4X construction.
- G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.
- H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -15 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.
- I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.
- J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

- K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.
- L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

## 2.02 ANALYTICAL INSTRUMENTS

- A. NOT USED

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

#### A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The Contractor shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.
2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

#### B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square 1/2-inch thick aluminum base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.
3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.
5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Contractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation tests, inspection, and calibration requirements specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.
2. The Contractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. The Contractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.
2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.
4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.
6. After completion of instrumentation installation, the Contractor shall perform a loop check where applicable. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

## SECTION 17635

### ROTAMETERS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all rotameters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Unpowered Instruments, General

#### PART 2 -- PRODUCTS

##### 2.01 ROTAMETERS

- A. Rotameters shall consist of a float chamber, tapered float, and a measuring ring.
- B. Rotameters shall have the following specifications:
  - 1. Process Fluid Temperature: 32° F to 140° F
  - 2. Accuracy: +/- 2.0% of full scale
  - 3. Repeatability: 0.5% of full scale
  - 4. Max. Process Fluid Pressure: 500 psig at 140° F
- C. The body material shall be 316 stainless steel. Wetted parts shall be as follows:
  - 1. Float: 316 stainless steel minimum; or compatible with process fluid
  - 2. Glass Tube: Borosilicate glass
  - 3. O-Rings: Viton minimum; or compatible with process fluid
  - 4. Others: Compatible with process fluid
- D. A graduated metal scale plate shall be provided for flow indication. A graduated metal scale plate shall be provided for flow indication. The indicator shall be large, easy to read, and calibrated in standard cubic feet per hour (scfh).
- E. Rotameters shall be as manufactured by King Instruments, no substitutions accepted.

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

SECTION 17650  
PRESSURE GAUGES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Unpowered Instruments, General
- C. Section 17698 – Instrumentation Accessories

PART 2 -- PRODUCTS

2.01 PRESSURE GAUGES

- A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".
- B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed the approximately 75% of the full-scale range.
- C. Features
  - 1. Mounting: ½" NPT, lower stem mount type
  - 2. Accuracy: 0.5% full scale
  - 3. Case: Solid front, black phenolic material
  - 4. Dial: White background and black letters
  - 5. Glass: Shatterproof
  - 6. Blow-out protection: Back
  - 7. Pressure element: stainless steel bourdon tube
  - 8. Movement: Stainless steel, Teflon coated pinion gear and segment
  - 9. Gaskets: Buna-N
- D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where

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halocarbon shall be used.

- E. Gauge size shall be 2" for line sizes up to 3" and 4½" for line sizes of 4" or greater.
- F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified under Section 17698 - Instrumentation and Control System Accessories.
- G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A ½" isolation stainless steel ball valve shall be provided for each gauge assembly.
- H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Refer to Section 17600, Part 3.

- END OF SECTION -

## SECTION 17670

### LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the float level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Unpowered Instruments, General

#### PART 2 -- PRODUCTS

##### 2.01 LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

- A. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5 inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three conductor cable a minimum of 20 feet in length. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A-115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings. Float switches shall be Model ENM as manufactured by Flygt, or equal.

#### PART 3 -- EXECUTION

##### 3.01 REQUIREMENTS

- A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

## SECTION 17698

### INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

#### PART 1 – GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.
- B. Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This Specification shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 –Instruments, General (Combined)
- C. Section 16902 – Electric Controls and Relays

##### 1.03 SUBMITTALS

- A. Per Section 17030, Control and Information System Submittals
- B. Impulse piping layout and routing drawings
- C. Instrument assembly drawings.

#### PART 2 – PRODUCTS

##### 2.01 PROCESS TUBING

- A. Process, impulse, or capillary tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with 37 degrees Type 316 stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.
- B. Piping for closely coupling instruments to process seals shall be standard stainless steel NPT threaded piping or NPT tapped mounting blocks.

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- C. A nickel-based lubricant shall be used on threaded stainless steel piping connections to prevent galling.

## 2.02 POWER, CONTROL, AND SIGNAL CABLES

- A. Power, control and signal wiring shall be provided under Division 16 of the Specifications, unless otherwise indicated.

## 2.03 CHEMICAL DIAPHRAGM SEALS

- A. Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Instrument Schedules for specific materials requirements.
- B. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries.
- C. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

## 2.04 ISOLATING RING SEALS

- A. For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).

### 1. Full Line Size Isolating Ring Seals

- a. Where indicated, the sensor body shall be full line size wafer design.
- b. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. Gauge or readout shall be oriented for viewing.
- c. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Manufacturer shall furnish seals with a quick-disconnect-type fitting for field disassembly and reassembly, however, seal and instruments shall be factory assembled prior to arriving at the job site
- d. Isolating ring seals shall be RED Valve Series 40, Ronningen Petter Iso Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.

## 2. Tapped Isolating Ring Seals

- a. Where indicated, pressure shall be sensed via a minimum 1-1/2" diameter spool type isolating ring seal mounted on a 1-1/2" pipe nipple at 90 degrees from the process piping.
- b. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The factory assembled and filled pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally.
- c. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen Petter Iso Spool, Onyx Isolator Ring, or equal.

### 2.05 FILLING MEDIUM:

- A. The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10 degrees F to +150 degrees F.
- B. Filling medium shall be silicone unless oxidizing agents, such as sodium hypochlorite, are present, then halocarbon shall be used.

### 2.06 TAMPER EVIDENT PAINT

- A. Piping and screwed/bolted connections of instrumentation containing the filling medium shall be marked with a small continuous tick mark of tamper evident paint over each piping/instrument joint. Tamper evident paint shall be applied prior to instrument assemblies arriving on the job site. Disturbance of the joint shall break the paint.
- B. Instrument assemblies with broken paint or missing paint shall not be accepted and shall be repaired or replaced at no additional cost to Owner. Paint shall be Dykem Cross-Check or equal.

### 2.07 ISOLATION VALVES

- A. Isolation valves shall be 1/2 inch diameter ball valves, unless otherwise indicated, with a Type 316 stainless steel body, Type 316 stainless steel ball. Where 316 stainless steel is not compatible with the process fluid, materials of construction shall be suitable for the associated process fluid (e.g., PVC for chemical service).

### 2.08 ALARM ANNUNCIATION DEVICE

- A. NOT USED.
- B. Strobe Lights:
  - 1. NOT USED

## PART 3 – EXECUTION

### 3.01 REQUIREMENTS

- A. Refer to Sections 17600, Part 3 of the Specifications.

- - END OF SECTION - -



## SECTION 17701

### MAGNETIC FLOW METERS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17700 – Powered Instruments, General

##### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. Furnish one spare signal converter.

#### PART 2 -- PRODUCTS

##### 2.01 MAGNETIC FLOW METER SYSTEMS

- A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.
- B. Each meter shall be furnished with a 316 stainless steel or carbon steel metering tube and carbon steel flanges with Teflon liner with no substitutions accepted. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.
- C. The flow tube shall be provided with flush mounted electrodes.
- D. Grounding rings shall be provided for both ends of all meters.

- E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.
- F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X/IP66 requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Where the flow tube is subject to submergence through installation in a meter vault or similar location, the flow tube assembly shall be rated NEMA 6P/IP68 and electronics shall be factory sealed against moisture intrusion. The use of field kits for modifying NEMA 4/4X/IP66 flow tubes to submergence duty shall not be acceptable. Transmitter will be integrated into the Telemetry Cabinet Door for a semi-flush installation. No Substitutions to this design shall be accepted.
- G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 420 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.
- H. The transmitter's preamplifier input impedance shall be a minimum of  $10^9$ - $10^{11}$  ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.
- I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.
- J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in nonvolatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.
- K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequencyshiftkeyed, high frequency signal superimposed on the 420 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 420 mA output loop. The remote configuration device shall be as specified under Section 17700. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.
- L. Accuracy shall be 0.30% of rate over the flow velocity range of 1.0 to 10.0 m/s (3.0 to 33 ft/sec) and 0.5% between 0.1 m/s and 1.0 m/s (1-3 ft/s). Repeatability shall be  $\pm 0.1\%$  of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100

seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.

- M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer and shall have no less than 6-ft of cable length.
- N. Magnetic flow meter systems shall be Model 8750W with optional high accuracy as manufactured by Rosemount, no substitutions accepted.

### PART 3 -- EXECUTION

#### 3.01 REQUIREMENTS

- A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.
- B. Refer to Section 17700, Part 3, for further requirements.

- END OF SECTION -

## SECTION 17760

### PRESSURE INDICATING TRANSMITTERS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure indicating transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17000 – Control and Information System Scope and General Requirements
- B. Section 17600 – Instruments, General

#### PART 2 -- PRODUCTS

##### 2.01 GAUGE PRESSURE INDICATING TRANSMITTERS

- A. Gauge pressure transmitters shall be of the capacitance type with a process-isolated diaphragm with silicone oil fill, microprocessor-based "smart" electronics, and a field adjustable rangeability of 100:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.025 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be -40 to 85 degrees Celsius at 0-100% relative humidity. Each transmitter shall have a stainless steel tag with calibration data attached to body.
- B. The piezoresistive silicon pressure sensor shall be mechanically, electrically, and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal

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superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Total long term stability (frequency of calibration) shall be not less than 0.20% URL for 15 years.

- C. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.
- D. Gauge pressure indicating transmitters shall be Model 3051S1TG as manufactured by Emerson Process Management (Rosemount), no substitutions accepted.

## 2.02 DIFFERENTIAL PRESSURE INDICATING TRANSMITTERS

- A. Differential pressure indicating transmitters shall be the same as the gauge pressure transmitters except for body specifications. Differential pressure units shall be furnished with close coupled stainless steel three valve manifold assembly.
- B. The electronics sections of differential pressure transmitters shall contain user-selectable square root extractors to provide a linear 4-20 mA DC output proportional to flow, when activated. Square root extractor circuitry shall be activated only for incompressible fluid flow applications (i.e., water). Flow rates for compressible fluids (i.e., air) shall be calculated externally using line temperature and static pressure corrections as specified elsewhere in Division 17. In addition, each flow transmitter shall be furnished with laminated flow versus differential pressure curves wall mounted adjacent to the transmitter.
- C. Pressure indicating transmitters shall be Model 3051S1CG as manufactured by Emerson Process Management (Rosemount), no substitutions accepted.

## 2.03 FLANGE MOUNTED LEVEL INDICATING TRANSMITTERS

- A. NOT USED.

# PART 3 -- EXECUTION

## 3.01 REQUIREMENTS

- A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

## SECTION 17900

### SCHEDULES AND CONTROL DESCRIPTIONS, GENERAL

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all hardware and software required to provide the Control And Information System as specified herein and as shown on the Drawings.

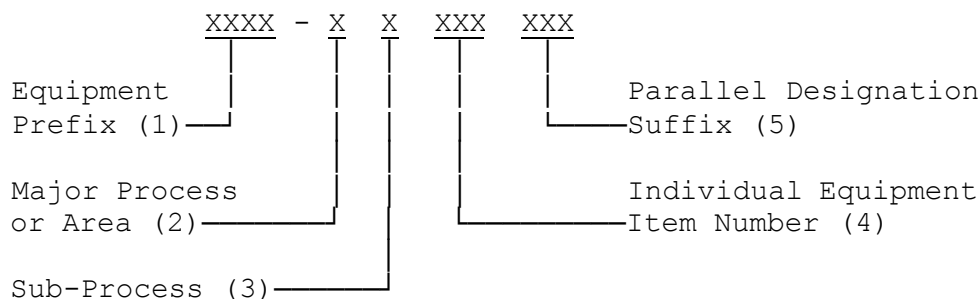
##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17910 – Instrument Schedule
- B. Section 17920 – Control System Input/Output Schedule
- C. Section 17950 – Functional Control Descriptions

#### PART 2 -- CONVENTIONS

##### 1.01 PLANT NUMBERING SYSTEM

- A. The plant equipment numbering system is based on a 5-digit code preceded by an equipment identification prefix and followed by a parallel designation suffix. The numbering system is broken down as follows:



1. Prefix letters are added as required to label a piece of equipment or describe instrumentation/control signal types. Instrumentation prefixes shall use the convention shown in the following table.

| INSTRUMENT PREFIX LETTERS |                                    |                       |                                         |                                                       |                        |
|---------------------------|------------------------------------|-----------------------|-----------------------------------------|-------------------------------------------------------|------------------------|
| FIRST LETTER              |                                    |                       | SUCCEEDING LETTERS                      |                                                       |                        |
| LETTER                    | MEASURED OR INITIATING VARIABLE    | MODIFIER              | READOUT OR PASSIVE FUNCTION             | OUTPUT FUNCTION                                       | MODIFIER               |
| A                         | ANALYSIS                           |                       | ALARM OR PLC/DCS DISCRETE ALARM INPUT   |                                                       |                        |
| B                         | BURNER, COMBUSTION                 |                       | USER'S CHOICE                           | USER'S CHOICE                                         | USER'S CHOICE          |
| C                         | CONDUCTIVITY (ELECTRICAL)          |                       |                                         | CONTROL OR PLC/DCS ANALOG OUTPUT                      |                        |
| D                         | DENSITY (MASS) OR SPECIFIC GRAVITY | DIFFERENTIAL          |                                         |                                                       |                        |
| E                         | VOLTAGE (EMF)                      |                       | PRIMARY ELEMENT                         |                                                       |                        |
| F                         | FLOW                               | RATIO (FRACTION)      |                                         |                                                       |                        |
| G                         | USER'S CHOICE                      |                       | GLASS OR VIEWING DEVICE                 |                                                       |                        |
| H                         | HAND (MANUALLY INITIATED)          |                       |                                         |                                                       | HIGH                   |
| I                         | CURRENT (ELECTRICAL)               |                       | INDICATE OR PLC/DCS ANALOG INPUT        |                                                       |                        |
| J                         | POWER                              | SCAN                  |                                         |                                                       |                        |
| K                         | TIME OR TIME SCHEDULE              | TIME RATE OF CHANGE   |                                         | CONTROL STATION                                       |                        |
| L                         | LEVEL                              |                       | LIGHT (PILOT)                           |                                                       | LOW                    |
| M                         | MOISTURE OR HUMIDITY               | MOMENTARY             |                                         |                                                       | MIDDLE OR INTERMEDIATE |
| N                         | USER'S CHOICE                      |                       | NOTIFY OR PLC/DCS DISCRETE STATUS INPUT | USER'S CHOICE                                         | USER'S CHOICE          |
| O                         | USER'S CHOICE                      |                       | ORIFICE (RESTRICTION)                   |                                                       |                        |
| P                         | PRESSURE OR VACUUM                 |                       | POINT (TEST CONNECTION)                 |                                                       |                        |
| Q                         | QUANTITY                           | INTEGRATE OR TOTALIZE | INTEGRATE OR TOTALIZE                   |                                                       |                        |
| R                         | RADIATION                          |                       | RECORD OR PRINT                         |                                                       |                        |
| S                         | SPEED OR FREQUENCY                 | SAFETY                |                                         | SWITCH                                                |                        |
| T                         | TEMPERATURE                        |                       |                                         | TRANSMIT                                              |                        |
| U                         | MULTIVARIABLE                      |                       | MULTIFUNCTION                           | MULTIFUNCTION                                         | MULTIFUNCTION          |
| V                         | VIBRATION OR MECHANICAL ANALYSIS   |                       |                                         | VALVE, DAMPER OR LOUVER                               |                        |
| W                         | WEIGHT OR FORCE                    |                       | WELL                                    |                                                       |                        |
| X                         | UNCLASSIFIED                       | X AXIS                | UNCLASSIFIED                            | UNCLASSIFIED OR PLC/DCS DISCRETE OUTPUT               | UNCLASSIFIED           |
| Y                         | EVENT, STATE OR PRESENCE           | Y AXIS                |                                         | RELAY, COMPUTE, OR CONVERT                            |                        |
| Z                         | POSITION, DIMENSION                | Z AXIS                |                                         | DRIVE, ACTUATOR OR UNCLASSIFIED FINAL CONTROL ELEMENT |                        |

2. Major process areas and associated sub-processes shall reference the Contract Drawings and be submitted as a list by the Contractor prior to furnishing of nameplates and loop tags.

- END OF SECTION -

SECTION 17910  
INSTRUMENT SCHEDULE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17900 – Schedules and Control Descriptions
- B. Section 17920 – Control System Input/Output Schedule
- C. Section 17950 – Functional Control Descriptions

PART 2 – PRODUCTS

2.01 NAMEPLATES

- A. Items of equipment listed in the instrument schedule, control panels, and digital hardware items shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include, as necessary, the equipment identification number, description, calibrated range, and set point(s). Abbreviations of the description shall be subject to the Engineer's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background. Nameplates attached to instruments may be black laser etched 1/8-inch high text on stainless steel with sharp edges made smooth. Stamped text shall not be acceptable.
- C. Nameplates shall be attached to metal equipment by NEMA rated stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of a braided stainless steel wire affixed with a permanent crimp.
- D. Submit sample nameplate of each type.

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## PART 3 – INSTRUMENT SCHEDULE

| Level Switches (Suspended Float) - Section 17670 |                                           |              |         |
|--------------------------------------------------|-------------------------------------------|--------------|---------|
| Tag Number                                       | Service Description                       | State/Span   | Remarks |
| 120-LSL-100                                      | Hansford Court wet well lo float          | Discrete     | Alarm   |
| 120-LSH-100                                      | Hansford Court wet well hi float          | Discrete     | Alarm   |
| 102-LSL-100                                      | Skyfarm A wet well lo float               | Discrete     | Alarm   |
| 102-LSH-100                                      | Skyfarm A wet well hi float               | Discrete     | Alarm   |
| 102-LSH-200                                      | Skyfarm A sump hi float                   | Discrete     | Alarm   |
|                                                  |                                           |              |         |
| Magnetic Flow Meters - Section 17701             |                                           |              |         |
| Tag Number                                       | Service Description                       | State/Span   | Remarks |
| 120-FIT-100                                      | Hansford Court discharge header flow rate | 0 – 500 gpm  | 6-inch  |
| 102-FIT-100                                      | Skyfarm A discharge header flow rate      | 0 – 700 gpm  | 4-inch  |
|                                                  |                                           |              |         |
| Pressure Gauges - Section 17650                  |                                           |              |         |
| Tag Number                                       | Service Description                       | State/Span   | Remarks |
| 120-PI-001                                       | Hansford Court Pump 1 Discharge Pressure  | 0 – 120 psig |         |
| 120-PI-002                                       | Hansford Court Pump 2 Discharge Pressure  | 0 – 120 psig |         |
| 102-PI-001                                       | Skyfarm A Pump 1 Suction Pressure         | 0 – 120 psig |         |
| 102-PI-002                                       | Skyfarm A Pump 2 Suction Pressure         | 0 – 120 psig |         |
| 102-PI-003                                       | Skyfarm A Pump 3 Suction Pressure         | 0 – 120 psig |         |
| 102-PI-004                                       | Skyfarm A Pump 1 Discharge Pressure       | 0 – 120 psig |         |
| 102-PI-005                                       | Skyfarm A Pump 2 Discharge Pressure       | 0 – 120 psig |         |
| 102-PI-006                                       | Skyfarm A Pump 3 Discharge Pressure       | 0 – 120 psig |         |
|                                                  |                                           |              |         |
| Air Bubbler Level Systems - Section 17303        |                                           |              |         |
| Tag Number                                       | Service Description                       | State/Span   | Remarks |
| 120-PIT-100                                      | Hansford Court wet well level             | 4 – 20 mA    |         |
| 120-FSL-100                                      | Hansford Court low airflow                | Discrete     |         |
| 102-PIT-100                                      | Skyfarm A wet well level                  | 4 – 20 mA    |         |
| 102-FSL-100                                      | Skyfarm A low airflow                     | Discrete     |         |

- END OF SECTION -

## SECTION 17920

### CONTROL SYSTEM INPUT/OUTPUT SCHEDULE

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all control system inputs and outputs as herein specified and as shown on the Drawings.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17900 – Schedules and Control Descriptions
- B. Section 17910 – Instrument Schedule
- C. Section 17950 – Functional Control Descriptions

#### PART 2 -- CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

| Tag Number  | Service Description              | Type      | Notes    |
|-------------|----------------------------------|-----------|----------|
| 120-FSL-100 | Hansford Court bubbler lo flow   | DI        | Bubbler  |
| 120-PIT-100 | Hansford Court wet well level    | 4 - 20 mA | Bubbler  |
| 120-LSL-100 | Hansford Court wet well lo level | DI        | Float    |
| 120-LSH-100 | Hansford Court wet well hi level | DI        | Float    |
| 120-YA-001  | Hansford Court Pump 1 Fault      | DI        |          |
| 120-YL-001  | Hansford Court Pump 1 Running    | DI        |          |
| 120-MSH-001 | Hansford Court Pump 1 Moisture   | DI        |          |
| 120-TSH-001 | Hansford Court Pump 1 Motor Temp | DI        |          |
| 120-ZL-001  | Hansford Court Pump 1 Auto       | DI        |          |
| 120-HS-001  | Hansford Court Pump 1 Start/Stop | DO        |          |
| 120-YA-002  | Hansford Court Pump 2 Fault      | DI        |          |
| 120-YL-002  | Hansford Court Pump 2 Running    | DI        |          |
| 120-MSH-002 | Hansford Court Pump 2 Moisture   | DI        |          |
| 120-TSH-002 | Hansford Court Pump 2 Motor Temp | DI        |          |
| 120-ZL-002  | Hansford Court Pump 2 Auto       | DI        |          |
| 120-HS-002  | Hansford Court Pump 2 Start/Stop | DO        |          |
| 120-FIT-100 | Hansford Court discharge flow    | 4 - 20 mA | Magmeter |
| 120-ZL-200  | Hansford Court ATS Bypass Power  | DI        |          |
| 120-ZL-210  | Hansford Court ATS Main Power    | DI        |          |

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| Tag Number  | Service Description                      | Type      | Notes       |
|-------------|------------------------------------------|-----------|-------------|
| 120-YL-300  | Hansford Court Generator Running         | DI        |             |
| 120-YA-310  | Hansford Court Generator Fault           | DI        |             |
| 120-YA-400  | Hansford Court Phase Fail Relay          | DI        |             |
| 120-YA-410  | Hansford Court Cabinet Intrusion Switch  | DI        |             |
| 120-YA-420  | Hansford Court Building Intrusion Switch | DI        |             |
| 120-LI-500  | Hansford Court wet well level to logger  | 4 - 20 mA | To Yokogawa |
| 120-FI-500  | Hansford Court flow to logger            | 4 - 20 mA | To Yokogawa |
| 120-YL-500  | Hansford Court Pump 1 Running            | DO        | To Yokogawa |
| 120-YL-510  | Hansford Court Pump 2 Running            | DO        | To Yokogawa |
| 120-EI-500  | Hansford Court Voltage A-B               | 4 - 20 mA | To Yokogawa |
| 120-EI-510  | Hansford Court Voltage B-C               | 4 - 20 mA | To Yokogawa |
| 120-EI-520  | Hansford Court Voltage C-A               | 4 - 20 mA | To Yokogawa |
| 120-UI-100  | Hansford Court multivariate              | Ethernet  | To Yokogawa |
| 102-FSL-100 | Skyfarm A bubbler lo flow                | DI        | Rotameter   |
| 102-PIT-100 | Skyfarm A wet well level                 | 4 - 20 mA | Bubbler     |
| 102-LSL-100 | Skyfarm A wet well lo level              | DI        | Float       |
| 102-LSH-100 | Skyfarm A wet well hi level              | DI        | Float       |
| 102-YA-001  | Skyfarm A Pump 1 Fault                   | DI        |             |
| 102-YL-001  | Skyfarm A Pump 1 Running                 | DI        |             |
| 102-MSH-001 | Skyfarm A Pump 1 Moisture                | DI        |             |
| 102-TSH-001 | Skyfarm A Pump 1 Motor Temp              | DI        |             |
| 102-ZL-001  | Skyfarm A Pump 1 Auto                    | DI        |             |
| 102-HS-001  | Skyfarm A Pump 1 Start/Stop              | DO        |             |
| 102-YA-002  | Skyfarm A Pump 2 Fault                   | DI        |             |
| 102-YL-002  | Skyfarm A Pump 2 Running                 | DI        |             |
| 102-MSH-002 | Skyfarm A Pump 2 Moisture                | DI        |             |
| 102-TSH-002 | Skyfarm A Pump 2 Motor Temp              | DI        |             |
| 102-ZL-002  | Skyfarm A Pump 2 Auto                    | DI        |             |
| 102-HS-002  | Skyfarm A Pump 2 Start/Stop              | DO        |             |
| 102-YA-003  | Skyfarm A Pump 3 Fault                   | DI        |             |
| 102-YL-003  | Skyfarm A Pump 3 Running                 | DI        |             |
| 102-MSH-003 | Skyfarm A Pump 3 Moisture                | DI        |             |
| 102-TSH-003 | Skyfarm A Pump 3 Motor Temp              | DI        |             |
| 102-ZL-003  | Skyfarm A Pump 3 Auto                    | DI        |             |
| 102-HS-003  | Skyfarm A Pump 3 Start/Stop              | DO        |             |
| 102-YA-004  | Skyfarm A Pump 4 Fault                   | DI        |             |
| 102-YL-004  | Skyfarm A Pump 4 Running                 | DI        |             |
| 102-MSH-004 | Skyfarm A Pump 4 Moisture                | DI        |             |
| 102-TSH-004 | Skyfarm A Pump 4 Motor Temp              | DI        |             |

| Tag Number  | Service Description                | Type      | Notes       |
|-------------|------------------------------------|-----------|-------------|
| 102-ZL-004  | Skyfarm A Pump 4 Auto              | DI        |             |
| 102-HS-004  | Skyfarm A Pump 4 Start/Stop        | DO        |             |
| 102-YA-005  | Skyfarm A Pump 5 Fault             | DI        |             |
| 102-YL-005  | Skyfarm A Pump 5 Running           | DI        |             |
| 102-MSH-005 | Skyfarm A Pump 5 Moisture          | DI        |             |
| 102-TSH-005 | Skyfarm A Pump 5 Motor Temp        | DI        |             |
| 102-ZL-005  | Skyfarm A Pump 5 Auto              | DI        |             |
| 102-HS-005  | Skyfarm A Pump 5 Start/Stop        | DO        |             |
| 102-YA-006  | Skyfarm A Pump 6 Fault             | DI        |             |
| 102-YL-006  | Skyfarm A Pump 6 Running           | DI        |             |
| 102-MSH-006 | Skyfarm A Pump 6 Moisture          | DI        |             |
| 102-TSH-006 | Skyfarm A Pump 6 Motor Temp        | DI        |             |
| 102-ZL-006  | Skyfarm A Pump 6 Auto              | DI        |             |
| 102-HS-006  | Skyfarm A Pump 6 Start/Stop        | DO        |             |
| 102-FIT-100 | Skyfarm A Discharge Flow Rate      | 4 - 20 mA | Magmeter    |
| 102-LSH-200 | Skyfarm A Sump Hi Level            | DI        |             |
| 102-ZL-300  | Skyfarm A ATS Bypass Power         | DI        |             |
| 102-ZL-310  | Skyfarm A ATS Main Power           | DI        |             |
| 102-YL-400  | Skyfarm A Generator Running        | DI        |             |
| 102-YA-410  | Skyfarm A Generator Fault          | DI        |             |
| 102-YL-500  | Skyfarm A HVAC In Auto             | DI        |             |
| 102-YA-600  | Skyfarm A Phase Fail Relay         | DI        |             |
| 102-YA-610  | Skyfarm A Cabinet Intrusion Switch | DI        |             |
| 102-LI-500  | Skyfarm A wet well level to logger | 4 - 20 mA | To Yokogawa |
| 102-FI-500  | Skyfarm A flow to logger           | 4 - 20 mA | To Yokogawa |
| 102-YL-500  | Skyfarm A Pump Set 1 Running       | DO        | To Yokogawa |
| 102-YL-510  | Skyfarm A Pump Set 2 Running       | DO        | To Yokogawa |
| 102-YL-520  | Skyfarm A Pump Set 3 Running       | DO        | To Yokogawa |
| 102-EI-500  | Skyfarm A Voltage A-B              | 4 - 20 mA | To Yokogawa |
| 102-EI-510  | Skyfarm A Voltage B-C              | 4 - 20 mA | To Yokogawa |
| 102-EI-520  | Skyfarm A Voltage C-A              | 4 - 20 mA | To Yokogawa |
| 102-UI-100  | Skyfarm A multivariate             | Ethernet  | To Yokogawa |

Notes:

- Input/Output types are as follows:

DI - Discrete Input

DO - Discrete Output  
AI - Analog Input  
AO - Analog Output  
Ethernet - Ethernet (CAT6) Communications Link

2. All available information from each RVSS via its RS485 port shall be provided to the PLC.

END OF SECTION -

## SECTION 17950

### FUNCTIONAL CONTROL DESCRIPTIONS

#### PART 1 -- GENERAL

##### 1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING COMPLETE FUNCTIONING SYSTEMS AS DESCRIBED HEREIN.
- B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.
- C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.
- D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Contractor through individual equipment suppliers.
- E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the electrical subcontractor under Division 16. The electrical subcontractor shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 17900 – Schedules and Control Descriptions, General
- B. Section 17910 – Instrument Schedule
- C. Section 17920 – Control System Input/Output Schedule

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## PART 2 -- FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

### 2.01 DEFINITIONS

- A. RUNNING status signals shall be from auxiliary contacts provided with the motor control equipment (i.e., starter, VFD, SCR, etc.).
- B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position or process control system in AUTO (versus MANUAL).
- C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as overtorque, overtemperature, low oil pressure, high vibration, etc.
- D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

### 2.02 CONVENTIONS

- A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:

| <u>Condition</u>   | <u>Color</u> |
|--------------------|--------------|
| Running/On/Open    | Green        |
| Auto/Ready         | Blue         |
| Stopped/Off/Closed | Red          |
| Fail/Alarm         | Amber        |
| Generic Status     | White        |

### 2.03 PROCESS CONTROL

- A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.
- B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:
  - 1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.
  - 2. For alarms and control actions derived from discrete input signals, use adjustable time delays.
  - 3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).

4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.
- C. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the operator workstations.
- D. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in PLC control logic. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.
- E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.
- F. A control discrepancy alarm shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.
- G. An instrument failure alarm shall be generated for any instrument which is generating a signal that is less than 4 mA or greater than 20 mA.
- H. Unless otherwise specified in an individual control description, an instrument failure or control discrepancy alarm shall cause the control strategy to maintain last values and to generate an alarm. Manual initiation of the automatic control strategy shall be required.
- I. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.
- J. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the operator workstation.

### PART 3 -- FUNCTIONAL CONTROL DESCRIPTIONS

#### 3.01 Hansford Court Pump Station

##### A. Process Overview

The Hansford Court Pump Station consists of two (2) submersible non-clog pumps operated in a lead/lag fashion. The lead pump is called to run when the wet well level, as measured by the air bubbler level sensor, exceeds an operator-adjustable setpoint. Likewise, the lead pump is called to stop when the measured wet well level goes below an operator-adjustable setpoint. During air bubbler level sensor failure the lead and lag pumps may be operated using the wet well lo-level and hi-level float.



## B. Control Operation

1. Local control
  - a. Each pump shall be equipped with the following local control buttons and indicators installed at the motor control center (MCC):
    - i. HAND-OFF-AUTO (HOA) switch
      1. When the HOA switch is in OFF the pump shall not operate.
      2. When the HOA switch is in AUTO the pump shall be controlled by the PLC.
      3. When the HOA switch is in HAND the pump shall START and run until the HOA switch is set to OFF or AUTO.
    - ii. A BLUE indicator light shall be furnished and configured to illuminate when the pump is in AUTO mode.
2. PLC Control
  - a. LEAD-LAG Configuration
    - i. The HMI shall be configured to display cumulative pump run times and allow the operator to change the lead/lag configuration of the pumps.
    - ii. Operators shall be alerted by an HMI to rotate pumps based on an OPERATOR-ADJUSTABLE elapsed runtime setpoint schedule (every time the pump with the greatest elapsed runtime has a runtime that is a multiple of the setpoint).
    - iii. The PLC shall START and STOP pumps based on the levels outlined in the Contract Drawings.
    - iv. The PLC shall STOP the active pumps if the LO level float is active.
  - b. ALARMS
    - i. The PLC shall indicate an alarm through the HMI if a pump is RUNNING and the discharge flow rate does not exceed an OPERATOR ADJUSTABLE setpoint following an OPERATOR ADJUSTABLE delay time.
    - ii. The HMI shall indicate an alarm when the LO or HI level float is active.
    - iii. The HMI shall indicate an alarm if the GENERATOR FAIL status is active.
  - c. OVERVIEW SCREENS
    - i. The HMI shall be configured to show a configuration of the pump station with pump operational parameters, wet well level, discharge flow rate and ancillary information. The screen shall be a schematic representation of the pump station and follow the requirements described in Section 17240 and throughout Division 17.

### 3.02 Skyfarm A Pump Station

#### A. Process Overview

The Skyfarm A Pump Station consists of six (6) non-clog pumps operated in sets of two (2) pumps using a lead/lag/lag-lag scheme. The two (2) lead pumps (primary and secondary) are called to run when the wet well level, as measured by the air bubbler level sensor, exceeds an operator-adjustable setpoint. Likewise, the lead pump is called to stop when the measured wet well level goes below an operator-adjustable setpoint. During air

bubbler level sensor failure and/or PLC failure, the lead and lag pumps may be operated using the lo-level and hi-level floats installed in the wet well. The secondary pump in each pump series is called to start based on an adjustable time delay after the primary pump in each set of two (2) pumps is called to start.

## B. Control Operation

1. Local control
  - a. Each set of two (2) pumps shall be equipped with the following local control buttons and indicators installed at the motor control center (MCC) (three sets of controls total):
    - i. HAND-OFF-AUTO (HOA) switch
      1. When the HOA switch is in OFF the pump shall not operate.
      2. When the HOA switch is in AUTO the pump shall be controlled by the PLC.
      3. When the HOA switch is in HAND the pump shall START and run until the HOA switch is set to OFF or AUTO.
    - ii. A BLUE indicator light shall be furnished and configured to illuminate when the pump is in AUTO mode.
2. PLC Control
  - a. LEAD-LAG Configuration
    - i. The HMI shall be configured to display cumulative pump run times and allow the operator to change the lead/lag configuration of the pumps.
    - ii. Operators shall be alerted by an HMI to rotate pumps based on an OPERATOR-ADJUSTABLE elapsed runtime setpoint schedule (every time the pump with the greatest elapsed runtime has a runtime that is a multiple of the setpoint).
  - b. AUTO Control Configuration
    - i. The PLC shall be configured with a USER-ADJUSTABLE start-time delay between the first and second pumps in each of the three pump pairs. The initial delay shall be set to 10 seconds.
    - ii. The PLC shall START and STOP pumps based on the levels outlined in the Contract Drawings.
    - iii. The PLC shall STOP the active pumps if the LO level float is active.
  - c. ALARMS
    - i. The PLC shall indicate an alarm through the HMI if a pump is RUNNING and the discharge flow rate does not exceed an OPERATOR ADJUSTABLE setpoint following an OPERATOR ADJUSTABLE delay time.
    - ii. The HMI shall indicate an alarm when the LO or HI level float is active.
    - iii. The HMI shall indicate an alarm if the GENERATOR FAIL status is active.
    - iv. The HMI shall indicate an alarm if the sump HI float is active.
  - d. OVERVIEW SCREENS
    - i. The HMI shall be configured to show a configuration of the pump station with pump operational parameters, wet well level, discharge flow rate and ancillary information. The screen shall be a schematic representation of the pump station and follow the requirements described in Section 17240 and throughout Division 17.

BID FORMS

**CITY OF SANTA ROSA**

**STATE OF CALIFORNIA**

SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION

The work to be performed and referred to herein is in the City of Santa Rosa, California and consists of improvements to be constructed in accordance with the provisions of the Invitation for Bids, containing the Notice to Bidders, the Special Provisions, the Project Plan(s), the Bid Forms and the Contract, all of which are by reference incorporated herein, and each Addendum, if any is issued, to any of the above which is also incorporated by reference herein.

TO THE AWARD AUTHORITY OF THE CITY OF SANTA ROSA

The undersigned, as bidder, declares that the only person or parties interested in this bid as principals are those named herein; that this bid is made without collusion with any other person, firm, or corporation; that Contractor has carefully examined the Project Plans, Invitation for Bids and conditions therefor, and is familiar with all bid requirements, that Contractor has examined this Contract and the provisions incorporated by reference herein, and Contractor hereby proposes, and agrees that if its bid is accepted by the City, Contractor will provide all necessary machinery, tools, apparatuses, and other means of construction, and to do all the work and furnish all the materials and services required to complete the construction in accordance with the Contract, the Special Provisions, the Project Plan(s), and Addenda to any of the above as incorporated by reference, in the time stated herein, for the unit prices and/or lump sum prices as follows:

NAME OF BIDDER: \_\_\_\_\_

Contract #: **C02201**

Project Title: **SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION**

| Line # | Description                                        | Units | Quantity | Unit Price | Total Price     |
|--------|----------------------------------------------------|-------|----------|------------|-----------------|
| 1      | MOBILIZATION AND DEMOBILIZATION                    | LS    | 1        | \$ _____   | \$ _____        |
| 2      | ALL OTHER WORK INCLUDING SHORING AND BRACING       | LS    | 1        | \$ _____   | \$ _____        |
| 3      | SKYFARM A LIFT STATION, BUILDING AND APPURTENANCES | LS    | 1        | \$ _____   | \$ _____        |
| 4      | HANSFORD CT LIFT STATION AND APPURTENANCES         | LS    | 1        | \$ _____   | \$ _____        |
| 5      | SKYFARM A GENERATOR                                | LS    | 1        | \$ _____   | \$ _____        |
| 6      | HANSFORD CT GENERATOR                              | LS    | 1        | \$ _____   | \$ _____        |
|        |                                                    |       |          |            | Total: \$ _____ |

In the case of any discrepancy between the unit price and the total set forth for the item, the unit price shall prevail; provided, however, that if the amount set forth as a unit price is ambiguous, unintelligible or uncertain for any reason, or is omitted, or in the case of lump sum items, is not the same amount as the entry in the "Total" column, then the amount set forth in the "Total" column for the item shall prevail in accordance with the following:

1. As to lump sum items, the amount set forth in the "Total" column shall be the unit price;
2. As to unit basis items, the amount set forth in the "Total" column shall be divided by the estimated quantity for the item and the price thus obtained shall be the unit price.

The Total Base Bid shall be the sum of the "Total" column. In case of discrepancy between the sum of the "Total" column and the amount entered as Total Base Bid, the sum of the "Total" column shall prevail. The bid comparison will be based on the sum of the "Total" column for each bidder.

If this Contract Bid is accepted by the City and the undersigned fails to execute the Contract and to give all the bonds required under the Contract, with a surety satisfactory to the Award Authority of the City of Santa Rosa, within ten calendar days after bidder has received the Notice of Award from the Engineer, then the Award Authority may, at its option, determine that the bidder has abandoned the Contract, and thereupon this bid and the acceptance thereof shall be null and void, and the forfeiture of the security accompanying this bid shall be in accordance with California Public Contract Code section 20172.

The undersigned understands and agrees that the City is not responsible for any error or omissions on the part of the undersigned in making this bid.

The bidder to whom the Contract is awarded agrees to execute the Contract in favor of the City, in the form attached, and to deliver any and all required bond(s) and insurance certificates within ten calendar days from the date of Contractor's receipt of the Notice of Award. Following the award of the Contract, Contractor shall commence work within ten calendar days from the day authorized in the Notice to Proceed and diligently prosecute the same to completion in accordance with Section 8-1.05.

## LIST OF SUBCONTRACTORS

**NAME OF BIDDER:** \_\_\_\_\_

The following is a list of each subcontractor who will perform work or labor or render services to the undersigned for the construction of the project in an amount in excess of ½ of 1% of the total amount of this bid.

The undersigned agrees that any portion of the work in excess of ½ of 1% of the total amount of this bid and for which no subcontractor is designated herein will be performed by the undersigned.

| SUBCONTRACTOR<br>NAME | SUBCONTRACTOR<br>LICENSE NUMBER | SUBCONTRACTOR<br>DIR<br>REGISTRATION<br>NUMBER | SUBCONTRACTOR<br>BUSINESS ADDRESS | DESCRIPTION<br>OF WORK<br>(ITEM NO.) |
|-----------------------|---------------------------------|------------------------------------------------|-----------------------------------|--------------------------------------|
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |
|                       |                                 |                                                |                                   |                                      |

### LIST OF PREVIOUS SIMILAR JOBS

NAME OF BIDDER:

[illegible]

NONCOLLUSION DECLARATION  
TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID

The undersigned declares:

I am the \_\_\_\_\_ of \_\_\_\_\_, the party making the foregoing bid. The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. 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 the bid price, or of that of any other bidder. All statements contained in the bid are true. 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, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof, to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on \_\_\_\_\_ [date], at \_\_\_\_\_ [city], \_\_\_\_\_ [state].

NOTE:           The above Noncollusion Declaration is part of the Contract Bid. Signing this Bid on the signature portion thereof shall also constitute signature of this Noncollusion Declaration.



BID BOND AFFIDAVIT AND BIDDER'S SIGNATURE PAGE

Accompanying this bid is a guaranty in the form of (Notice: Insert the words "cash \$," "Cashier's Check," "Certified Check," or "Bidder's Bond" as the case may be):

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in an amount equal to at least ten percent of the total of this bid.

The undersigned further agrees that if Contractor does not execute the Contract and deliver the necessary bonds to the City within the period of time specified in this Invitation for Bids, the proceeds of the security accompanying this bid shall become the property of the City of Santa Rosa, California, and this bid and the acceptance thereof may, at the option of the City, be considered null and void.

The undersigned is licensed in accordance with an act providing for the registration of Contractors, License No. \_\_\_\_\_, Class \_\_\_\_\_, expiration date \_\_\_\_\_.

The undersigned is registered with the Department of Industrial Relations, Registration No. \_\_\_\_\_.

**IMPORTANT NOTICE:** If bidder or other interested person is a corporation, state legal name of corporation, also names of the president, secretary, treasurer, and manager of the corporation; if a partnership, state true name of partnership, also the names of all partners in the partnership; if the bidder is a sole proprietor, state the business name and the proprietor's name in full.

Secretary of State Business Entity Number: \_\_\_\_\_.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Business Address

\_\_\_\_\_

Telephone Number

I declare under penalty of perjury that the foregoing is true and correct.

BIDDER'S SIGNATURE: \_\_\_\_\_

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

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

**Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion  
Lower Tier Covered Transactions**

This certification is required by the regulations implementing Executive Orders 12549 and 12689, 2 C.F.R part 180, Debarment and Suspension, and 2 C.F.R. § 200.213. Copies of the regulations may be obtained by contacting the person to which this proposal is submitted.

**(BEFORE COMPLETING CERTIFICATION,  
READ INSTRUCTIONS FOR CERTIFICATION BELOW)**

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals are presently debarred, suspended, proposed for disbarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Firm Name: \_\_\_\_\_

Name and Title of Authorized Representative: \_\_\_\_\_

Signature of Authorized Representative: \_\_\_\_\_

Date: \_\_\_\_\_

## INSTRUCTIONS FOR CERTIFICATION

1. By signing and submitting this proposal, the prospective lower tier participant is providing the certification set out above.
2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.
3. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549, at 2 C.F.R. Parts 180 and 417. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.
5. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.
6. The prospective lower tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion Lower Tier Covered Transactions," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.
7. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the System for Award Management (SAM) database.
8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

## CERTIFICATION REGARDING LOBBYING

The undersigned [Contractor] certifies, to the best of his or her knowledge, that:

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

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

2. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31, U.S.C. § 1352 (as amended by the Lobbying Disclosure Act of 1995). Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Contractor, \_\_\_\_\_, certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, Contractor understands and agrees that the provisions of 31 U.S.C. § 3801 *et seq.*, apply to this certification and disclosure, if any.

Signature of Contractor's Authorized Official:

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Name and Title of contractor's Authorized Official:

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Date:

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**CONTRACT**

**CITY OF SANTA ROSA**

**CALIFORNIA**

**CITY CONTRACT NO. C02201  
FEMA PUBLIC ASSISTANCE DR-4344  
FEMA PUBLIC ASSISTANCE PROJECT NOS.38691 and 38692  
SKYFARM 'A' AND HANSFORD COURT LIFT STATION RECONSTRUCTION**

This Contract is made and entered into as of date to be added upon award at Santa Rosa, California, between the City of Santa Rosa ("City") and \_\_\_\_\_, of \_\_\_\_\_, California ("Contractor").

ARTICLE I - For and in consideration of the payment and agreement hereinafter mentioned, to be made and performed by City, and under the conditions expressed in the required bonds hereunto annexed, Contractor agrees that for the benefit of City, at its own cost and expense, to do all the work and furnish all the materials, except such as are mentioned in the Special Provisions to be furnished by City, necessary to construct and complete the work herein described in a good, workmanlike, and substantial manner. The work embraced herein shall be done in accordance with the State of California Department of Transportation Standard Specifications 2015 and Revised Standard Specifications 2015, insofar as the same may apply (Standard Specifications); in accordance with the City of Santa Rosa Construction Specifications for Public Improvements (City Specifications); in accordance with the City of Santa Rosa Design and Construction Standards, (City Standards); in accordance with the State of California Department of Transportation Standard Plans 2015 and Revised Standard Plans 2015 (Standard Plans), (collectively, "Contract Documents") and in accordance with the Special Provisions hereinabove set forth, all of which are hereby incorporated into and made part of this Contract.

ARTICLE II - Contractor agrees to receive and accept the following prices as full compensation for furnishing all materials and doing all the work contemplated and embraced in this Contract; also for all loss or damages arising out of the nature of the work aforesaid, or from the acts of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered in the prosecution of the work until its acceptance by City and for all expenses incurred by or in consequence of the suspension or discontinuance of work, and for well and faithfully completing the work, and the whole thereof in the manner and according to the Project Plans and Invitation for Bids therefor, and the requirements of the Engineer under them to wit:

| ITEM NUMBER                            | QUANTITY | DESCRIPTION | UNIT PRICE | TOTAL    |
|----------------------------------------|----------|-------------|------------|----------|
|                                        |          |             | \$ _____   | \$ _____ |
| TOTAL BASE BID (SUM OF "TOTAL" COLUMN) |          |             | \$ _____   |          |

**BID ITEMS IN THIS SECTION WILL BE INSERTED  
UPON AWARD OF THE CONTRACT AND SHALL BE  
THE SAME AS THOSE BID UPON.**

ARTICLE III - City and Contractor hereby promise and agree that Contractor shall provide the materials and do the work according to the terms and conditions herein contained and referred to, for the prices aforesaid, and City hereby agrees to pay for the same at the time, in the manner, and upon the conditions set forth; and the parties for themselves, their heirs, executors, administrators, successors, and assigns, do hereby agree to full performance of the covenants herein stated.

ARTICLE IV - By execution of this Contract, Contractor hereby represents and certifies that Contractor is aware of the provisions of Labor Code section 3700 which require every employer to be insured against liability for Workers' Compensation or to undertake self-insurance in accordance with the provisions of that Code, and Contractor hereby agrees to comply with such provisions before commencing the performance of the work of this Contract.

ARTICLE V - It is further expressly agreed by and between the parties hereto that the Invitation for Bids, containing the Notice to Bidders including any required Bonds, the Contract Documents, and any Addenda are all essential parts of this Contract and are specially referred to and by such reference made a part hereof. In the event of any conflict in the provisions thereof, the terms of said documents shall control each over the other, in the following order:

1. Special Provisions
2. Project Plans
3. City Standards
4. City Specifications
5. Standard Specifications
6. Standard Plans

provided, that in the event of a conflict between any Federal Requirement in Section 10 of the Special Provisions and any other provision in the Contract Documents, the more stringent provision shall control and prevail.

ARTICLE VI - Contractor agrees to commence work pursuant to this Contract within ten calendar days from the date authorized in the Notice to Proceed and to diligently prosecute the same to completion in accordance with Section 8-1.05 of the Special Provisions.

This Contract shall not be transferred or assigned without the prior written consent of City, which may be withheld by City in its sole and absolute discretion.

If Contractor is a corporation, two corporate officers of Contractor, one from each of the following two groups shall execute this Contract: a) the chairman of the board, president or any vice-president; b) the secretary, any assistant secretary, chief financial officer, or any assistant treasurer. The name and title of the corporate officers shall be printed under the signature.

In witness whereof, the parties hereto have executed this Contract as of the date first written above.

**City:**

City of Santa Rosa,  
a Municipal corporation

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

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

ATTEST:

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

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

Approved as to form:

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

Office of City Attorney

**Contractor:**

Name of Contractor,  
Type of entity

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

Name: \_\_\_\_\_

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

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

Name: \_\_\_\_\_

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