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GUAM PUBLIC UTILITIES COMMISSION
RECEIVED
DATE: 10/17/25
TIME: 11:37 pm

BEFORE THE GUAM PUBLIC UTILITIES COMMISSION

IN THE MATTER OF: **REQUEST BY THE GUAM WATERWORKS AUTHORITY TO APPROVE PRESSURE ZONE REALIGNMENT PHASE II PROJECT**	**GWA DOCKET NO. 26-01** **GUAM WATERWORKS AUTHORITY'S RESPONSE TO CALJ's RFI NO. 1**

The GUAM WATERWORKS AUTHORITY ("GWA"), by and through its counsel of record, THERESA G. ROJAS, hereby files its response to the PUC Administrative Law Judge (ALJ) Requests for Information sent on October 17, 2025. In response to the Requests, GWA provides the following answers to the six (6) specific questions posed:

1. There was a bidder that offered a lower price than Sumitomo. Why wasn't the low bidder selected? The lowest bidder was determined to be non-responsible.

   The lowest bidder was determined to be non-responsible and therefore GWA was unable to further award or permit the bidder to compete.

2. The Resolution states that these PRV projects are "critical". Can you send me documentation from the Master Plan, CIP, or other source explaining why these projects are critical.

   Pressure Reducing Valves (PRV) and Pressure Reducing Sustaining Valves (PRSV) are mechanical devices installed within a water distribution system meant to automatically reduce higher pressure to a lower more manageable source. These valves are essential and critical to establishing pressure zones in the distribution system. In areas without PRV's, GWA's operators are often forced to manually "choke down" valves to reduce pressure where needed and these manual chokes are a less precise and sustainable method. Installing PRV's would give us greater control over the pressure level in our system. Pressure zones are imperative and critical to controlling water pressure throughout our network and to protecting our pipes and other infrastructure from higher pressure levels. Installed pressure zones also save energy and ensure reliable service.

3. We are only dealing with Phase II in this project, correct?

Correct; however, GWA's Phase II project is divided into Phase 2A and Phase 2B. Each sub-phase involves a distinct scope of work, budget, and funding source. This is all explained further in no. 4 below.

4. The total contract cost is over $25M, but the sources of funding in the Petition do not add up to that amount; why is that?

The project was phased out into phase 2A, totaling $14,956,418.00 funded by grants, and phase 2B, totaling $8,286,359 funded by grants, internally funded CIP, and Series 2025A Bond monies.

Although a narrative explaining these amounts was provided with GWA Docket 26-01; a simplified breakdown is also presented in the table below.

		Amount	Notes
Phase 2A Award		$ 13,854,832.16	Grant M-98T48323
		$ 1,101,585.84	Grant M-96902619
	2A Sub-Total	$ 14,956,418.00	
Phase 2B Proposed Change Order	2B Sub-Total	$ 8,286,359.00	
	Total	$ 23,242,777.00	Total Bid amount for Phase 2A + 2B

Phase 2B Funding	Amount	Notes
USEPA Grant No. M-98T48323	$ 772,151.84	US EPA Grants
PW 09-04 Pressure Zone Realignment	$ 5,624,399.03	IFCIP Monies
MP-PW-Pipe-15 Pressure Zone Realignment Phase 2	$ 1,889,808.13	2025 Series A Bonds
Total	$ 8,286,359.00	

To the question, the total contract amount is $25,567,054.70. This amount is made up of the $23,242,777 base bid amount (presented in the above table) plus a ten percent contingency of $2,324,277.00. Although not included in the docket or table above, the contingency amount of $2,232,277.00 is likely be paid from IFCIP monies.

5. Is there a timeline on when this project will be completed?

The contract time for final completion is 760 days from Notice to Proceed (NTP). The NTP for Phase 2A was issued on April 21, 2025. Phase 2B was considered in the total 760 days' timeline so the project is expected to be complete by June 20, 2027.

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6. Would the RFP or proposed contract for Sumitomo explain the projects further? If so, please provide.

A copy of the Technical Specifications for GWA's Pressure Zone Realignment Construction Project for Phase II (2) and a blank Bid Form to illustrate and explain the project further is attached herein as a Attachments A and B.

RESPECTFULLY SUBMITTED this 17th day of October 2025.

By: _____/s/_____
THERESA G. ROJAS
GWA Legal Counsel

Technical Specifications

For

GWA Pressure Zone Realignment Construction – Phase 2

GWA Project No.: W18-001-BND

Prepared for:

GUAM WATERWORKS AUTHORITY

March 2023

Prepared By

GHD

Technical Specifications

For

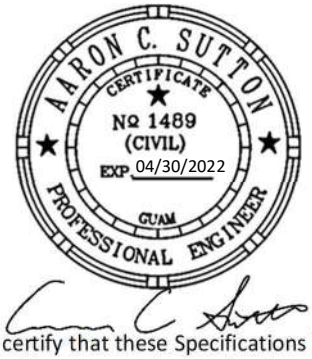
GWA Pressure Zone Realignment Construction – Phase 2

GWA Project No.: W18-001-BND

Prepared for:

GUAM WATERWORKS AUTHORITY

March 2023

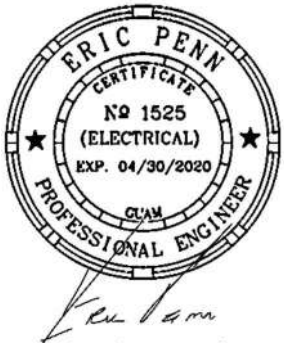


I hereby certify that these Specifications have been prepared by me or under by direct supervision

(Civil Engineering Design)

I hereby certify that these Specifications have been prepared by me or under by direct supervision

(Structural Engineering Design)



I hereby certify that these Specifications have been prepared by me or under by direct supervision

(Electrical Engineering Design)

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contract description.
2. Substantial completion
3. Training Budget Bid Item
4. Order of precedence of contract documents
5. Contractor's use of Site.
6. Work sequence.
7. Permits.
8. Fish and Wildlife
9. Cultural resources
10. Unexploded Ordnance
11. Specification conventions.

1.2 CONTRACT DESCRIPTION

A. Work of the Project comprises construction of Pressure Reducing/Sustaining Valve (PRSV) and Meter Stations and other improvements at different locations. It includes piping and connections, concrete vaults, electrical systems, SCADA systems, concrete control buildings, site work, pavement restoration, testing, startup, and appurtenant work at all sites, as shown and specified, complete and operable in accordance with the Contract Documents.

B. Perform Work of Contract under fixed cost Contract with Owner according to Conditions of Contract.

C. The Work to be performed under this Contract shall consist of furnishing plant, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents, which may be necessary for the complete and proper construction of the Work in good faith, shall be provided by the Contractor as though originally so indicated, at no increase in cost to GWA.

1.3 SUBSTANTIAL COMPLETION

A. Substantial Completion for each site is hereby defined as “the time at which the new PRSV/meter stations and electrical and SCADA equipment as defined in the base bid are operational” and can be used for the purpose for which they are intended. Substantial Completion will be awarded for the project as a whole. Each site will be considered

substantially complete upon completion of the PRSV/meter stations and pipe connections, disinfection, calibration of the instrumentation, programming and testing of the SCADA equipment, and the site is fully functional and operable, including other preparations and proof of Guam EPA acceptance, as necessary for owner's use of the PRSV/meter stations, piping, and equipment to distribute potable water at correct system pressures.

B. Project Milestones: Include the milestones specified herein as a part of the progress schedule required under Section 013216 – Construction Progress Schedule. Following is a detailed description of the project milestones, excluding any delays due to abnormal weather in accordance with Paragraph 1.7 of Section 013216.

1. Base Bid Substantial Completion: The Contractor shall begin work upon issuance of the Notice to Proceed (NTP) and base bid work shall be substantially complete, for all sites, as specified no later than 730 calendar days from NTP.

C. GWA shall have the right to utilize or place into service any item of equipment or other usable portion of the Work prior to completion of the Work. Whenever GWA plans to exercise said right, the Contractor will be notified in writing by GWA, identifying the specific portion or portions of the Work to be so utilized or otherwise placed into service.

1. It shall be understood by the Contractor that until such written notification is issued, all responsibility for care and maintenance of all the Work shall be borne by the Contractor. Upon issuance of said written notice of Substantial Completion, GWA will accept responsibility for the protection and maintenance of all such items or portions of the Work described in the written notice.

D. **Liquated Damages for Delays relative to Substantial Completion work:** As liquidated damages, and not as a penalty, for Contractor's delays in substantial completion of the work beyond the dates agreed upon in accordance with the Contract Documents or within such extensions of time as may be granted by GWA, the Contractor shall pay GWA fixed and liquidated damages for each calendar day(s) delay until said Work at all the sites is satisfactory completed at the rate of **$3,000 per day**.

E. Final Completion: Final Completion is defined as completing and having GWA accept all Work required under this Bid. Work includes warranty work, replacement work and warranty periods required by law or this bid. Final Completion shall be no later than 60 calendar days following Substantial Completion. Include the Final Completion date as a project milestone of the progress schedule required under Section 013216 – Construction Progress Schedule.

1.4 TRAINING BUDGET BID ITEM

A. The contractor shall include a budget of $120,000 designated by GWA for off-island training of GWA staff. The budget will pay for training of SCADA, meters, pressure reducing/sustaining valves, and/or pumps. Air fair, lodging, per diem expenses, car rental and the cost of the training will be paid for out of the budget until the amount is fully spent.

B. The training budget is separate from the Demonstration/training in Section 019100 – Commissioning.

1.5 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

A. In case of discrepancy between the contract documents, the order of precedence from the highest to lowest is as follows:
   1. General and Special Conditions
   2. Technical Specifications
   3. Project Plan Details
   4. Project Plan Sheets
   5. GWA Standard Plans and Details
   6. DPW Standard Plans

1.6 CONTRACTOR'S USE OF SITE

A. Limit use of Sites to allow:

   1. Owner occupancy of existing Mangilao Reservoirs and site piping.
   2. Owner occupancy of existing Latte Heights Booster Pump Station and site piping.
   3. Owner occupancy of existing Well A-19 building and piping for the Pago Bay PRSV site.
   4. GWA, or another GWA contractor, may utilize any part of the Sites. The Contractor shall cooperate and coordinate with GWA or their contractors to facilitate GWA's operations and to minimize interference with the Contractor's operations at the same time. In any event, GWA and their contractors shall be allowed access to the Sites during the period of construction.
   5. See other requirements in Article 5 of the Standard General Conditions of the Construction Contract.

B. Construction Operations:

   1. Limited to areas indicated on Drawings.
   2. The Contractor's use of the Sites shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.
   3. Contractor shall be responsible for all areas of the Sites used by him or their Subcontractors in the performance of the Work. Contractor will exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to GWA or others. Contractor has the right to exclude from the Site all persons who have no purpose related to the Work or its inspection, and may require all persons on the Site (except GWA's employees or representatives) to observe the same regulations as he requires of his employees.
   4. GWA does not warrant the condition of any existing pipeline or facility. The Contractor is cautioned that any fit-ups and connections to existing facilities may require a substantial amount of fit-up Work. The Contractor shall be solely responsible for performing all work and for furnishing all materials, labor and equipment necessary to complete the Work. The Contractor shall make necessary survey measurements of existing facilities and submit detailed shop drawings prior to the shutdown or staging to ensure proper fit-up.
   5. The Contractor shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 013216 – Construction Progress Schedule. The schedules shall include the Contractor's activities necessary to satisfy all constraints of the Contract Documents.

C. Time Restrictions for Performing Work:

1. All work shall be performed during regular working hours, unless otherwise approved by GWA.
2. Access to the sites is limited to the hours between 8:00 AM and 5:00 PM, Monday to Friday except for legal holidays, unless otherwise approved by GWA. The Contractor shall not permit the performance of Work requiring special inspection or QC or QA testing on Saturday, Sunday or any legal holidays without GWA's written consent given after submitting prior written request to the Contracting Officer a minimum of 72 hours in advance.
3. The Contractor shall pay for the Construction Manager's cost for approved general observance, special inspection, and QC or QA testing that are performed on Saturday, Sunday, or any legal holidays.

D. Utility Outages and Shutdown:

1. The Contractor shall schedule and conduct activities to enable the existing facilities to operate continuously, unless otherwise specified.
2. Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities may require the temporary outage of existing water system service. In such cases, the Contractor shall coordinate Work with the Contracting Officer and GWA as described below. The Contractor shall complete the GWA Scheduled Outage Request Form.
3. The Contractor shall perform Work continuously during critical connections and changeovers as required to prevent interruption of GWA's operations. When necessary, plan, design and provide various temporary services, utilities, connections, temporary piping, access, and similar items to maintain continuous operations of GWA's facility at no additional cost to GWA.
4. The Contractor shall not close lines, open or close valves, or take other action which would affect the operation of existing systems. Only GWA staff is authorized to operate existing equipment, valves, and systems; and such request by the Contractor will be considered within 48 hours after receipt of Contractor's written request.
5. In addition to the construction schedule required under Section 013216 – Construction Progress Schedule, the Contractor shall submit a detailed outage plan and time schedule for all construction activities which will make it necessary to remove a tank, pipeline, electrical circuit, equipment, structure, road or other facilities from service. The Contractor shall schedule all connections to existing facilities with GWA and the interruption to system operations and services shall be held to a minimum. This may require outages to be scheduled at off-peak times. The cost for overtime labor of GWA staff required during an outage shall be borne by the Contractor and considered part of the cost of the outage.
6. The outage plans shall be submitted to the Contracting Officer for acceptance and receive a favorable review before submitting the outage request to GWA. The outage plan shall describe the Contractor's method; the length of time required to complete said operation; any necessary temporary power, controls, instrumentation or alarms required to maintain control and monitoring for the water system; detailed shop drawing showing pipe lengths, fittings, couplings, and pipe profiles as a minimum; and the manpower and equipment which the Contractor shall provide in order to ensure minimum outage time and proper operation of associated water system. The GWA water system has older fittings that may be difficult to remove and cause delays to an outage. The Contractor shall verify and research existing fittings that are to be removed or modified as part of the new connection

and account for possible difficulties and delays in the timing of the outage plan. Details of possible methods of removal shall be included in the outage plan. All costs for preparing and implementing the outage plans shall be at no increase in cost to GWA.

7. Outages and service connections shall be performed during the dry weather season, unless specifically allowed to occur during the wet weather season. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section.
8. The removal of the existing system from service and reconnect the pipelines to resume service shall be completed no more than **8 hours** for each shut down. The Contractor shall perform all cutting, patching, and connection to existing facilities with extreme care and take all precautions necessary to ensure that the existing facilities are not damaged. The Contractor shall be responsible for dewatering of the existing lines and disposal of water as required at no additional cost to GWA.
9. The Contractor shall not begin an alteration affecting existing facilities until specific written approval has been granted by GWA in each case. An outage request shall be submitted to GWA a minimum of 14 calendar days in advance of the time that such outages are required. No more than one outage request will be considered per week. The Contractor shall coordinate the planned procedures with GWA. GWA has the authority to modify any proposed shutdown procedures if such procedures would adversely impact the water system operations.
10. The Contracting Officer shall be notified in writing at least seven (7) calendar days in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.
11. The Contractor shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.

1.7 REPORTS OF PHYSICAL CONDITIONS

A. Existing Structures: In the preparation of the Contract Documents, the Engineer has relied upon the following drawings of physical conditions in or relating to the existing surface and subsurface structures, which are at or contiguous to the Sites that have been utilized in the preparation of the Contract Documents:

1. Government of Guam Public Utility Agency of Guam, “FY 67 Water System Improvements for The Government Of Guam.”
2. Government of Guam Public Utility Agency of Guam, “FY 68 Water System Improvements for The Government Of Guam.”
3. Government of Guam Public Utility Agency of Guam, “Mangilao-Maimai-Chalan Pago Water Transmission Line.”
4. Government of Guam Public Utility Agency of Guam, “Dededo-Mangilao Water Transmission Line.”
5. Government of Guam Public Utility Agency of Guam, “Mangilao Reservoir and Pipeline.”
6. Government of Guam Public Utility Agency of Guam, “Yigo-Mangilao Water Transmission Line.”
7. Guam Waterworks Authority, “Tract 10432 and Tract 10433 Waterline-Yigo.”

B. These reports and drawings are not part of the Contract Documents. Neither GWA nor the Engineer makes any representation as to the completeness of the reports or drawings referred to above or the accuracy of any data or information contained therein. The Contractor may rely

upon the accuracy of the technical data contained in such reports and drawings, except for such physical dimensions that can be field verified; however, the interpretation of such technical data, including any interpolation or extrapolation thereof, and opinions contained in such reports and drawings are not to be relied on by the Contractor.

C. Data and information made available in these documents are for the Contractor's information. GWA assumes no responsibility for any interpretation of or conclusion drawn from the data or information by the Contractor.

1.8 WORK SEQUENCE

A. **Order of Work:** The Work shall be performed in such order or precedence as determined by the Contractor, subject to the conditions and restraints specified in this Section and the approval of the Contracting Officer.

B. Except as specifically noted below, the Contractor shall not operate any valves or turn off or on or manipulate any controls or equipment on existing facilities.

C. Work shall be scheduled, sequenced, and performed in a manner that minimizes disruption to the public.

D. **Major Construction Sequencing Elements:** The following list of main construction sequencing elements is not all inclusive and is not intended to be a comprehensive description of all Work. The Contractor shall review the list and ensure that each item, if awarded, is adequately considered and addressed in his construction schedule and work plan. It is the responsibility of the Contractor to identify and complete all related Work that is required to comply with the stated sequence.

1. Mobilize on each site prior to start of work.
2. Pothole to locate existing utilities as needed to confirm locations, sizes, crossing elevations and connection points.
3. Begin construction of Asan, Talofofo, Sinajana and East Agana Meters first and complete as possible.
4. Implement the Storm Water Pollution Prevention Plan ("SWPPP") and the erosion and sediment control measures.
5. Construct the facilities as shown and specified at each site, including completion of PRSV/meter vaults, piping, control building or equipment supports, electrical, instrumentation, controls, testing and disinfection, and appurtenances to allow for substantial completion of the facilities within the timelines specified.
6. Complete all remaining work and project closeout, including pavement restoration, finished grading, restoration seeding and all other Work as required.

1.9 PERMITS

A. Promptly furnish and pay fees for all necessary permits for construction of Work including, but not limited to, the following:

1. Building permit.
2. Highway Encroachment permit

3. Stormwater and erosion control permit.
4. Dewatering permit.
5. Disposal permit.
6. Utility clearances
7. SHPO clearances
8. Temporary and permanent power.
9. Temporary water.

B. The Contractor shall abide by the conditions of all permits and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the Work by the Owner.

C. Permitting and scheduling of the work with DPW and GWA is the responsibility of the Contractor.

1.10 FISH AND WILDLIFE

A. In accordance to the Endangered Species Act (ESA) of 1973, (16 U.S.C. 1531 et seq.) and the US Fish and Wildlife Technical Assistance Letter dated December 7, 2022, the following procedures are implemented to insure protection of endangered species and fair compensation to the Contractor for delays attendant to biological investigations.

B. The Contractor shall provide a qualified biologist to survey the project site daily, prior to conducting work to determine if ESA-listed species are in the area.
1. Surveying for Mariana Fruit Bats should be conducted in the early morning hours to verify their absence and presence.
2. Surveying for tree snails shall be conducted in undeveloped, forested areas. If discovered, survey must continue outwards until individuals are no longer detected in all directions.
3. Surveying for the Mariana Eight Spot Butterfly individuals, chrysalis, caterpillars, eggs, and host plants (Elatostema calcareum, Procris pedunculate).

C. Work shall be postponed or halted if ESA-listed species are observed within the project area and shall only resume after the animal has voluntarily departed the area. If a fruit bat is present within 492 feet (150 meters) of the project site, work shall be postponed.

D. If tree snails are discovered, the inhabited plants shall be flagged with brightly colored flagging tape and a 33-foot buffer will be maintained around the location of any individual or cluster to prevent entry of people and equipment.

E. If a Mariana Eight Spot Butterfly or its host plant is discovered, the area shall be visibly marked and the buffer distances listed in Table 011000-1.8.D shall be observed.

Table-011000-1.8.D: Buffer Distances for listed plants and butterfly host plants

Proposed Action	Buffer Distances	
	Herbs/Shrubs	Trees
Vegetation removal (hand tools)	1 m (3 ft)	1 m (3 ft)
Vegetation removal (mechanical)	Variable[a]	Variable[a]
Vegetation removal (heavy equipment)	Variable[b]	250 m (820 ft)
Hand application of herbicide	3 m (10 ft)	Crown Diameter
Ground spray of herbicide (e.g., backpack sprayer)	15 m (50 ft)	76 m (250 ft)
Aerial spray of herbicide (ball applicator)	76 m (250 ft)	76 m (250 ft)
Aerial spray of herbicide (paintball or individual treatment)	30 m (100 ft)	30 m (100 ft)
Aerial spray of herbicide (boom)	Prohibited	Prohibited
Ground/soil disturbance (hand tools)	6 m (20 ft)	2 times Crown Diameter
Ground/soil disturbance (heavy equipment)	100 m (328 ft)	250 m (820 ft)
Surface hardening/soil compaction (trails)	6 m (20 ft)	2 times Crown Diameter
Surface hardening/soil compaction (roads/utilities/buildings)	100 m (328 ft)	250 m (820 ft)
Prescribed burns	Prohibited	Prohibited
Farming, ranching, and silviculture	250 m (820 ft)	250 m (820 ft)

[a]3 feet, or the height of the vegetation to be removed, whichever is greater.
[b]2 times the width of the equipment, plus the height of the vegetation to be removed.

F. All on-site personnel shall be brief on the types of ESA listed species present in the project and the process of notifying a qualified biologist if ESA-listed species is sited.

G. Litter control program shall be implemented at the project site as to prevent potential pest establishing on the site.

H. Heavy equipment entering the project site shall be cleaned away from project area to prevent the spread of invasive species.

I. All equipment, materials, debris, and vegetation clipping shall be removed upon completion of work.

J. Minimize the use of pesticides. Insecticides and herbicides are chemicals that have direct and indirect effects to listed species. Insecticides can kill listed invertebrates, have secondary effects to listed bird and bat species, can reduce prey availability for insectivorous bat and bird species, and can result in reductions in numbers of plant pollinators. Spray drift and volatilization can result in effect far downwind of application site. Follow label instructions

K. Manual equipment will be used for any vegetation trimming and trees will not be removed prior to a Guam Department of Aquatic and Wildlife Resources or U.S. Fish and Wildlife Service biologist confirming there is not a roosting Mariana fruit bat present. Vegetation clearing outside of existing developed areas shall be avoided as much as possible and a 200-foot buffer will be established around the tree snail locations in which no vegetation trimming or removal will occur.

L. All work will be performed during daylight hours.

M. Equitable adjustment of the construction contract shall be made in the following manner:
   1. Time Extension
      a. If the work temporarily suspended is on the "critical path," the total number of days for which the suspension is in effect shall be added to the number of allowable contract days.
      b. If a portion of work at the time of such suspension is not on the "critical path" but subsequently becomes work on the critical path, the allowable contract time will be computed from the date such work is classified as on the critical path.
   2. Additional Compensation
      a. If, as a result of a suspension of the work, the Contractor sustain a loss which could not have been avoided by his judicious handling of forces, equipment, and (plant) or redirection of forces or equipment to perform other work on the contract, there shall be paid to the Contractor an amount as determined by the Engineer to be fair and reasonable compensation for the Contractor's actual loss in accordance with the following:
         1) Idle Time of Equipment - Compensation for equipment idle time will be determined on a force account (time and materials) basis, and shall include the cost of extra moving of equipment and rental loss.
         2) Idle Time of Labor - Compensation for idle time of workers will be determined by the Engineer as "labor" less any actual productivity factor of this portion of the work force.
         3) Increased Cost of Labor and Materials - Increased costs of labor and materials will be compensated only to the extent such increases was in fact caused by the suspension, as determined by the Engineer.
      b. Compensation for actual loss due to idle time of either equipment or labor shall not include markup for profit.
      c. The hours for which compensation will be paid will be the actual normal working time during which such delay conditions exist, but will in no case exceed eight hours in any one day.
      d. The days for which compensation will be paid shall be full or partial calendar days, excluding Saturdays, Sundays, and legal holidays, during the existence of such delay.

1.11 CULTURAL RESOURCES

A. In accordance to the National Historic Preservation Act of 1966, (16 U.S.C. 470) and Guam laws applicable to historic preservation, including, but not limited to, 21 G.C.A. Chapter 76, the following procedures are implemented to insure historic preservation and fair compensation to the Contractor for delays attendant to cultural resource investigations.

B. In the event of potential historical, architectural, archeological or cultural resources (herein after cultural resources) are discovered during subsurface excavations at the site of construction, the following procedures shall be instituted:

   1. The Engineer (authorized representative) shall issue a "Stop Work Order" directing the Contractor to cease all construction operations at the location of such potential cultural find.

2. Such "Stop Work Order" shall be effective until such Time as a qualified archaeologist can be called to assess the value of these potential cultural resources and make recommendations to the state Historical Preservation Officer. Any "Stop Work Order" shall contain the following:
   a. A clear description of the work to be suspended;
   b. Any instructions regarding issuance of further orders by the Contractor for material services;
   c. Guidance as to action to be taken on subcontractors;
   d. Any suggestions to the Contractor as to minimization of his cost;
   e. Estimated duration of the temporary suspension;
3. If the archeologist determines that the potential find is a true cultural resource, at the direction of the state Historic Preservation Officer, the Engineer shall extend the duration of the "Stop Work Order" in writing, and the Contractor shall suspend work at the location of the find.

C. Equitable adjustment of the construction contract shall be made in the following manner:
   1. Time Extension
      a. If the work temporarily suspended is on the "critical path," the total number of days for which the suspension is in effect shall be added to the number of allowable contract days.
      b. If a portion of work at the time of such suspension is not on the "critical path" but subsequently becomes work on the critical path, the allowable contract time will be computed from the date such work is classified as on the critical path.
   2. Additional Compensation
      a. If, as a result of a suspension of the work, the Contractor sustain a loss which could not have been avoided by his judicious handling of forces, equipment, and (plant) or redirection of forces or equipment to perform other work on the contract, there shall be paid to the Contractor an amount as determined by the Engineer to be fair and reasonable compensation for the Contractor's actual loss in accordance with the following:
         1) Idle Time of Equipment - Compensation for equipment idle time will be determined on a force account (time and materials) basis, and shall include the cost of extra moving of equipment and rental loss.
         2) Idle Time of Labor - Compensation for idle time of workers will be determined by the Engineer as "labor" less any actual productivity factor of this portion of the work force.
         3) Increased Cost of Labor and Materials - Increased costs of labor and materials will be compensated only to the extent such increases was in fact caused by the suspension, as determined by the Engineer.
      b. Compensation for actual loss due to idle time of either equipment or labor shall not include markup for profit.
      c. The hours for which compensation will be paid will be the actual normal working time during which such delay conditions exist, but will in no case exceed eight hours in any one day.
      d. The days for which compensation will be paid shall be full or partial calendar days, excluding Saturdays, Sundays, and legal holidays, during the existence of such delay.

D. Archaeological Monitoring: Contractor shall provide archaeological monitoring per Guam SHPO requirements. Monitoring shall include the following:

1. Archaeological Monitoring and Data Recovery Plan (AMDRP) – prepare draft and final AMDRP to monitor all project related ground disturbing activities
2. Fieldwork
    a. Preliminary recordation of identified archaeological sites and features identified during archaeological monitoring
    b. Recovery of artifacts
    c. Preliminary Assessment of identified site types and associations
    d. Consultation with GWA and Guam SHPO regarding findings
3. Data Analysis
    a. Analysis of recovered artifacts
    b. Radiocarbon dating
    c. GPS data processing
    d. GIS database development
    e. Report map production
4. Report Preparation and Production
    a. Draft and Final Reports including research methods, results of investigations, results of analyses, site significance evaluations, and recommendation for additional work (if needed)
    b. Preparation of GHPO Site Inventory form

E. Notwithstanding any provision above, Contractors will follow regulations promulgated by the Guam State Historic Preservation Office. The Guam State Historic Preservation Office is located at the Department of Parks and Recreation, Historic Resources Division, 490 Chalan Palayso, Agana Heights, Guam.

1.12 UNEXPLODED ORDNANCE

A. Stop all work immediately if any material or object believed to be unexploded ordnance or material potentially presenting an explosive hazard is encountered and execute first response protocols immediately. Follow Article 5.06, paragraphs E and F, of the General Conditions. Coordinate with the appropriate Government agency.

B. The Contractor shall not blow-in-place or counter-charge any unexploded ordnance.

1.13 SPECIFICATION CONVENTIONS

A. These Specifications are written in imperative mood and streamlined form. This imperative language is directed to Contractor unless specifically noted otherwise.

B. Omissions of such words and phrases as “The Contractor shall,” “in conformity therewith,” “shall be,” “as shown on the Drawings,” “a,” “an,” “the,” and “all” are intentional in streamlined sections.

1. Omitted words shall be supplied by inference in the same manner as when a note appears on the Drawings.
2. Omission of such words shall not relieve the Contractor from providing the items and Work described herein or indicated on the Drawings.
3. Words “shall be” are included by inference where colon (:) is used within sentences or phrases.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 011000

SECTION 012000 - PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Schedule of Values.

B. Application for Payment.

C. Change procedures.

D. Defect assessment.

1.2 SCHEDULE OF VALUES

A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed and incorporated into the cost loading function of the CPM Schedule as specified in Section 013216 – Construction Progress Schedule. Monthly progress payment amounts shall be determined from the monthly progress updates of the CPM Schedule activities.

B. The Schedule of Values shall be developed independent but simultaneous with the development of the CPM Schedule activities and logic.

C. Submit electronic file to Contracting Officer of schedule on most recent version of AIA G703 - Continuation Sheet for G702.

D. Submit Schedule of Values as electronic file to Contracting Officer for review within 21 calendar days after date established in Notice to Proceed. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the CPM Schedule activities, sufficient detailed breakdown shall be provided to meet this requirement. The Contracting Officer shall be the sole judge of acceptable numbers, details and description of values established. If, in the opinion of the Contracting Officer, a greater number of Schedule of Values items than proposed by the Contractor is necessary, the Contractor shall add the additional items so identified by the Contracting Officer.

E. Format: The minimum detail of breakdown of the major Work components is indicated below. Greater detail shall be provided as directed by the Contracting Officer.

1. Mobilization – Limited to five percent of the contract total, no breakdown required. Include obtaining all permits, bond and insurance; moving all equipment onto the site; furnishing and erecting temporary facilities and other construction facilities; implementing erosion and sediment control measures; and implementing security requirements. Request for payment after complete and permits approved.
2. Section 013216 – Construction Progress Schedule, broken down by submittal.

3. The electrical work shall be broken down by site. Electrical work shall be broken down into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations, lighting, and duct bank designation and substations.
4. Instrumentation, control and SCADA work shall be broken down by site, panel and control equipment.
5. Protective coating work shall be broken down by structure and site. Where specific coating work at structures or yard areas may be critical to performing the work to meet milestone and contract dates, such work shall be included as individual pay and schedule activity items.
6. Piping work shall be broken down into individual pipelines running from and to contract termination points. Each pipeline shall be an individual pay item unless otherwise allowed by the Contracting Officer. Connections that require system outage shall be an individual pay item.
7. Concrete structures shall be broken down by structure or vault (sufficient breakdown shall be provided to accommodate necessary schedule detail).
8. Civil site work shall be broken down into potholing, removal and disposal of existing structures, site concrete, pavement restoration, excavation and backfill, clearing and grubbing, fencing, and any other items determined to be necessary for the establishment of pay and schedule activity items.
9. Closeout and demobilization – no breakdown required.
10. All other work not specifically included in the above items shall be broken down as necessary for establishment of pay and schedule activity items as may be directed by the Contracting Officer.

F. Revise schedule to list approved Change Orders with each Application for Payment.

1.3 APPLICATION FOR PAYMENT

A. Submit two (2) copies of each Application for Payment on most recent versions of AIA G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet for G702.

B. Content and Format: Use Schedule of Values for listing items in Application for Payment.

C. Submit updated progress construction schedule with each Application for Payment.

D. Payment Period: Monthly, first through the end of the month.

E. Submit submittals with cover letter.

F. Substantiating Data: When Contracting Officer requires substantiating information, submit data justifying dollar amounts in question. Include the following with Application for Payment:

1. Record Documents as specified in Section 017000 - Execution and Closeout Requirements, for review by Contracting Officer, which will be returned to Contractor.
2. Affidavits attesting to off-Site stored products.
3. Construction Progress Schedule, revised and current as specified in Section 013300 - Submittal Procedures.
4. Certified Payroll Reports for the general contractor and all subcontractors.

1.4 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of Contracting Officer, Engineer of Record or GWA, it is not practical to remove and replace the Work, Contracting Officer will direct appropriate remedy or adjust payment.

C. Individual Specification Sections may modify these options or may identify specific formula or percentage sum/price reduction.

D. Authority of GWA to assess defects and identify payment adjustments is final.

E. Nonpayment for Rejected Products: Payment will not be made for rejected products for any of the following reasons:

1. Products wasted or disposed of in a manner that is not acceptable.
2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from transporting vehicle.
4. Products placed beyond lines and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected products.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 012000

SECTION 013000 - ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Coordination and Project conditions.

B. Preconstruction meeting.

C. Site mobilization meeting.

D. Progress meetings.

E. Preinstallation meetings.

F. Closeout meeting.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various Sections of the plans and specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Project communication and submission of documents between the Contracting Officer (Construction Manager) and the Contractor shall be as directed by the Contracting Officer and/or GWA.

C. Verify that utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.

D. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

1. Coordination Drawings: Prepare as required to coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important.

E. Coordination Meetings: In addition to other meetings specified in this Section, hold coordination meetings with personnel and Subcontractors to ensure coordination of Work.

F. In finished areas, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.

G. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion.

H. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

I. Contractor to submit list of sub-contractors for review and approval/denial with the bid per requirements of the General Conditions. The information should include company history, performance, relevant work, available equipment, and roles in the project.

1.3 PRECONSTRUCTION MEETING

A. GWA and its Contracting Officer will schedule and preside over meeting after Notice of Award and prior to the commencement of Work at the site.

B. Attendance Required: Contracting Officer (Construction Manager), GWA, appropriate governmental agency representatives selected by GWA, major Subcontractors, and Contractor’s project manager and superintendent.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the Contractor prior to the meeting date. However, the Contractor should be prepared to discuss all of the items listed below.

D. Minimum Agenda:

1. Status of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Building Permit acquisition
5. Submission of list of Subcontractors, list of products, schedule of values, Progress Schedule, and preconstruction submittals.
6. Communication procedures.
7. Procedures and processing of requests for interpretations, field decisions, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.
9. Critical Work sequencing.
10. Maintaining record documents.
11. Use of Site and storage areas, security, housekeeping, and GWA’s needs.
12. Construction Waste Management Plan.
13. Survey and building layout.
14. Temporary utilities
15. Major equipment deliveries and priorities.
16. Contractor’s assignments for safety and first aid.
17. Daily reports.
18. Procedures for testing.

E. Contracting Officer: Record minutes and distribute to participants within seven (7) days after meeting.

F. The Contractor and its subcontractors should plan on the conference taking no less than four (4) hours, to cover the items listed in Paragraphs C and D, and review the Plans and Specifications, in extensive detail, with the Contracting Officer and GWA.

1.4 PROGRESS MEETINGS

A. The Contracting Officer will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Contracting Officer will make arrangements for meetings, prepare agenda with copies for participants, and preside over meetings.

C. Attendance Required: Construction Project Manager, Job superintendent, major Subcontractors and suppliers, and Owner, as appropriate to agenda topics for each meeting.

D. Minimum Agenda:

1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems impeding planned progress.
5. Review of submittal schedule and status of submittals.
6. Review of off-Site fabrication and delivery schedules.
7. Maintenance of Progress Schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on Progress Schedule and coordination.
13. Other business relating to Work.

E. Contracting Officer: Record minutes and distribute to participants within five (5) working days after meeting.

1.5 PREINSTALLATION MEETINGS

A. When required in individual Specification Sections, convene preinstallation meetings at Project Site before starting Work of specific Section.

B. Convene preinstallation meetings at Project Site two (2) days before starting Work for GWA system outage.

C. Require attendance of parties directly affecting, or affected by, Work of specific Section.

D. Notify Contracting Officer four (4) working days in advance of meeting date.

E. Prepare agenda and preside over meeting:

1. Review conditions of installation, preparation, and installation procedures.
2. Review coordination with related Work.

F. Record minutes and distribute to participants within four (4) working days after meeting.

1.6 CLOSEOUT MEETING

A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.

B. Attendance Required: Contractor, Contracting Officer, major Subcontractors, GWA, and others appropriate to agenda.

C. Notify Contracting Officer and GWA a minimum of four (4) working days in advance of meeting date.

D. Minimum Agenda:

1. Start-up of facilities and systems.
2. Operations and maintenance manuals.
3. Testing, adjusting, and balancing.
4. System demonstration and observation.
5. Operation and maintenance instructions for Owner's personnel.
6. Contracting Officer’s inspection of Work.
7. Contracting Officer’s preparation of an initial "punch list."
8. Procedure to request Architect/Engineer/Contracting Officer inspection to determine date of Substantial Completion.
9. Completion time for correcting deficiencies.
10. Inspections by authorities having jurisdiction.
11. Certificate of Occupancy and transfer of insurance responsibilities.
12. Partial release of retainage.
13. Final cleaning.
14. Preparation for final inspection.
15. Closeout Submittals:

    a. Project record documents.
    b. Operating and maintenance documents.
    c. Operating and maintenance materials.
    d. Affidavits.

16. Final Application for Payment.
17. Contractor's demobilization of Site.
18. Maintenance.

E. Contracting Officer: Record minutes and distribute to participants within five (5) working days after meeting, to Owner, Contractor, and those affected by decisions made.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 013000

SECTION 013216 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. Bar chart schedules.

D. Review and evaluation.

E. Updating schedules.

F. Inclement Weather Provisions Of The Schedule.

G. Acceptance.

H. Distribution.

1.2 SUBMITTALS

A. The Contractor shall submit proposed preliminary bar chart schedule at the Preconstruction Conference defining planned operations for first 60 days of Work, with general outline for remainder of Work. The chart shall be so prepared to show the accomplishment of the Contractor's early activities (mobilization, permits, submittals necessary for early material and equipment procurement, submittals necessary for long lead equipment procurement, CPM submittals, initial Site work and other submittals and activities required in the first 60 days).

B. Participate in review of preliminary and complete bar chart schedule jointly with Contracting Officer.

C. Within 14 calendar days after joint review of proposed preliminary Gantt bar chart, submit hard copy draft of proposed complete Original CPM Schedule in PDF format and scheduling software files in a format compatible with Primavera P6 software. In addition, provide any related computerized schedule report tabulations for review. This submittal shall have already been reviewed and approved by the Contractor's project manager, project superintendent, and the project estimator prior to submission. The Gantt chart shall describe the activities to be accomplished and their chronological relationships and show the critical path. The Contractor's attention is directed to the requirement that the schedule shall contain sufficient detail and information to cost load the CPM schedule in accordance with the approved schedule of values. Include written certification that major Subcontractors have reviewed and accepted proposed schedule.

D. Submit updated Gantt bar chart schedules at the end of each calendar month and at least seven (7) calendar days prior to each Application for Payment.

E. Submit one (1) hard copy and electronic files (PDF and schedule software files).

F. Submit network schedules under transmittal letter form specified in Section 013300 - Submittal Procedures.

G. Schedule Updates:

1. Overall percent complete, projected and actual.
2. Completion progress by listed activity and subactivity, to within five (5) working days prior to submittal.
3. Changes in Work scope and activities modified since submittal.
4. Delays in submittals or resubmittals, deliveries, or Work.
5. Adjusted or modified sequences of Work.
6. Other identifiable changes.
7. Revised projections of progress and completion.

H. Narrative Progress Report:

1. Submit with each monthly submission of Progress Schedule.
2. Summary of Work completed during the past period between reports.
3. Work planned during the next two (2) month period, specify critical activities.
4. Explanation of differences between summary of Work completed and Work planned in previously submitted report.
5. Current and anticipated delaying factors and estimated impact on other activities and completion milestones.
6. The status of major material and equipment procurement.
7. Corrective action taken or proposed.

1.3 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel specializing in CPM scheduling with two years' minimum experience in scheduling construction work of complexity comparable to the Project, and having use of computer facilities capable of delivering detailed graphic printout within 48 hours of request.

B. Contractor shall submit a statement of computerized CPM capability within 14 calendar days after Notice to Proceed to verify that either (1) the Contractor has in-house capability qualified to use CPM techniques or (2) the Contractor will arrange for the services of a CPM consultant so qualified. In either event the statement shall identify the individual who will perform the CPM scheduling and shall describe the construction project experience. The statement shall also identify the contact persons for the referenced projects with current telephone and address information.

1.4 GANTT BAR CHART SCHEDULES

A. Format: Gantt bar chart Schedule, to include at least:

1. Identification and listing in chronological order of those activities reasonably required to complete the Work, including:

a. Subcontract Work.
b. Major equipment design, fabrication, factory testing, and delivery dates including required lead times.
c. Move-in and other preliminary activities.
d. Equipment and equipment system test and startup activities.
e. Project closeout and cleanup.
f. Work sequences, constraints, and milestones.

2. Listings identified by Specification Section number.
3. Identification of the following:

a. Horizontal time frame by year, month, and week.
b. Duration, early start, and completion for each activity and subactivity.
c. Critical activities and Project float.
d. Subschedules to further define critical portions of Work.

B. All float in the schedule shall belong to the project. The computerized schedule report tabulations shall include the following:

1. Report of activities sorted by activity number. Activity numbers, where practical, shall correlate to the areas designated in the Contract Drawings and further defined in Section 011000 - Summary.
2. Report of activities sorted by early start date.
3. Report of activities sorted by total float.
4. Report of activities sorted by responsibility code. Responsibility codes shall be established for the Contractor, Contracting Officer, GWA, subcontractors, suppliers, etc. These codes shall be identified in the bar chart.
5. A successor-predecessor report which shall identify the successor and predecessor activities for each activity and ties between schedule activities.

1.5 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of schedules with Contracting Officer at each submittal.

B. The monthly progress schedule update submittal will be reviewed with the Contractor during the first monthly construction progress meeting after the end of each calendar month. The goal of these meetings is to enable the Contractor and the Contracting Officer to initiate appropriate remedial action to minimize any known or foreseen delay in completion of the Work and to determine the amount of Work completed since the last month's schedule update. The status of the Work will be determined by the percent complete of each activity in the updated CPM schedule. These meetings are considered a critical component of the overall monthly schedule update submittal, and the Contractor shall have appropriate personnel attend. As a minimum, these meetings shall be attended by the Contractor's Project Manager and General Superintendent. The Contractor shall plan on the meeting taking no less than 2 hours per week. Within seven (7) Workdays after the monthly progress meeting, the Contractor shall submit the revised CPM schedule, the revised CPM computerized tabulations as noted in this Section, the revised successor/predecessor report, and the project narrative reports as defined above and the Contractor's application for payment. Within five (5) Workdays of receipt of the revised submittals, the Contracting Officer will either accept or reject the monthly schedule update

submittal. If accepted, the percent complete in the monthly update shall be the basis for the Application for Payment to be submitted by the Contractor. If rejected, the update shall be corrected and resubmitted by the Contractor before the application for payment for the update period will be processed.

C. Items discussed at monthly construction progress meetings may include status of major Project components (percent complete, amount of time ahead or behind schedule) and an explanation of how the Project will be brought back on schedule if delays have occurred, progress made on critical activities, explanations for lack of work on critical path activities, explanations for schedule changes, a list of critical activities scheduled to be performed within the next two-month period, status of major material and equipment procurement, delays encountered during reporting period, and assessment of inclement weather delays and effects on progress of Work.

D. After review, revise schedules incorporating results of review, and resubmit within 10 calendar days.

1.6 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update schedules to depict current status of Work.

C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

D. Upon approval of a Change Order, include the change in the next schedule submittal.

E. Neither the submission nor the updating of the Contractor's original schedule submittal nor the submission, updating, change, or revision of any other report, curve, schedule, or narrative submitted to the Contracting Officer by the Contractor under this Contract, nor the Contracting Officer's review or acceptance of any such report, curve, schedule, or narrative shall have the effect of amending or modifying, in any way, the Contract Times or milestone dates or of modifying or limiting, in any way, the Contractor's obligations under this Contract. Only a signed, fully executed change order can modify contractual obligations.

F. Indicate changes required to maintain Date of Substantial Completion.

G. Submit sorts as required to support recommended changes.

H. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect.

I. GWA reserves the right to require that the Contractor adjust, add to, or clarify any portion of the schedule which may later be discovered to be insufficient for the monitoring of the Work or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.

1.7 ABNORMAL WEATHER LOST WORK DAY PROVISIONS OF THE SCHEDULE

A. See 00800 Supplementary Conditions, Article 4, SC-4.05, 2. Adverse weather conditions.

Account for the Weather Calendar by assigning to any activity that could be impacted by abnormal weather as float for each month. The GWA will issue a modification in accordance with the contract clauses, giving the Contractor a time extension for the difference of days between the anticipated and actual abnormal weather delay if the number of actual abnormal weather delay days exceeds the number of days anticipated for the month in which the delay occurs and the abnormal weather delayed activities are critical to contract completion. A lost workday due to weather conditions is defined as a day in which the Contractor cannot work at least 50 percent of the day on the impacted activity.

B. In addition to the provisions of paragraph 1.7.A. above, to be eligible for a delay the weather must be experienced at the project Site during the Contract period and must be found to be abnormal weather actually causing a delay to the completion of the project. It will be the Contractor's responsibility to prove in writing that a critical path activity was negatively affected. Weather delays occurring after the required completion date, prior to the date of the Notice to Proceed, and during other non-workdays will not be considered for a time extension. Time extension on account of inclement weather on weekends or holidays shall be granted only if the Contractor confirms in writing at least seven (7) calendar days in advance their intention to work on weekends or holidays.

C. All inclement weather delays during the original Contract Time or any extended period, regardless of when they are encountered, shall be non-compensable.

1.8 ACCEPTANCE

A. Acceptance of the Contractor's schedule by the Contracting Officer and GWA will be based solely upon compliance with the requirements. By way of the Contractor assigning activity durations and proposing the sequence of the Work, the Contractor agrees to utilize sufficient and necessary management and other resources to perform the work in accordance with the schedule. Upon submittal of a schedule update, the updated schedule shall be considered the "current" project schedule.

B. Submission of the Contractor's progress schedule to GWA or Contracting Officer shall not relieve the Contractor of total responsibility for scheduling, sequencing, and pursuing the Work to comply with the requirements of the Contract Documents, including adverse effects such as delays resulting from ill-timed Work.

1.9 DISTRIBUTION

A. Following joint review, distribute copies of updated schedules to Contractor's Project site file, to Subcontractors, Contracting Officer, and Owner.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 013216

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Definitions.

B. Submittal procedures.

C. Proposed product list.

D. Product data.

E. Use of electronic CAD files of Project Drawings.

F. Shop Drawings.

G. Samples.

H. Other submittals.

I. Design data.

J. Test reports.

K. Certificates.

L. Manufacturer's instructions.

M. Manufacturer's field reports.

N. Contractor review.

O. Contracting Officer review.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's and Contracting Officer's responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Architect/Engineer's and Contracting Officer's responsive action. Submittals may be rejected for not complying with requirements.

C. PDF: Portable Document Format is an open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed layout document format.

D. FTP: File Transfer Protocol is a standard network protocol used for the transfer of files between computers over a network. A FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

E. Cloud: Cloud Computing: the practice of using a network of remote servers hosted on the internet to store, manage, and process data, rather than a local server or a personal computer.

F. CMS: Construction Management Software: this specification refers strictly to Web-Based systems.

1.3 SUBMITTAL PROCEDURES

A. Within 14 calendar days after date of Notice to Proceed, the Contractor shall submit the following preconstruction submittal items to the Contracting Officer for Review

1. A preliminary schedule of Shop Drawings, Samples, Products and proposed Substitutes ("or approved equivalent") submittals listed in the Bid.
2. A schedule of submittals based on the Contractor's priority, planned construction sequence and schedule, long-lead items, and size of submittal package.
3. A list of all permits and licenses the Contractor shall obtain indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.
4. Warranties on Equipment provided. Note, Contractor is the warranty administrator for all goods/services provided under this Bid.
5. A 60-day plan of operation in accordance with the submittal of the preliminary bar chart schedule in Section 013216 – Construction Progress Schedule.

B. Within 30 calendar days after date of Notice to Proceed, the Contractor shall submit the following submittal items to the Contracting Officer for Review

1. Flow meter Product Data.
2. Pressure reducing/sustaining valve (PRSV) Product Data

C. Transmit each submittal with Contracting Officer-accepted form.

D. Number submittal transmittal forms so each submittal is assigned a unique number, beginning with the specification section most pertinent to the submittal followed by a hyphen and sequential numbers. Mark revised submittals with original number and sequential revision letter suffix "A", "B", 'C", etc.

E. Identify: Project, Contractor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.

F. Apply Contractor's stamp, signed, certifying that the Contractor has reviewed, approved, verified the products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.

G. Normally, a separate transmittal form shall be used for each specific item or class of material or equipment for which a submittal is required. Transmittal of a submittal of various items in the same specification section using a single transmittal form will be permitted only when the items

taken together constitute a manufacturer's "package" or are so functionally related that expediency indicates review of the group or package as a whole. A multiple-page submittal shall be collated into sets, and each set shall be stapled or bound, as appropriate, prior to transmittal to the Contracting Officer. Pages shall be numbered and shall be in order.

H. Format:

1. Minimum sheet size shall be 8½ inches by 11 inches, and maximum sheet size shall be 24 inches by 36 inches.
2. Number every page in a submittal in sequence.
3. Collate and staple or bind, as appropriate, each copy of a submittal; the Contracting Officer will not collate sheets or copies.
4. Where product data from a manufacturer is submitted, clearly mark and/or notate which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports.
5. Present a sufficient level of detail for assessment of compliance with the Contract Documents.
6. All digital submittals may be directed by the Contracting Officer and/or GWA. Digital files shall follow format requirements. Digital files shall be PDF or acceptable file format for the type of submittal.

I. Electronic File Format

1. Provide all submittals in electronic format, with exception of samples items.
2. Name the file in this format, SITE_SSSSSS_QQX, where:
    a. SITE: name of the site if not a general submittal for all sites.
    b. SSSSSS: 6-digit numeric Section Number to which the submittal pertains.
    c. QQ: 2-digit sequential number assigned by contractor unique to each original submittal.
    d. X: revision letter; omit if original.
    e. Example: DairyRd_033000_01A
3. PDF: provide files in Adobe PDF format.
    a. Compile the submittal file as a single, complete document, to include Transmittal Form described within.
    b. Generate PDF files from original documents with bookmarks so that the text included in the PDF files is both searchable and can be copied.
    c. If documents are scanned, Optical Character Resolution (OCR) routines are required.
    d. Index and bookmark files exceeding 30 pages to allow efficient navigation of the file.
    e. When required, the electronic file must include a valid electronic signature, or scan of a signature.
4. AutoCAD: where specified, provide files in AutoCAD 2021 format.
5. Microsoft Excel (MS Excel): where specified, provide files in (.xlsx) format.
6. Microsoft Word (MS Word): where specified, provide files in (.docx) format.

J. Schedule submittals to expedite Project. Coordinate submission of related items.

K. Electronic Submittal: For all electronic communication, Contractor shall strictly adhere to protocol to be provided by Contracting Officer at Preconstruction Conference.

1. Email: Email electronic submittal documents fewer than 10MB to an email address as directed by the Contracting Officer. Provide electronic documents over 10MB on an optical disc, or through some form of FTP service.
2. Cloud: The Contracting Officer may setup an account with a commercially available Cloud Storage Service Provider specifically for this project. Folders will be created for each section number. Upload submittal in corresponding folders. Send e-mail (without attachments) notifying Contracting Officer that submittals are uploaded. Contractor is responsible for obtaining access to the Cloud Storage Service for all Contractor personnel requiring access at no additional cost to Contracting Officer.
3. CMS: The Contracting Officer may purchase or provide access to a CMS. The Contracting Officer will provide training on the use of the system and the process for uploading submittals and other documents for the project.

L. For each submittal for review, allow a minimum of 21 working days excluding delivery time to and from Contractor.

M. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.

N. Allow space on submittals for Contractor and Architect/Engineer/Contracting Officer review stamps.

O. When revised for resubmission, identify changes made since previous submission.

P. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

Q. Submittals not requested will not be recognized nor processed.

R. Incomplete, Disorganized, or Improperly Numbered Submittals: Architect/Engineer or Contracting Officer will not review and will return marked “unreviewed”. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Architect/Engineer or Contracting Officer.

1.4 PROPOSED PRODUCT LIST

A. Within 30 calendar days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.5 PRODUCT DATA

A. Product Data: Action Submittal: Submit to Contracting Officer for review for assessing conformance with information given and design concept expressed in Contract Documents.

B. Post electronic submittals as PDF electronic files to Project website or submit electronic submittals via email as PDF electronic files.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 017000 - Execution and Closeout Requirements.

1.6 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

A. Electronic CAD Files of Project Drawings: May only be used to expedite production of Shop Drawings for the Project. Reproductions of the contract drawings as shop drawings is unacceptable. Use for other Projects or purposes is not allowed.

B. Electronic CAD Files of Project Drawings: Distributed only under the following conditions:

1. Use of files is solely at receiver's risk. Architect/Engineer does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Architect/Engineer of discrepancy and use information in hard-copy Drawings and Specifications.
2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.
3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents. Shop Drawings submitted with information associated with other trades or with references to Contract Documents will not be reviewed and will be immediately returned.
4. Receiver shall not hold Architect/Engineer responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.
5. Receiver shall understand that even though Architect/Engineer has computer virus scanning software to detect presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.
6. Receiver shall not hold Architect/Engineer responsible for such viruses or their consequences, and shall hold Architect/Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

1.7 SHOP DRAWINGS

A. Shop Drawings: Action Submittal: Submit to Contracting Officer for assessing conformance with information given and design concept expressed in Contract Documents.

B. The term “Shop Drawings” as used herein shall be understood to include design calculations, shop-prepared drawings, fabrication, and installation drawings, erection drawings, list, graphs, catalog sheets, data sheets, and similar items.

C. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

D. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer responsible for designing components shown on Shop Drawings.

1. Include signed and sealed calculations to support design.
2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
3. Make revisions and provide additional information when required by authorities having jurisdiction.

E. Post electronic submittals as PDF electronic files to Project website or Submit electronic submittals via email as PDF electronic files.

F. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 017000 - Execution and Closeout Requirements.

1.8 SAMPLES

A. Samples: Action Submittal: Submit to Contracting Officer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Samples for Selection as Specified in Product Sections:

1. Submit to Contracting Officer for aesthetic, color, and finish selection.
2. Submit Samples of finishes, textures, and patterns for GWA selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

D. Include identification on each Sample, with full Project information, specified physical characteristics and Manufacturer’s name.

E. Submit three (3) Samples or the number specified in individual Specification Sections; Contracting Officer will retain one (1) Sample.

F. Samples, as required herein, shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work. The Contractor shall schedule sample submittals for acceptance such that the Contractor has sufficient time to provide the products or materials without delay to the construction schedule after the Contracting Officer selects colors and textures and no less than 45 calendar days prior to ordering such material for delivery to the Site.

G. Unless indicated otherwise, all colors and textures of items presented in sample submittals shall be from the manufacturer’s standard colors and standard materials, products, or equipment lines. If the samples represent non-standard colors, materials, products, or equipment lines and their selection will require an increase in Contract Times or Price, the Contractor shall clearly indicate same on the transmittal page of the submittal.

H. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

I. Samples will not be used for testing purposes unless specifically stated in Specification Section.

J. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 017000 - Execution and Closeout Requirements.

1.9 OTHER SUBMITTALS

A. Closeout Submittals: Comply with Section 017000 - Execution and Closeout Requirements.

B. Informational Submittal: Submit data for Contracting Officer's knowledge as Contract administrator or for Owner.

C. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

1.10 TEST REPORTS

A. Informational Submittal: Submit reports for Contracting Officer's knowledge as Contract administrator or for Owner.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.11 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Contracting Officer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product but must be acceptable to Contracting Officer.

1.12 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for Contracting Officer's knowledge as Contract administrator or for Owner.

B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Contracting Officer in quantities specified for Product Data.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.13 MANUFACTURER'S FIELD REPORTS

A. Informational Submittal: Submit reports for Contracting Officer's knowledge as Contract administrator or for Owner.

B. Submit report within 5 days of observation to Contracting Officer for information.

C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.14 CONTRACTOR REVIEW

A. Review for compliance with Contract Documents and approve submittals before transmitting to Contracting Officer.

B. Contractor: Responsible for:

1. Determination and verification of materials including manufacturer's catalog numbers.
2. Determination and verification of field measurements and field construction criteria.
3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
4. Determination of accuracy and completeness of dimensions and quantities.
5. Confirmation and coordination of dimensions and field conditions at Site.
6. Construction means, techniques, sequences, and procedures.
7. Safety precautions.
8. Coordination and performance of Work of all trades.

C. Stamp, sign, and date each submittal to certify compliance with requirements of Contract Documents.

D. Do not fabricate products or begin Work for which submittals are required until approved submittals have been received from Contracting Officer. Products and work started without the review of a submittal shall be subject to rejection and replacement at the Contractor’s expense.

1.15 CONTRACTING OFFICER REVIEW

A. The Contracting Officer or Architect/Engineer will review and accept, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for general conformance with information given and the design concept expressed in the Contract Documents. Corrections or comments made on the submittal or shop drawings during review do not relieve the Contractor from compliance with the requirements of the Contract Documents, including, without limitation, the plans, specifications and applicable laws, codes and regulations. Review of a specific item shall not include review of an assembly of which the item is a component.

B. Do not make "mass submittals" to Contracting Officer. "Mass submittals" are defined as six or more submittals or items in one (1) day or 15 or more submittals or items in one (1) week. If "mass submittals" are received, Contracting Officer's review time stated above will be extended

as necessary to perform proper review. Contracting Officer will review "mass submittals" based on priority determined by Contracting Officer after consultation with Owner and Contractor.

C. Informational submittals and other similar data are for Contracting Officer's information, do not require Contracting Officer's responsive action, and will not be reviewed or returned with comment.

D. If a submittal is returned to the Contractor marked “No Exceptions Taken,” formal revision and resubmission of said submittal will not be required.

E. If a submittal is returned to the Contractor marked “Make Corrections Noted,” formal revision and resubmission of said submittal will not be required.

F. Resubmittals:

1. If a submittal is returned to the Contractor marked “Amend-Resubmit,” the Contractor shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the Contracting Officer.
2. Resubmittal of portions of multi-page or multi-drawing submittals will not be accepted: For example, if a Shop Drawing submittal consisting of 10 drawings contains one (1) drawing noted as “Amend-Resubmit,” the submittal as a whole is deemed “Amend-Resubmit,” and 10 drawings are required to be resubmitted.
3. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

G. Rejected Submittals:

1. If a submittal is returned to the Contractor marked “Rejected-Resubmit,” the Contractor shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the Contracting Officer.
2. The resubmittal of rejected portions of a previous submittal will not be accepted.

H. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

I. Submittal approval does not authorize changes to Contract requirements unless accompanied by Change Order.

J. Owner may withhold monies due to Contractor to cover additional costs beyond the second submittal review.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality control.

B. Submittals.

C. Owner’s Quality Assurance.

D. Tolerances.

E. References.

F. Labeling.

G. Testing and inspection services.

H. Manufacturers' field services.

I. Quality Control Program.

J. Owner Inspection.

1.2 QUALITY CONTROL

A. Specific quality control requirements for the Work are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the Work beyond furnishing of manufactured products.

B. The term “Quality Control” (QC) includes inspection, sampling, testing and associated requirements performed by the Contractor, as means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract Documents.

C. The term “Quality Assurance” (QA) refers to similar inspection and testing performed by GWA or the Contracting Officer to review the quality control process.

D. Contractor shall have the primary responsibility for QC. GWA will perform its own QA for the sole purpose of checking the Contractor’s QC program. The Contractor shall not use GWA’s QA program to satisfy or assist with the Contractor’s QC program and shall perform all necessary testing and other QC functions required for submittals and construction to assure a quality project. If the Contractor does not perform the minimum QC functions as outlined in this Section and the detailed Specifications, GWA will perform said QC and retain sufficient money as required from each pay request to reimburse GWA for performing Contractor’s QC.

E. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.

F. Comply with specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

G. Perform Work using persons qualified to produce required and specified quality.

H. Products, materials, and equipment may be subject to inspection by Architect/Engineer, Contracting Officer and Owner at place of manufacture or fabrication. Such inspections shall not relieve Contractor of complying with requirements of Contract Documents.

I. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

1.3 SUBMITTALS

A. QC Program: Contractor shall submit a QC program satisfactory to GWA not later than 30 calendar days after receipt of the Notice-to-Proceed and prior to the commencement of work at the site.

1.4 OWNER'S QUALITY ASSURANCE

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

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

1. Relieve contractor of responsibility for providing adequate quality control measures;
2. Relieve contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance;
4. Relieve contractor from coordinating with Guam DPW for acceptance; or
5. Affect the continuing rights of GWA after acceptance of the completed Work.

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

D. Unless otherwise indicated, all sampling and testing will be in accordance with the methods prescribed in the referenced standards, as applicable to the class and nature of the article or materials considered; however, GWA reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the Contracting Officer will assure GWA that the quality of the workmanship is in full accord with the Contract Documents.

1.5 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Contracting Officer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.6 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current as of date for receiving Bids except where specific date is established by code.

C. Obtain copies of standards and maintain on Site when required by product Specification Sections.

D. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Contracting Officer before proceeding.

E. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of Contracting Officer shall be altered from Contract Documents by mention or inference in reference documents.

1.7 LABELING

A. Label Information: Include manufacturer's or fabricator's identification and the following information, as applicable, on each label:

1. Model number.
2. Serial number.
3. Performance characteristics.

1.8 TESTING AND INSPECTION SERVICES

A. Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing.

1. Before starting Work, submit testing laboratory name, address, and telephone number, and names of full-time Professional Engineer and responsible officer.
2. Submit copy of report of laboratory facilities' inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.

B. Contractor shall not use the same independent third party for its QC as GWA selects for its QA. GWA will provide the testing agency to be used for QA upon request.

C. Independent firm will perform tests, inspections, and other services specified in individual Specification Sections and as required by Architect/Engineer, Contracting Officer, Owner, or authorities having jurisdiction.

1. Laboratory: Authorized to operate at Project location.
2. Laboratory Staff: Maintain full-time Professional Engineer on staff to review services.
3. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

D. Testing, inspections, and source quality control may occur on or off Project Site. Perform off-Site testing as required by Architect/Engineer or Owner.

E. Contractor shall interrupt the Work when necessary to allow testing, including sampling, to be performed by GWA or the Contractor. Contractor shall have no claim for an increase in Contract Price or Contract Times due to such interruptions. When testing activities, including sampling, are performed in the field by the testing firm's laboratory personnel, Contractor shall furnish personnel and facilities to assist in the activities for both GWA's program and the Contractor's program.

F. Reports shall be submitted by independent firm to Contracting Officer, Contractor, and authorities having jurisdiction, in duplicate, indicating observations and results of tests and compliance or noncompliance with Contract Documents.

1. Submit final report indicating correction of Work previously reported as noncompliant.

G. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1. Notify Contracting Officer and independent firm 48 hours before expected time for operations requiring services.
2. Make arrangements with independent firm and pay for additional Samples and tests required for Contractor's use.

H. Employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work according to requirements of Contract Documents.

I. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by same independent firm on instructions from Contracting Officer. Payment for retesting or re-inspection will be borne the Contractor at no additional cost to GWA.

J. Payment for additional costs from QA testing agency or laboratory for retesting or re-inspection required because of nonconformance with specified or indicated requirements or when Work by Contractor is not ready at the time specified for inspection or test will be charged to Contractor by deducting testing charges from Contract Sum/Price.

K. If test results and the quality of Work are questionable in the opinion of GWA, confirmation testing - in addition to QC testing - may be ordered by GWA. If confirmation testing is ordered by GWA and the Work does not pass the test, costs for such testing shall be paid for by Contractor at no additional cost to GWA. If confirmation tests are satisfactory, the costs for confirmation testing will be paid for by GWA at no additional cost to the Contractor. Testing services conducted by GWA for their QA are for the sole benefit of GWA; however, test results will be provided to Contractor.

L. Agency Responsibilities:

1. Test Samples of mixes submitted by Contractor.
2. Provide qualified personnel at Site. Cooperate with Contracting Officer and Contractor in performance of services.
3. Perform indicated sampling and testing of products according to specified standards.
4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
5. Promptly notify Contracting Officer and Contractor of observed irregularities or nonconformance of Work or products.
6. Perform additional tests required by Contracting Officer.
7. Attend preconstruction meetings and progress meetings, as requested.

M. Agency Reports: After each test, promptly submit two (2) copies of report to Contracting Officer, Contractor, and authorities having jurisdiction. When requested by Contracting Officer, provide interpretation of test results. Include the following:

1. Date issued.
2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and Specification Section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

N. Limits on Testing Authority:

1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

1.9 MANUFACTURER'S FIELD SERVICES

A. When specified in individual Specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel, a regular employee of the manufacturer (not the local supplier), to observe Site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, and commissioning as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Contracting Officer 30 calendar days after date established in Notice to Proceed. Observer is subject to approval of Contracting Officer.

C. Report observations and Site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions.

D. Refer to Section 013300 - Submittal Procedures, "Manufacturer's Field Reports" Article.

1.10 QUALITY CONTROL PROGRAM

A. Quality Control Program: The Contractor shall develop a detailed written QC Program for all Work required under Divisions 0 thru 40, and it shall be reviewed and approved by the Contracting Officer prior to commencement of the Work. The QC program shall be submitted to the Contracting Officer for approval per Section 013300 – Submittal Procedures. The Contractor shall appoint a full time QC Officer who will have the sole responsibility for monitoring the implementation of the QC Program.

B. The QC program manual as a minimum shall contain the following:

1. Project Organization Chart: Contractor shall provide an organizational flow chart and individual responsibilities with respect to QC, including:
    a. All essential Contractor personnel and Subcontractors shall be outlined by title, function, and name.
    b. Field personnel responsible for QC functions shall be named.
    c. Job functions shall be provided detailing Work responsibilities relating to QC.
    d. Qualifications and experience shall be provided for each individual named in Items a and b above.
2. Contractor shall name the independent testing laboratory/laboratories and show their organizational relationship, including all special inspectors required.
3. Policy for providing training and/or certifications to their personnel to perform QC functions.
4. Contractor shall provide a statement in their QC Program that the Contractor shall submit to the Contracting Officer for approval, the qualifications of any individual proposed as a new or alternate QC Officer during the course of the project.

C. Stop Work Authority: Contractor shall provide the names of the individuals who have authority to stop Work, which does not comply with the Contract requirements. Each location or activity of Work shall have a field Quality Control Representative (who reports to the Quality Control Officer) with the “Stop Work Authority” overseeing the Work.

D. Documentation and Records: Contractor shall describe the levels of responsibilities for documentation control and transmittal of records/information to the Contracting Officer, including but not limited to:

1. Submittal procedures,
2. As-built procedures,
3. Material and Equipment delivery and tracking procedures,
4. Test reporting and quantity tracking procedures,
5. Deficiency/Non-compliance reporting, resolution, and tracking procedures,
6. Transmittal procedures and time frames, and

7. Audit procedures and frequencies of QC Program.

E. Quality Control Reports: Contractor shall detail their procedures for reporting the QC testing and inspections activities and problem resolutions performed. The Contractor shall provide a description of each type of report and an example of each report form shall be included as an appendix to the QC program manual. The QC reports shall include at a minimum:

1. Daily QC reports,
2. Monthly reports summarizing all QC activities, testing, and reports, and
3. Final certified report.

F. Inspection and Testing Notification and Reporting: Contractor shall provide the procedure on how verbal and written notifications shall be issued to the Contracting Officer of inspections and testing to be performed on upcoming activities. Minimum time frames for notifications shall be outlined by the Contracting Officer. Contractor shall utilize 'Inspection Sign-Off' forms which shall be used at a minimum, for each of the major activities of Work. "Inspection Sign-Off' forms shall include signatures from both the Contractor's QC representative and the Contracting Officer's representative(s). Contractor shall include, as an appendix to the QC Program Manual, copies of the Inspection and Testing Notification forms. At a minimum the Contractor shall include:

1. Notifications of inspections and/or testing forms
2. Inspection Sign-Off forms
3. Minimum 1-Work Week schedule of concrete pours, compaction testing, and special inspections, detailing location(s), quantity(ies), date(s), and approximate time(s) of pours

G. Contractor shall coordinate with Guam DPW for any required inspections by DPW personnel for acceptance of the project.

H. Inspection and Testing Procedures: Contractor shall provide written procedures defining methods of construction, control measures and the performance of inspections and testing for the different types of Work. The procedures shall detail "Hold Points", where Work shall not proceed until the required QC and/or GWA QA functions are performed and documentation shows the Work meets the requirements of the Contract. The procedures shall detail problem resolution steps in the event the Work does not meet the Contract Specifications. Contractor shall state that new procedures shall be submitted to the Contracting Officer for approval, as deemed necessary by either the Contracting Officer or Contractor, during the course of the Work. Procedures shall be provided for all major activities of Work and shall be provided for more specific items of Work, as deemed necessary by either the Contracting Officer or Contractor, to properly control the Work. Major Work activities shall include, but not be limited to:

1. Earthwork
2. Asphalt concrete
3. Portland cement concrete
4. Pipe installations
5. Mechanical installations
6. Equipment installations
7. Electrical installations
8. Instrumentation and control installations
9. Painting and protective coatings

10. All quality control activities required for Divisions 2 through 40 inclusive

I. Failing Inspections or Tests: Contractor shall provide procedure(s) detailing actions to be taken when tests show the Material or item of Work does not meet the minimum Contract requirements. In order to control failing QC and Quality Assurance inspections and/or testing, Contractor shall perform 'informational testing." Contractor shall detail how informational testing will be utilized prior to requesting any acceptance inspection and/or testing from GWA. Informational testing shall be performed by the Contractor to determine the amount of effort necessary to provide Work which is in compliance with the Contract Documents. Informational testing shall be performed in addition to the minimum testing required by the Contract and approved QC Program. Passing informational test(s), which represent the Work being performed may be submitted as part of the minimum testing required by the Contract and approved QC Program, only if GWA was given proper advance notification of the testing. Informational testing is not required to be submitted to GWA as part of the QC documentation but shall be made available for review at GWA's request.

J. Conflict Resolution: Contractor shall propose what procedures shall be followed whenever there is disagreement between the Contractor's Quality Control and GWA's Quality Assurance inspection and/or test results. Third party inspections and/or testing may be proposed under the following conditions:

1. The third party shall be a separate independent laboratory, meeting the minimum qualifications set forth above , not performing any additional Work for the Contractor, Subcontractors and/or Suppliers.
2. The third party shall be agreed to by both the Contractor and GWA.
3. Costs for the third party testing shall be paid as follows:

    a. Initial inspection or test for the disputed work in question shall be included as part of Contract, paid for by the Contractor.
    b. If the third party's inspection and/or test results reflect GWA's results, Contractor shall pay for any additional inspection(s) or testing performed by the third party after the initial inspection or test.
    c. If the third party's inspection and/or test results reflect the Contractor's results, GWA shall pay for any additional inspection(s) or testing performed by the third party after the initial inspection or test.

4. Compensation for third party conflict resolution, for each instance of conflict between the Contractor's and GWA's inspection and/or testing, shall be as provided in Items 1 through 3 above.

K. Subcontractor QC Programs: Contractor shall certify in writing that the Contractor is responsible for quality control on the project and the Contractor's QC Program shall govern over all the Work, including all Subcontractors. In the event a Subcontractor has a QC Program, the Contractor shall include it as an appendix to the Contractor's QC Program. The Subcontractor's QC Program shall at a minimum provide the requirements set forth in this specification, tailored to the Subcontractor's scope of Work. The Contractor shall detail each Subcontractor's level of QC responsibilities within the Contractor's QC Program.

L. Testing and Inspection Quantities and Frequencies: Contractor shall include, as an appendix to the Contractor's QC Program, a list of all items of Work and material to be inspected and/or tested for the Work. The Testing and Inspection Quantities and Frequencies list shall be used to

verify the minimum frequency of QC testing and/or inspections required are being performed. In all cases the minimum testing frequencies required in the Contract Documents shall maintain precedence. The list shall include the following:

1. Estimated quantity of all Material or Work expected to be incorporated into the project
2. Type(s) of inspections, certifications and/or tests required
3. Expected minimum number of tests and/or inspections to be performed

M. Testing Timetable: Contractor shall provide a list of all tests expected to be performed by the Contractor, Independent testing laboratory, Subcontractor, Special Inspector, or other denoted Quality Control field representative stating the time required to perform the test and/or inspection which includes the time required to obtain the results. The Testing Timetable list shall be referenced within the Contractor's Inspection and Testing Procedures as hold points until the results have been obtained and transmitted to the appropriate Quality Control representative and the Contracting Officer.

N. Program Revisions

1. QC is an on-going process throughout the duration of the Work. Revisions, modifications, additions, and/or deletions to the procedures set forth in the approved QC Program may be necessary at any time during the life of the Contract Work. Such revisions, modifications, additions, and/or deletions to the procedures may be requested by the Contractor or ordered by the Contracting Officer.
2. Contractor shall submit for approval any revisions, modifications, additions, and/or deletions to the procedures. All revisions, modifications, additions, and/or deletions to the QC procedures shall be submitted in accordance with Section 01300 – Contractor Submittals. All Work affected by any revisions, modifications, additions, and/or deletions to the procedures shall not be performed until they are approved by the Contracting Officer for incorporation into the Contractor's QC Program. No increase in Contract Times or Price shall be due the Contractor for any delays to the Contract Work caused by any such revisions, modifications, additions, and/or deletions to the QC procedures whether or not such changes were requested by the Contractor or ordered by the Contracting Officer.

O. Contractor's Quality Control Officer shall input a detailed daily Quality Control Report that summarizes all testing and quality control activities performed that day as part of the Contractor's Daily Report.

P. Progress Pay Estimate: The approval of the initial Progress Pay Estimate is dependent on the acceptance of the Quality Control Program by GWA.

Q. Noncompliance Report

1. If any Work is not performed in accordance with the Contract Documents, GWA may issue a Noncompliance Report (NCR). With the issuance of an NCR, GWA reserves the right to withhold payment for the Work in question until such time as that Work has been corrected and is in compliance with the Contract Documents.
2. Noncompliance Reports shall be corrected immediately unless otherwise agreed to in writing with GWA.

R. Final Reporting: Contractor shall submit a final report cataloging all test results prior to final payment. The final report shall contain a certification by the testing laboratory indicating that all reports are included and were performed in accordance with the Contract Documents.

1.11 OWNER INSPECTION

A. Owner's Access: At all times during the progress of the Work and until the date of final completion, afford GWA and Contracting Officer reasonable, safe, and proper facility for inspecting and performing testing for all Work at the site or at the manufacturer facilities. Any observation, inspections, and/or testing performed by GWA shall not relieve the Contractor of the Contractor's obligations to perform the QC inspections, sampling and/or testing required under this Contract. Contractor shall replace Work rejected due to faulty design, inferior or defective materials, poor workmanship, improper installation, excessive wear, or nonconformity with the requirements of the Contract Documents, with satisfactory Work at no additional cost to GWA. Contractor shall replace as directed, finished or unfinished Work found not to be in strict accordance with the Contract, even though such Work may have been previously approved and payment made therefor.

B. Rejection: GWA and the Contracting Officer shall have the right to reject materials and workmanship which are defective or require correction. Contractor shall promptly remove rejected Work and materials from the Site.

C. Removal for Examination: Should it be considered necessary or advisable by GWA or GWA's authorized representatives, at any time before final acceptance of the Work, to make examinations of portions of the Work already completed, by removing or tearing out such portions, Contractor shall promptly furnish all necessary facilities, labor, and material, to make such an examination. If such Work is found to be defective in any respect, Contractor shall defray all expenses of such examination and of satisfactory reconstruction. If, however, such Work is found to meet the requirements of the Contract, the cost of examination and restoration of the Work will be considered a change in the Work to be paid for in accordance with applicable provisions of the Contract.

D. Operation Responsibility: Contractor shall assume full responsibility for the proper operation of equipment during tests, start-up and training sessions. Contractor shall make no claim for damage which may occur to equipment prior to the time when GWA accepts the Work.

E. Rejection Prior to Warranty Expiration: If, at any time prior to the expiration of any applicable warranties or guarantees, equipment is rejected by GWA, Contractor shall repay to GWA all sums of money received for the rejected equipment on progress certificates or otherwise on account of the Contract lump sum prices, and upon the receipt of the sum of money, GWA will execute and deliver a bill of sale of all its rights, title, and interest in and to the rejected equipment. Contractor shall not remove the equipment from the premises of GWA until GWA obtains from other sources equipment to take the place of that rejected. GWA hereby agrees to obtain other equipment within a reasonable time and the Contractor agrees that GWA may use the equipment furnished by the Contractor without rental or other charge until the other new equipment is obtained. After rejected equipment is replaced, Contractor shall remove rejected equipment from the Site at no cost to GWA.

F. Work buried prior to examination by GWA or the Contracting Officer shall be re-excavated for examination at no additional cost to GWA.

G. Contractor shall reimburse GWA for the costs of any job Site inspection and testing between the hours of 4:30 p.m. and 7:00 a.m. Monday through Saturday, and all day Sundays and legal holidays.

H. Special Inspection

1. Special inspections shall be provided by and the responsibly of the Contracting Officer /Owner and conducted in accordance with provisions of IBC 2009 Section 1704.
2. In addition to the inspection procedures and requirements of IBC 2009, the Contracting Officer/Owner shall employ one or more DPW - approved special inspector(s), as required by and acceptable to the DPW/building Official, who shall provide "special inspections" during construction.
3. Special inspection shall cover, but not be limited to, the following type of work:
    a. Concrete
    b. Anchor bolts installed in concrete
    c. Reinforcing steel
    d. Epoxy dowels and anchors
    e. Mechanical anchors
    f. Structural welding and high strength bolting
4. Special Inspector shall furnish signed testing and inspection reports to the Construction Manager and the Contractor indicating the work inspected on a daily and/or weekly basis as the discretion. Discrepancies shall be brought to the immediate attention of the Contractor for correction, then, if uncorrected, to the Construction Manager.
5. Final Report: Special Inspector shall submit a final report stating whether the work requiring special inspection was, to the best of the inspector's knowledge, in conformance with the construction documents and the applicable provisions of the building code.
6. On a weekly basis, the Contractor shall provide a two week look-ahead schedule specifically for work requiring special inspections. Special inspection requests shall be in writing and received by the Construction Manager a minimum of two (2) full working days prior the desired inspections. Failure to provide two (2) full working days advance notice shall not be grounds for a delay claim or time extension.
7. The contractor shall cause the work to remain accessible and exposed for inspection purposes during the hours of 8:00 AM through 5:00 PM, Monday to Friday unless otherwise agreed to by the Construction Manager.
8. The Contractor shall not permit the performance of Work requiring special inspection or QA testing on Saturday, Sunday or any legal holidays without the written consent after submitting prior written request to the Construction Manager a minimum of three (3) full working days in advance.
9. It shall be at the contractor's expense if removal and replacement of materials are required to allow inspection.
10. The special inspector shall not be responsible for the means, methods, techniques, sequences or procedures of construction selected by the contractor.
11. The contractor shall be solely responsible for final quality control review of work to ensure that items observed by the special inspector shall not have been moved, removed, displaced or dislodged by the various subcontractors working on the site between inspection and completion of work.
12. Contractor shall pay for all related costs such as re-work, including material replacement, and re-testing when non-conforming work has been found resulting from tests and inspections.
13. The special inspection final report shall document the required special inspections and corrections of discrepancies noted in the inspections. It is not a guarantee or warranty that

the final construction is in complete conformance with the construction documents nor the workmanship provisions of the building code.

14. Acceptance as a result of inspection shall not be construed as an acceptance of a violation of building code provisions or other ordinances of the Guam jurisdiction.
15. Substitution as a result of an inspection shall not be allowed. The contractor shall seek the approval of the engineer of record for any changes or substitutions.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 INSTALLATION

A. Inspection: The Contractor shall inspect materials or equipment upon the arrival on the Site and immediately prior to installation and reject damaged and defective items.

B. Measurements: The Contractor shall verify measurements and dimensions of the Work, as an integral step of starting each installation.

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:

1. Temporary electricity.
2. Temporary lighting for construction purposes.
3. Temporary ventilation.
4. Temporary water service.
5. Temporary sanitary facilities.

B. Construction Facilities:

1. Field offices and sheds.
2. Vehicular access.
3. Parking.
4. Progress cleaning and waste removal.
5. Project identification.
6. Fire-prevention facilities.

C. Temporary Controls:

1. Barriers.
2. Fencing.
3. Security.
4. Water control.
5. Dust control.
6. Erosion and sediment control.
7. Pest and rodent control.
8. Pollution control.

D. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

A. Provide, maintain and pay for power service required from utility source as needed for construction operation.

B. Provide temporary electric feeder from existing utility source at location as directed by Contracting Officer and the power company representative. Do not disrupt Owner's use of service.

C. Complement existing power service capacity and characteristics as required for construction operations.

D. Provide power outlets with branch wiring and distribution boxes located as required for construction operations. Provide suitable, flexible power cords as required for portable construction tools and equipment. Electrical facilities shall conform to the requirements of Subpart K of the OSHA Safety and Health Standards for Construction.

E. The Contractor shall provide a weatherproof, grounded, temporary power distribution system sufficient for performance of entire Work of project, including temporary electrical cooling where indicated, operation of test equipment and test operation of building equipment and systems which cannot be delayed until permanent power connections are operable, temporary operation of other temporary facilities, including permanent equipment and systems which must be placed in operation prior to use of permanent power connections (pumps, HVAC equipment, and similar equipment), and power for temporary operation of existing facilities (if any) at the Site during change-over to new permanent power system. Provide circuits of adequate size and proper power characteristics for each use; run circuit wiring generally overhead, and rise vertically in locations where it will be least exposed to possible damage from construction operations and will result in minimal interference with performance of the Work; provide rigid steel conduit or equivalent raceways for wiring which must be exposed on grade, floors, decks, or other exposures to damage or abuse.

F. Provide main service disconnect and overcurrent protection at convenient location and meter.

G. Permanent convenience receptacles shall not be used during construction.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain lighting for construction operations conducted at night or under conditions of deficient daylight to insure proper Work and to afford adequate facilities for inspection and safe working conditions.

B. Permanent site lighting may be used during construction if available.

1.4 TEMPORARY VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases for safe working conditions.

1.5 TEMPORARY WATER SERVICE

A. Provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations. Coordinate with GWA for obtaining water service connection to existing water source and install backflow preventer per GWA standards. Allow three (3) week notice to GWA. Provide separate metering and reimburse Owner for cost of water used. Pay all fees for the water meter and all other charges for water use.

B. Extend branch piping with outlets located so that water is available by hoses with threaded connections.

C. The Contractor shall provide and operate all pumping facilities, pipelines, valves, hydrants, storage tanks, and all other equipment necessary for the adequate development and operation of the temporary water supply system. Water used for domestic purposes shall be free of contamination and shall conform to the requirements of Guam EPA for potable water. The Contractor shall be solely responsible for the adequate functioning of its water supply system and shall be solely liable for any claims arising from the use of same, including discharge or waste of water therefrom.

D. The Contractor shall not operate existing valves or fire hydrants.

1.6 TEMPORARY SANITARY FACILITIES

A. Provide and maintain fixed or portable chemical toilets wherever needed for the use of Contractor's employees. Provide facilities at time of Project mobilization. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction and applicable safety laws of Guam.

B. Establish a regular weekly collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in a manner satisfactory to the Contracting Officer and in accordance with all laws and regulations pertaining thereto.

C. No permanent sewer connection shall be made by the Contractor.

1.7 FIELD OFFICES AND SHEDS

A. Provide field offices as needed for use by the contractor. Contractor is responsible to provide the location.

B. Storage Areas and Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and inspection of products to suit requirements in Section 016000 - Product Requirements.

C. Preparation: Fill and grade Sites for temporary structures sloped for drainage away from buildings. Place six (6) inches thick compacted base rock around temporary structures and a path to the parking area to provide all-weather access.

D. Maintenance and Cleaning:
   1. Maintain walks free of mud, water, and the like.

1.8 VEHICULAR ACCESS

A. Construct temporary access roads from public thoroughfares to serve construction area, of width and load-bearing capacity to accommodate unimpeded traffic for construction purposes.

B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.

C. Continuous, unobstructed, safe, and adequate pedestrian and vehicular access shall be provided to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300 feet shall be provided. The Contractor shall cooperate with parties involved in the delivery of mail and removal of trash and garbage so as to maintain existing schedules for such services. Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time.

D. Extend and relocate vehicular access as Work progress requires and provide detours as necessary for unimpeded traffic flow.

E. Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder, and it shall so conduct its operations as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of the Contracting Officer and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise indicated. Toe boards shall be provided to retain excavated material if required by the Contracting Officer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the Contractor to assure the use of sidewalks and the proper functioning of all gutters, storm drain inlets, and other drainage facilities.

F. Locate site access as indicated on Drawings.

G. Provide unimpeded access for emergency vehicles. Maintain 20 foot-wide driveways with turning space between and around combustible materials.

H. Provide and maintain access to control valves free of obstructions.

I. Provide means of removing mud from vehicle wheels before entering streets.

J. Do not use existing on-Site pavement for construction traffic.

K. Investigate the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. It shall be the Contractor's responsibility to construct and maintain any haul roads required for its construction operations.

1.9 PARKING

A. Provide temporary gravel surface parking areas to accommodate construction personnel.

B. Locate as approved by Contracting Officer.

C. If Site space is not adequate, provide additional off-Site parking.

D. Use of existing on-Site pavement used for construction traffic is not permitted. Tracked vehicles are not allowed on paved areas.

E. Do not allow heavy vehicles or construction equipment in paved areas.

F. Do not allow vehicle parking on existing pavement.

G. Designate 1 parking space for Contracting Officer.

H. Maintenance:

1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, and the like.
2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original condition.

I. Removal, Repair:

1. Remove temporary materials and construction at Substantial Completion.
2. Remove underground Work and compacted materials to depth of 2 feet; fill and grade Site as indicated and to the satisfaction of the Contracting Officer.
3. Repair existing and permanent facilities damaged by use, to original condition and to the satisfaction of the Contracting Officer.

J. Mud from Site vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.10 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain Site in clean and orderly condition.

B. Broom and vacuum clean interior areas before starting surface finishing, and continue cleaning to eliminate dust.

C. Collect and remove waste materials, debris, and rubbish from Site weekly and dispose of off-Site. Comply with Section 017419 - Construction Waste Management and Disposal.

1.11 PROJECT IDENTIFICATION

A. Project Identification Sign:

1. Two painted signs for the project installed at sites designated by GWA, 32-sq ft area, bottom 6 feet aboveground.
2. Content:

a. Project number, title, and GWA and CCU logos.
b. Names and titles of Contracting Officer and Engineer.
c. Name of Prime Contractor and major Subcontractors.

d. Other information per GWA and as shown on sample signs.

3. Graphic Design, Colors, and Style of Lettering: Designated by GWA.

B. Design sign and structure to withstand 100-mph wind velocity.

C. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

D. Show content, layout, lettering, color, and sizes.

E. Sign Materials:

1. Structure and Framing: New wood, structurally adequate.
2. Sign Surfaces: Exterior grade plywood with medium-density overlay, minimum of 3/4 inches thick, single piece without joints.
3. Rough Hardware: Galvanized.
4. Paint and Primers: Exterior quality, two coats; sign background of white color.
5. Lettering: Exterior quality paint, colors as selected or precut vinyl self-adhesive products.

F. Installation:

1. Install Project identification sign within 15 calendar days after date established by Notice to Proceed.
2. Erect at location of high public visibility adjacent to main entrance to Site and acceptable to the Contracting Officer.
3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
4. Install sign surface plumb and level, with butt joints. Anchor securely.
5. Paint all exposed surfaces of sign, supports, and framing.

G. Maintenance: Maintain clean signs and supports; repair deterioration and damage.

H. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.12 FIRE-PREVENTION FACILITIES

A. Prohibit smoking within buildings or structures. Designate area on Site where smoking is permitted. Provide approved ashtrays in designated smoking areas.

B. Establish fire watch for cutting, welding, and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.

C. Portable Fire Extinguishers: NFPA 10; 10-pound capacity, 4A-60B: C UL rating.

1. Provide minimum of one (1) fire extinguisher in every construction trailer and storage shed.

1.13 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of Site**,** and to protect existing facilities and adjacent properties from damage from construction operations.

1.14 FENCING

A. Construction: Commercial-grade chain-link fence.

B. Provide 6-foot-high fence around construction Site when not within the public right-of-way; equip with vehicular gates with locks.

1.15 SECURITY

A. Security Program:

1. Protect Work on existing premises from theft, vandalism, and unauthorized entry.
2. Initiate site security system and program at Project mobilization which shall provide adequate 24-hour security for the construction facilities and stored and installed material at the Site. The Contracting Officer shall be the judge of what is considered adequate security. Considerations will include, but not be limited to, the following:

    a. Protect and maintain existing Site security fencing. Promptly repair any damage made to fencing.
    b. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.
    c. Keep gates and doors locked when not working onsite. Secure Site at end of each day.
    d. Provide high security locked containers in fenced area for material storage or off-site approved and bonded storage area.
    e. Allow permanent lock structures to be capable of being serviced with temporary or permanent high security lock prior to installation.
    f. Remove temporary fences and restore Site to original condition at completion of the Work.

3. Maintain program throughout construction period until Owner's acceptance precludes need for Contractor's security. This includes non-working hours, weekends, and holidays.
4. Provide the Contracting Officer with a list of 24-hour emergency phone numbers.
5. The Contractor is wholly responsible for the security of the construction facilities, storage compound and laydown areas, and for all their plant, material, equipment and tools at all times. This includes the contents of the Contracting Officer and GWA field office in the event of theft.

B. Entry Control:

1. Restrict entrance of persons and vehicles to Project Site and existing facilities.
2. Allow entrance only to authorized persons with proper identification.
3. Maintain log of workers and visitors and make available to Owner on request.

4. Control entrance of persons and vehicles related to Owner's operations.
5. Maintain the program throughout the construction period.

C. Security Service:

1. Employ uniformed guard service to provide guards on Site during nonworking hours, weekends, and holidays.

1.16 WATER CONTROL

A. Grade Site to drain. Maintain excavations free of water. Provide, operate, and maintain necessary pumping equipment.

B. Protect Site from puddles or running water. Provide water barriers as required to protect Site from soil erosion.

1.17 DUST CONTROL

A. Execute Work by methods that minimize raising dust from construction operations.

B. Provide positive means to prevent airborne dust from dispersing into atmosphere and into Owner-occupied areas.

1.18 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction by methods to control surface drainage from cuts and fills from borrow and waste disposal areas. Prevent erosion and sedimentation.

B. Minimize surface area of bare soil exposed at one time.

C. Provide temporary measures including berms, dikes, drains, and other devices to prevent water flow.

D. Construct fill and waste areas by selective placement to avoid erosive surface silts and clays.

E. Periodically inspect earthwork to detect evidence of erosion and sedimentation. Promptly apply corrective measures.

F. Comply with sediment and erosion control plan indicated on Drawings.

1.19 PEST AND RODENT CONTROL

A. Provide methods, means, and facilities to prevent pests and insects from entering facility.

1.20 POLLUTION CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances and pollutants produced by construction operations.

B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.21 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, and materials before Final Application for Payment and final inspection.

B. Remove underground installations to minimum depth of 2 feet. Grade Site as indicated on Drawings.

C. Clean and repair all damage caused by installation or use of temporary Work.

D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product delivery requirements.

C. Product storage and handling requirements.

D. Product options.

E. Equipment electrical characteristics and components.

1.2 PRODUCTS

A. At minimum, comply with specified requirements and reference standards.

B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.

C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that manufacturer's production capacity can provide sufficient product, on time, to meet Project requirements.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Comply with delivery requirements in Section 017419 - Construction Waste Management and Disposal.

B. Transport and handle products according to manufacturer's instructions.

C. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

D. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

E. Provide equipment and personnel to handle products; use methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products according to manufacturer's instructions and by methods and means, which will prevent damage, deterioration, and loss including theft.

B. Store products with seals and labels intact and legible.

C. Store sensitive products in weathertight, climate-controlled enclosures in an environment suitable to product.

D. For exterior storage of fabricated products, place products on sloped supports aboveground.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

G. Provide equipment and personnel to store products; use methods to prevent soiling, disfigurement, or damage.

H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Products complying with specified reference standards or description.

B. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit Request for Substitution for any manufacturer not named, according to Article 7 of the General Conditions.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 016000

SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Field engineering.

B. Closeout procedures.

C. Starting of systems.

D. Asset Register

E. Project record documents.

F. Operation and maintenance data.

G. Manual for materials and finishes.

H. Manual for equipment and systems.

I. Spare parts and maintenance products.

J. Product warranties and product bonds.

K. Maintenance and Guarantee.

L. Execution.

M. Cutting and patching.

N. Protecting installed construction.

O. Final cleaning.

1.2 FIELD ENGINEERING

A. Employ Guam licensed and registered land surveyor and acceptable to Contracting Officer.

B. Locate, verify and protect survey control and reference points. Promptly notify Contracting Officer of discrepancies discovered.

C. Control datum for survey is indicated on Drawings.

D. Verify setbacks, easements, and right-of-way lines in relation to the work prior to and after construction; confirm Drawing dimensions and elevations.

E. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.

F. Submit copy of Site drawing and certificate signed by Guam licensed and registered land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

G. Maintain complete and accurate log of control and survey Work as Work progresses.

H. On completion of foundation walls and major Site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction and Site Work.

I. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.

J. Promptly report to Contracting Officer loss or destruction of reference point or relocation required because of changes in grades or other reasons.

K. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Contracting Officer.

1.3 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:

1. Submit maintenance manuals, Project record documents, and other similar final record data in compliance with this Section.
2. Complete facility startup, all testing and disinfection, calibration and adjusting, commissioning of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance Section 019100 Commissioning.
3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
6. Make final change-over of locks and transmit keys directly to Owner.
7. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
8. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Contractor considers Work to be substantially complete, submit to Contracting Officer:

a. Written certificate that Work, or designated portion, is substantially complete.
b. List of items to be completed or corrected (initial punch list).

2. Within seven (7) days after receipt of request for Substantial Completion, Contracting Officer will make inspection to determine whether Work or designated portion is substantially complete.
3. Should Contracting Officer determine that Work is not substantially complete:

a. Contracting Officer will promptly notify Contractor in writing, stating reasons for its opinion.
b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Contracting Officer.
c. Contracting Officer will re-inspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes Contracting Officer's inspection.

4. When Contracting Officer finds that Work is substantially complete, Contracting Officer will:

a. Prepare Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by Contracting Officer and Owner (final punch list).
b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.

5. After Work is substantially complete, Contractor shall:

a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
b. Complete Work listed for completion or correction within time period stipulated.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.

1. When Contractor considers Work to be complete, submit written certification that:

a. Contract Documents have been reviewed.
b. Work has been examined for compliance with Contract Documents.
c. Work has been completed according to Contract Documents.
d. Work is completed and ready for final inspection.

2. Submittals: Submit following:

a. Final punch list indicating all items have been completed or corrected.
b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
d. Accounting statement for final changes to Contract Sum.

e. Contractor's affidavit of payment of debts and claims on AIA G706 - Contractor's Affidavit of Payment of Debts and Claims.
f. Contractor affidavit of release of liens on AIA G706A - Contractor's Affidavit of Release of Liens.
g. Consent of surety to final payment on AIA G707 - Consent of Surety to Final Payment Form.

3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:

1. Within seven (7) calendar days after receipt of request for final inspection, Contracting Officer will make inspection to determine whether Work or designated portion is complete.
2. Should Contracting Officer consider Work to be incomplete or defective:

a. Contracting Officer will promptly notify Contractor in writing, listing incomplete or defective Work.
b. Contractor shall remedy stated deficiencies and send second written request to Contracting Officer that Work is complete.
c. Contracting Officer will re-inspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes Contracting Officer's inspection.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify Contracting Officer ten (10) working days prior to startup of each item.

C. Supply and furnish chemicals, fuel, power, oil and grease, and other necessary materials.

D. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

E. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

F. Verify that wiring and support components for equipment are complete and tested.

G. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.

H. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.

I. Follow requirements in Section 019100 Commissioning.

1.5 ASSET REGISTER

A. Complete an asset register from a GWA supplied template. Submit for review prior to requesting Certificate of Substantial Completion.

B. Assets to include are vaults, buildings, valves, control valves, meters, major electrical components, instrumentation components, and other items as GWA requires.

C. Data for each asset may include location, size, number, manufacturer and model, material type, cost, recommended frequency for inspection, maintenance, rehab and replacement.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain on each respective Site one (1) set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, product data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:

1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
2. Include locations of concealed elements of the Work.
3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
5. Identify and locate existing buried or concealed items encountered during Project.
6. Measured depths of foundations in relation to finish floor datum.
7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
9. Field changes of dimension and detail.
10. Details not on original Drawings.

F. Submit marked-up paper copy documents and PDF electronic files of marked-up documents to Contracting Officer with claim for final Application for Payment.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit in PDF composite electronic indexed file.

B. Submit data bound in 8-1/2 x 11-inch text pages, three (3) D side ring binders with durable plastic covers at the 75 percent construction completion point. An additional (1) percent of the Contract Price will be retained from any monies due the Contractor as progress payments if not submitted meeting the requirements of this section. The aforementioned amount will be retained by GWA as the agreed, estimated value of the approved Technical Manual. Any such retention of money for failure to submit the approved Technical Manual on or before the 75 percent construction completion point shall be in addition to the retention of any payments due to the Contractor under the General Provisions.

C. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," title of Project, and subject matter of binder when multiple binders are required.

D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

F. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:

1. Part 1: Directory, listing names, addresses, and telephone numbers of Contracting Officer, Contractor, Subcontractors, and major equipment suppliers.
2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by Specification Section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following:

    a. Significant design criteria.
    b. List of equipment.
    c. Parts list for each component.
    d. Operating instructions.
    e. Maintenance instructions for equipment and systems.
    f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
    g. Safety precautions to be taken when operating and maintaining or working near equipment.

3. Part 3: Project documents and certificates, including the following:

    a. Shop Drawings and product data.
    b. Air and water balance reports.
    c. Certificates.
    d. Photocopies of warranties.

1.8 MANUAL FOR MATERIALS AND FINISHES

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of Work. Contracting Officer will review draft and return one (1) copy with comments.

B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten (10) working days after acceptance.

C. Submit one (1) copy of completed volumes before Substantial Completion. Draft copy be reviewed and returned after Substantial Completion, with Contracting Officer comments. Revise content of document sets as required prior to final submission.

D. Submit five (5) sets of revised final volumes within ten (10) working days after final inspection.

E. Submit in PDF composite electronic indexed file of final manual within ten (10) working days after final inspection.

F. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations.

G. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

H. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

I. Additional Requirements: As specified in individual product Specification Sections.

J. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

1.9 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of Work. Contracting Officer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten (10) working days after acceptance.

C. Submit one (1) copy of completed volumes before Substantial Completion. Draft copy will be reviewed and returned after Substantial Completion, with Contracting Officer comments. Revise content of document sets as required prior to final submission.

D. Submit five (5) sets of revised final volumes within ten (10) working days after final inspection.

E. Submit in PDF composite electronic indexed file of final manual within ten (10) working days after final inspection.

F. Each Item of Equipment and Each System: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

G. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

H. Include color-coded wiring diagrams as installed.

I. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.

J. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

K. Include servicing and lubrication schedule and list of lubricants required.

L. Include manufacturer's printed operation and maintenance instructions.

M. Include sequence of operation by controls manufacturer.

N. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

O. Include control diagrams by controls manufacturer as installed.

P. Include Contractor's coordination drawings with color-coded piping diagrams as installed.

Q. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

R. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

S. Additional Requirements: As specified in individual product Specification Sections.

T. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

B. Deliver to place in location as directed by Owner; obtain receipt prior to final payment.

1.11 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within ten (10) working days after completion of applicable item of Work.

B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information, and are notarized.

D. Co-execute submittals when required.

E. Include table of contents and assemble in three (3) D side ring binder with durable plastic cover.

F. Submit prior to final Application for Payment.

G. Time of Submittals:

1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten (10) working days after acceptance.
2. Make other submittals within ten (10) working days after date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten (10) working days after acceptance, listing date of acceptance as beginning of warranty or bond period.

1.12 MAINTENANCE AND GUARANTEE

A. The Contractor shall comply with the maintenance and guarantee requirements contained in the General Provisions.

B. Furnish service of components indicated in Specification Sections during warranty period.

C. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.

D. Replace earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the Contractor shall have obtained a statement in writing from the affected private owner or public agency releasing GWA from further responsibility in connection with such repair or resurfacing.

E. Make all repairs and replacements promptly upon receipt of written order from GWA. If the Contractor fails to make such repairs or replacements promptly, GWA reserves the right to do the Work and the Contractor and its surety shall be liable to GWA for the cost thereof.

F. Warranty Repair Priority

1. The nature of the warranty issue and its impact on operations will be evaluated by the Owner and a Response Priority assigned to the notice as followings:

2. First Priority Code 1 – Contractor to provide on-site inspection to evaluate the situation and determine the course of action within four (4) hours, initiate the work within six (6) hours and work continuously to completion or relief.
3. Second Priority Code 2 – Perform on-site inspection to evaluate the situation and determine the course of action within eight (8) hours, initiate the work within 24 hours and work continuously to completion or relief
4. Third Priority Code 3 – Necessary work to be initiated within three working days and work performed during standard work hours each subsequent day to completion or relief.

G. Contractor's Response to Construction Warranty Requirements

1. Following the oral or written notification by the Owner, the Contractor shall respond to construction warranty service requirements in accordance with the assigned Response Priority code. The Contractor shall submit a report within seven (7) calendar days after completion of activities on any warranty item that has been repaired during the warranty period. The report shall include.
2. If the Contractor does not perform the construction warranty items within the time frames specified above, the Owner retains the right to perform the work and recover all costs from the Contractor or its surety.

H. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of Owner.

I. The Contractor shall provide a bond to guarantee performance of the provisions contained in the General Provisions.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual Specification Sections.

D. Verify that utility services are available with correct characteristics and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 EXECUTION

A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one (1) set of manufacturer's installation instructions at Project Site during installation and until completion of construction.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Contracting Officer before proceeding.

C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Contracting Officer for final decision.

E. Allow for expansion of materials and building movement.

F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting heights choices to Contracting Officer for final decision.
2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

3.4 CUTTING AND PATCHING

A. Employ skilled and experienced installers to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting:

1. Structural integrity of element.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Visual qualities of sight-exposed elements.
5. Work of Owner or separate contractor.

C. Execute cutting, fitting, and patching including excavation and fill to complete Work and to:

1. Fit the several parts together, to integrate with other Work.
2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and nonconforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.

E. Cut masonry and concrete materials using masonry saw or core drill.

F. Restore Work with new products according to requirements of Contract Documents.

G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

J. Identify hazardous substances or conditions exposed during the Work to Contracting Officer for decision or remedy.

3.5 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual Specification Sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Use durable sheet materials to protect finished floors and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

3.6 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment.

1. Employ experienced personnel or professional cleaning firm.

B. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces.

C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.

D. Clean filters of operating equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean Site; sweep paved areas, rake clean landscaped surfaces, seed disturbed soil.

G. Lubricate all equipment in accordance with the manufacturers' recommendations.

H. Remove waste and surplus materials, rubbish, and construction facilities from Site.

I. Final acceptance of the Work by GWA will be withheld until the Contractor has satisfactorily performed the final cleanup of the Site.

END OF SECTION 017000

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction waste management plan.
2. Construction waste recycling.
3. Construction waste adaptive reuse.

B. Related Sections:
1. Section 019100 - Commissioning: General commissioning requirements.

1.2 PLAN REQUIREMENTS

A. Develop and implement construction waste management plan as approved by Contracting Officer.

B. Intent:

1. Divert construction, demolition, and land-clearing debris from landfill disposal.
2. Redirect recyclable material back to manufacturing process.
3. Generate cost savings or increase minimal additional cost to Project for waste disposal.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures contains requirements for submittals.

B. Construction Waste Management Plan: Submit construction waste management plan, within 14 calendar days after the date established in the Notice to Proceed, describing methods and procedures for implementation and monitoring compliance including the following:

1. Recycling and adaptive reuse processing facilities and waste type each facility will accept.
2. Construction waste materials anticipated for recycling and adaptive reuse.
3. On-Site sorting and Site storage methods.

1.4 CONSTRUCTION WASTE MANAGEMENT PLAN

A. Implement construction waste management plan at start of construction.

B. Review construction waste management plan at preconstruction meeting and progress meetings specified in Section 013000 - Administrative Requirements.

C. Distribute approved construction waste management plan to Subcontractors and others affected by plan requirements.

D. Oversee plan implementation, instruct construction personnel for plan compliance, and document plan results.

E. Purchase products to prevent waste by:

1. Ensuring correct quantity of each material is delivered to Site.
2. Choosing products with minimal or no packaging.
3. Requiring suppliers to use returnable pallets or containers.
4. Requiring suppliers to take or buy back rejected or unused items.

1.5 CONSTRUCTION WASTE RECYCLING

A. Use source separation method or comingling method suitable to sorting and processing method of selected recycling center. Dispose nonrecyclable trash separately into landfill.

B. Source Separation Method: Recyclable materials separated from trash and sorted into separate bins or containers, identified by waste type, prior to transportation to recycling center.

C. Comingling Method: Recyclable materials separated from trash and placed in unsorted bins or container for sorting at recycling center.

D. Materials suggested for recycling include:

1. Packing materials including paper and cardboard.
2. Recyclable plastics.
3. Metals.
4. Equipment oil.

1.6 CONSTRUCTION WASTE ADAPTIVE REUSE

A. Arrange with processing facility for salvage of construction material and processing for reuse. Do not reuse construction materials on-Site except as allowed by Contracting Officer.

B. Materials suggested for adaptive reuse include:

1. Concrete and crushed concrete.
2. Masonry units.
3. Lumber suitable for re-sawing or refinishing.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE COLLECTION

A. Collect construction waste materials in marked bins or containers and arrange for transportation to recycling centers or adaptive salvage and reuse processing facilities.

B. Maintain recycling and adaptive reuse storage and collection area in orderly arrangement with materials separated to eliminate co-mingling of materials required to be delivered separately to waste processing facility.

C. Store construction waste materials to prevent environmental pollution, fire hazards, hazards to persons and property, and contamination of stored materials.

D. Cover construction waste materials subject to disintegration, evaporation, settling, or runoff to prevent polluting air, water, and soil.

3.2 CONSTRUCTION WASTE DISPOSAL

A. Deliver construction waste to waste processing facilities.

B. Dispose of construction waste not capable of being recycled or adaptively reused by delivery to landfill, incinerator, or other legal disposal facility.

END OF SECTION 017419

SECTION 019100 - COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commissioning description.
2. Submittals.
3. Commissioning responsibilities.
4. Commissioning meetings.
5. Commissioning reports.
6. Sequencing.
7. Scheduling.
8. Maintenance materials.
9. Test equipment.
10. Verification check and startup procedures.
11. Functional performance test procedures.
12. Function performance test methods.
13. Deficiencies and test approvals.
14. Demonstration.

B. Related Sections:

1. Division 26 Electrical: Electrical system commissioning requirements.
2. Section 331116 Site Water Utility Distribution Piping: Meter and pressure reducing valve.
3. Section 409001 – Instrumentation and Control Components: Flow meter, pressure transmitter, intrusion switches, and float switches.

1.2 COMMISSIONING DESCRIPTION

A. Commissioning: Systematic process of ensuring systems perform interactively according to design intent and Owner's operational needs. Commissioning process encompasses and coordinates system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training, and verification of actual performance.

B. The startup of a facility and systems requires the combined expertise of the Contractor, manufacturers' representatives, Subcontractors, the Contracting Officer, and GWA. The Contractor shall be responsible for coordinating all parties for a successful startup and commissioning: the Contracting Officer and GWA will be available for technical and operational advice prior to and during startup and commissioning.

C. Commissioning Intent:

1. Verify equipment and systems are installed according to manufacturer's instructions, industry accepted minimum standards, and Contract Documents.
2. Verify equipment and systems receive adequate operational checkout by Contractor.
3. Verify and document proper performance of equipment and systems.
4. Verify complete operation and maintenance documentation is delivered to Contracting Officer.
5. Verify Owner's operating and maintenance personnel are adequately trained.

D. Equipment and Systems to Be Commissioned:

1. Electrical system
2. SCADA system
3. Instrumentation and control system
4. Pressure reducing/sustaining valve
5. Water meter

E. Commissioning does not relieve Contractor of responsibility to provide finished and fully functioning Project.

F. During system testing and startup, product water shall not be wasted unless otherwise approved by GWA. The Contractor shall be responsible for the discharge and disposal of the product water or wastewater complying with all local and Territory of Guam regulations and obtain all permits as required for the discharge and disposal of product water or wastewater at no additional cost to GWA.

G. Commissioning Process Overview and General Order of Commissioning Tasks:

1. Commissioning begins with initial commissioning meeting.
2. Discuss commissioning at progress meetings throughout construction to plan, scope, coordinate, and schedule future activities and to resolve problems.
3. Equipment documentation is submitted to Contracting Officer during normal submittals with detailed startup procedures.
4. Contractor works with equipment and system installers to develop startup plans and startup documentation formats, including verification checklists to be completed by installers, during verification check and startup process.
5. In general, checkout and performance verification proceeds from simple to complex, that is, from component level to equipment to systems and intersystem levels, with verification checklists being completed before functional testing.
6. Equipment and system installers execute and document verification checklists and perform verification check and startup. Contractor verifies that checklists and startup were completed according to approved plans.
7. Contractor develops specific equipment and system functional performance test procedures. Equipment and system installers and Contractor review procedures. Equipment shall be tested to the satisfaction of the Contracting Officer.
8. Equipment and system installers execute procedures under direction of and documentation by Contractor.
9. Items of noncompliance in material, installation, or setup are corrected at Contractor's expense, and system is retested.
10. Contractor reviews operation and maintenance documentation for completeness.
11. Commissioning is completed before Substantial Completion.

12. Contracting Officer reviews, approves, and coordinates training provided by equipment and system installers and verifies training was completed.
13. Deferred testing is conducted as specified.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures contains requirements for submittals.

B. Qualification Data: Submit the following prior to start of Work:

1. Name of individual assigned to Project and assuming role as Commission Authority.
2. Detailed description of three commissioning projects completed, by individual assigned to Project within past five years. Include names and telephone numbers of owner's project manager and Contractor's Site superintendent.

C. System Outage Requests: Request for shutdown of existing systems as necessary to test or startup new facilities or systems.

1.4 COMMISSIONING SUBMITTALS

A. Furnish one copy of submittals directly to Contracting Officer for review according to procedures specified in Section 013300 - Submittal Procedures.

1. Make submittals for each piece of equipment or system indicated to be commissioned.

B. Furnish one copy of preliminary operation and maintenance data manuals to Contracting Officer for each piece of equipment or system indicated to be commissioned.

1. Submit required manuals at least 30 days prior to scheduled commissioning.

C. Submit the name and documentation of certification of the proposed Manufacturer's Representative. The Manufacturer's Representative shall be regularly engaged in the installation of the type and complexity of equipment specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

D. Make additional submittals requested by Contracting Officer for each piece of equipment or system indicated to be commissioned. Incorporate requested submittal information into related operation and maintenance manuals. Include the following:

1. Manufacturer's printed, detailed installation and startup, operating, troubleshooting, and maintenance procedures.
2. Equipment performance information.
3. Factory test reports.
4. Full sequence of operation and control diagrams.
5. Proposed testing, adjusting, and balancing procedures.
6. Complete warranty information, identifying Owner responsibilities to keep warranty in force.
7. Lists of installation and checkout materials shipped with equipment.

8. Manufacturer's field checkout forms to be used by factory or field technicians.
9. Other documentation necessary for commissioning process.

E. Furnish one copy of verification check and startup plan to Contracting Officer for review and approval. Include the following at minimum:

1. Verification checklists with party responsible for each item indicated.
2. Manufacturer's standard startup procedures copied from installation manuals.
3. Manufacturer's standard field checkout sheets.
4. Supplemental procedures and checklists prepared by equipment and system installers to accommodate Project conditions.
5. Sensor and actuator calibration procedures.
6. Include boxes or lines for recording and documenting checking and inspections of each procedure and summary statement with signature block at end of plan.

F. Submit written training plan to Contracting Officer for review and approval prior to conducting training including the following:

1. Equipment included in training session.
2. Intended audience.
3. Location of training.
4. Objectives.
5. Subjects covered.
6. Duration of training on each subject.
7. Instructor for each subject.
8. Instructional methods to be used.

G. Contracting Officer will review submittals for conformance to Contract Documents as related to commissioning process, for primary purpose of aiding development of functional testing procedures and secondary purpose of verifying compliance with equipment Specifications.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements contains requirements for closeout submittals.

B. Operation and Maintenance Data: Submit operation and maintenance manuals as specified in individual equipment and system Specifications.

1. Submittals made to Contracting Officer do not constitute compliance with operation and maintenance manual documentation.

C. Commissioning Record: Commissioning Authority will submit five (5) copies of commissioning record for inclusion in operation and maintenance manuals. Furnish records in following format, arranged by system, with each part separated by tabbed flyleafs:

1. Commissioning plan.
2. Final commissioning report.
3. System 1: Provide the following separated by tabbed flyleafs:
   a. Design narrative and criteria, sequences, and approvals.

b. Startup plan and report, approvals, corrections, and blank verification checklists. Separate data for each equipment type with colored separators.
c. Completed, functional tests, trending and analysis, approvals and corrections, training plan, record and approvals, blank functional test forms, and recommended re-commissioning schedule.

4. System 2: As specified for System 1.

D. Final Commissioning Report: Commissioning Authority will submit one copy of final commissioning report including the following:

1. Executive summary with list and roles of participants, brief Project description, overview of commissioning and testing scope, and general description of testing and verification methods.
2. For Each Piece of Commissioned Equipment: Include statement regarding compliance with Contract Documents in the following areas:
   a. Equipment Specifications.
   b. Equipment installation.
   c. Functional performance and efficiency.
   d. Equipment documentation and design intent.
   e. Operator training.
3. Include recommendations for improvement to equipment or operations, future actions, and commissioning process changes.
4. List outstanding deficiencies referenced to specific functional test, inspection, trend log, or other record where deficiency is documented.
5. Include brief description of verification method used as well as observations and conclusions from testing for each commissioned piece of equipment and system.

1.6 QUALITY ASSURANCE

A. Perform Work according to GWA's standard.

1.7 QUALIFICATIONS

A. Commissioning Authority: Individual employed by Contractor or third-party firm specializing in performing Work of this Section with minimum five (5) years documented experience.

1. Experienced in operation and troubleshooting mechanical systems, electrical systems, and SCADA systems.
2. Knowledgeable in testing of water control valves and meters.
3. Excellent verbal and written communication skills, highly organized, and able to work with both management and installers.

1.8 COMMISSIONING SERVICES

A. Employ and pay for services of an independent firm as Commissioning Authority acceptable to Owner to perform specified commissioning.

1.9 COMMISSIONING RESPONSIBILITIES

A. Responsibilities indicated for Owner, Contracting Officer, and Commissioning Authority are provided only to clarify commissioning process.

B. Contracting Officer/Engineer Responsibilities:

1. Perform Site observation of each system immediately before system startup.
2. Furnish design narratives and sequence documentation requested by Commissioning Authority or Contractor.
3. Clarify operation and control of commissioned equipment when Specifications, control drawings, or equipment documentation is not sufficient for writing detailed testing procedures.
4. Coordinate resolution of design issues affecting system performance identified during commissioning.
5. Coordinate resolution of system deficiencies identified during commissioning, according to Contract Documents.
6. Prepare and submit final design intent documentation reflecting installed conditions for inclusion in operation and maintenance manuals.
7. Review and approve operation and maintenance manuals.
8. Review verification checklists for major pieces of equipment.
9. Review functional test procedure forms for major pieces of equipment.
10. Witness tests for the following equipment and systems:
    a. Electrical system
    b. SCADA system
    c. Instrumentation and control system
    d. Pressure reducing/sustaining valve
    e. Water meter

C. Commissioning Authority Responsibilities:

1. Basic Responsibilities:
    a. Coordinate, direct, and provide commissioning Work.
    b. Develop and coordinate execution of commissioning plan. Revise commissioning plan to suit Project conditions.
    c. Schedule commissioning Work for inclusion in Progress Schedule.
    d. Plan and conduct commissioning meetings.
    e. Request and review commissioning submittals required to perform commissioning tasks.
    f. Write and distribute verification tests and checklists.
    g. Develop verification check and startup plan in cooperation with equipment and system installers.
    h. Write functional performance test procedures in cooperation with equipment and system installers.
    i. Attend selected Project progress and pre-installation meetings. Review meeting minutes. Resolve potential conflicts with commissioning activities.
    j. Document that equipment and systems are installed and perform according to design intent and Contract Documents.
    k. Notify Contracting Officer of deficiencies.
    l. Coordinate and supervise required deferred testing and deficiency corrections.
    m. Oversee Owner's personnel training.

n. Review and approve operation and maintenance manuals.
o. Compile commissioning record and testing data manual.
p. Provide final commissioning report.

2. Detailed Responsibilities:
   a. Witness and document testing and commissioning of each system to include control valve, electrical system, SCADA system, pressure reducing/sustaining valve, instrumentation and control system, and meter testing, cleaning, and flushing. Include documentation in operation and maintenance manuals.
   b. Approve verification tests and checklist completion by reviewing verification checklist reports, Site observation, and spot checking.
   c. Approve system startup by reviewing startup reports and Site observation.
   d. Oversee functional testing of control system. Approve control system for use for operations.
   e. Analyze functional performance trend logs and monitor data to verify performance.
   f. Coordinate, witness, and approve manual functional performance tests performed by equipment and system installers.
      1) Coordinate retesting until satisfactory performance is achieved.
   g. Maintain deficiency and resolution log and separate testing record. Submit progress reports and test results with recommended actions to Contracting Officer.
   h. Review equipment warranties to ensure Owner's responsibilities are defined.
   i. Return to Site minimum of two months before expiration of warranty period.
      1) Review with Owner's personnel the current equipment and system operation and condition of outstanding issues related to original commissioning.
      2) Interview Owner's personnel to identify problems or concerns regarding equipment and system operation.
      3) Make suggestions for improvements and for recording changes in operation and maintenance manuals.
      4) Identify deficiencies covered by warranty or original construction contract.
      5) Assist Owner's personnel to develop reports, documents, and requests for services to remedy outstanding problems.
3. Commissioning Authority may not:
   a. Release, revoke, alter, or enlarge on requirements of Contract Documents.
   b. Approve or accept any portion of the Work.
   c. Assume duties of Contracting Officer.
   d. Stop the Work.

D. Owner Responsibilities:

1. Arrange for Owner's personnel to attend commissioning activities and training sessions according to commissioning plan.
2. Approve commissioning Work completion.
3. Ensure deferred testing and deficiency issues are addressed.

E. Contractor Responsibilities:

1. Include requirements for commissioning submittal data, operation and maintenance data, commissioning tasks and training in each purchase order and subcontract for equipment and systems indicated to be commissioned.
2. Facilitate coordination of commissioning Work by Commissioning Authority.
3. Attend commissioning meetings.

4. Cooperate with Commissioning Authority.
5. Require equipment and system installers to execute test and to review and provide comments on functional test procedures.
6. Require manufacturers to review commissioning test procedures for equipment installed by manufacturer.
7. Furnish proprietary test equipment required by manufacturers to complete equipment and system tests.
8. Furnish qualified personnel to assist in completing commissioning.
9. Furnish manufacturer's qualified field employee as specified in Section 014000 - Quality Requirements and individual Specification Sections to assist in completing commissioning. Control valve and meter startup service technician shall be a regular employee of manufacturer.
10. Ensure equipment and system installers execute commissioning responsibilities according to Contract Documents and Progress Schedule.
11. Coordinate Owner's personnel training by qualified service technician.
12. Prepare operation and maintenance manuals specified in Section 017000 - Execution and Closeout Requirements. Update original sequences of operation reflecting actual installation.
13. Ensure equipment and system installers execute deferred functional performance testing, witnessed by Commissioning Authority.
14. Ensure equipment and system installers correct deficiencies and make necessary adjustments to operation and maintenance manuals and record documents for issues identified in testing.

1.10 COMMISSIONING MEETINGS

A. Section 013000 - Administrative Requirements contains requirements for progress meetings.

B. Commissioning Authority will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Initial Commissioning Meeting:

1. Commissioning Authority will schedule meeting within 60 days prior to scheduled or expected Substantial Completion. The Initial Commissioning Meeting may be included in a regular progress meeting.
2. Attendance Required: Commissioning Authority, Contracting Officer, Owner, Owner's facility operating personnel supervisor, Contractor, Subcontractors, and testing agency. Require attendance by installers of the following equipment and systems indicated to be commissioned, including:

    a. Mechanical equipment and systems.
    b. Plumbing equipment and systems.
    c. Electrical equipment and systems.
    d. SCADA equipment and systems.

3. Agenda:

    a. Designation of personnel representing parties for commissioning activities.
    b. Review commissioning process and responsibilities.

c. Review commissioning plan development procedures.
d. Review required commissioning submittals.
e. Present initial commissioning schedule.

D. Commissioning Meetings:

1. Commissioning will be a regular topic in the progress meetings throughout progress of the Work.
2. Commissioning Authority will schedule a minimum of one Commissioning Meeting per system to be commissioned. Meetings shall be one week prior to each commissioning.
3. Attendance Required: As required.
4. Agenda Items:

a. Coordination of commissioning activities.
b. Commissioning deficiency resolution.
c. Commissioning schedule.

E. Commissioning Authority will record meeting minutes and distribute copies within two (2) days after meeting to participants and those affected by decisions made.

1.11 COMMISSIONING REPORTS

A. Commissioning Authority Reports: Submit reports regularly to Contracting Officer, and Contractor. Include the following.

1. Observation reports of specific commissioning activities.
2. Testing progress and approvals.
3. Deficiencies and deficiency resolution reports.

B. Commissioning Authority Functional Performance Test Procedures: Develop test procedures including forms with following information. Include completed documentation in operation and maintenance manuals.

1. System and equipment or component names.
2. Equipment location and identification number.
3. Unique test identification number and reference to unique verification checklist and startup documentation identification numbers for piece of equipment.
4. Date.
5. Project name.
6. Participating parties.
7. Copy of Specification Section describing test requirements.
8. Copy of specific sequence of operations or other specified parameters being verified.
9. Formulas used in calculations.
10. Required pre-test field measurements.
11. Instructions for setting up test.
12. Special cautions, alarm limits, and safety concerns.
13. Specific step-by-step procedures to execute test, in clear, sequential, and repeatable format.
14. Acceptance criteria of proper performance with "Yes/No" check box to allow for marking whether or not proper performance of each part of test was achieved.

15. Section for comments.
16. Signatures and date block for Contractor and Contracting Officer verification.

1.12 SEQUENCING

A. Section 011000 - Summary contains requirements for sequencing.

B. Sequence Work to complete commissioning, except for functional testing and Owner's personnel training, before Substantial Completion.

C. Sequence Work to achieve functional completion before final completion. Complete the following for each piece of equipment and system indicated to be commissioned to achieve functional completion:

1. Complete and sign startup and verification checklist documentation.
2. Complete functional testing.
3. Submit final approved test report.
4. Complete training of Owner personnel.
5. Submit approved operation and maintenance data manuals.
6. Correct identified deficiencies or obtain approval by Owner to exclude deficiencies from functional completion.

1.13 SCHEDULING

A. Section 013216 - Construction Progress Schedule contains requirements for scheduling.

B. Schedule Work to allow adequate time for commissioning activities.

C. Identify commissioning milestones, activities, and durations on Progress Schedule.

1. Identify the following for each piece of equipment and system including:

a. Operation and maintenance manual submittal.
b. Verification check and startup.
c. Functional performance test.
d. Functional completion.
e. Demonstration and training sessions.
f. Commissioning completion.

1.14 MAINTENANCE MATERIALS

A. Section 017000 - Execution and Closeout Requirements contains requirements for maintenance materials.

B. Furnish one set of manufacturer's proprietary test equipment, tools, and instruments required to complete commissioning.

1. Deliver test equipment to Owner after completion of functional performance test. Obtain signed receipt.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Testing Equipment: Calibrated within last year; of sufficient quality and accuracy to test and measure system performance within the following tolerances unless otherwise specified for individual equipment or systems.

1. Pressure Sensors: Accuracy of plus or minus 2.0 percent of measured value range.

B. All equipment and apparatus used in testing shall be installed by specialists properly skilled in the trades and professions required to assure first-class workmanship. Where required by detailed specifications, the Contractor shall cause the installation of specific equipment testing items to be accomplished under the supervision of factory trained installation specialists furnished by the equipment manufacturers. The Contractor shall document the skills and training of all workers engaged in the installation of all testing equipment furnished by the Contractor.

C. Recalibrate test equipment according to manufacturer's recommended intervals and when dropped or damaged.

1. Affix calibration tags to test equipment or furnish certificates upon request.

D. Equipment Furnished by Contractor and Remaining Property of Contractor:

1. Standard testing equipment required to perform verification check and startup and required functional performance testing.
2. Two-way radios for personnel performing commissioning.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements contains requirements for verification of existing conditions before starting Work.

B. Verify equipment and systems are installed according to individual Specification Sections.

C. Verify utility and power connections are complete and services operational.

3.2 VERIFICATION CHECK AND STARTUP PROCEDURES

A. Notify Commissioning Authority and Contracting Officer and schedule verification check and startup activities with each party required to complete verification check and startup a minimum of four weeks in advance.

B. Allow Commissioning Authority and Contracting Officer to witness verification check and startup.

1. Primary Equipment: Commissioning Authority and Contracting Officer will witness procedures for each piece of equipment. For multiple units, Commissioning Authority and Contracting Officer will witness procedures on 20 percent, but not less than four, of each type unit.
2. Secondary Equipment: Contracting Officer will witness sampling of on 20 percent, but not less than four, of each type of unit.

C. Verification Check and Startup:

1. Perform verification check and startup according to approved verification check and startup plan.
2. Complete entire plan for each piece of equipment or system indicated to be commissioned.
3. Complete each procedure in sequence performed by party assigned to each procedure.
4. Record completion of each procedure. Indicate results of procedure where required. Sign and date plan by individual performing procedure.
5. Identify items not completed successfully.
6. Sign and date plan indicating completion of entire plan.
7. Submit executed plan to Contracting Officer within two days of completion.

D. Deficiencies and Approvals:

1. Commissioning Authority will review verification check and startup reports and issue deficiency report or approval.
2. Correct deficiencies and resubmit updated verification check and startup report with statement indicating corrections made for Commissioning Authority approval.
3. Repeat process until verification check and startup report are approved.
4. Costs for incomplete verification check and startup items that later cause deficiencies or delays during functional tests may be charged to party responsible for incomplete item.

3.3 FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. Complete the following before performing functional tests:

1. Verification check and startup.
2. Control system testing.

B. Notify Commissioning Authority and Contracting Officer of completion of verification check and startup activities.

C. Commissioning Authority and Contracting Officer will direct, witness and document results of functional performance tests.

D. Conduct functional performance tests as specified in individual sections for each system.

E. Demonstrate that each piece of equipment and system is operating according to documented design intent and Contract Documents.

1. Conduct testing proceeding from components, to subsystems, to systems.
2. Bring equipment and systems to condition capable full dynamic operation.

3. Verify performance of individual components and systems.
4. Verify performance of interactions between systems.
5. Equipment shall run without abnormal noise, vibration or heating.
6. Identify and correct areas of deficient performance.

F. Operate each piece of equipment and system through each specified mode of operation including open, close, warmup, cool-down, partial load, and full load conditions.

1. Verify each sequence in sequences of operation.
2. Test for proper responses to power failure, overheating, low oil pressure, no flow, equipment failure, and other abnormal conditions.

3.4 FUNCTIONAL PERFORMANCE TEST METHODS

A. Perform testing and verification by using manual testing or by monitoring performance and analyzing results using control system trend log capabilities or by standalone data loggers as specified for each piece of equipment or system.

1. Commissioning Authority may require alternate or additional method other than specified method.
2. Commissioning Authority will determine test method when method is not specified.

B. Simulated Conditions: Simulating conditions, not by overwritten values, is permitted. Timing tests to use real conditions is encouraged wherever practical.

C. Overwritten Values: Overwriting sensor values to simulate conditions may be used with caution and avoided when possible.

D. Simulated Signals: Using signal generator to create simulated signals to test and calibrate transducers controls is generally recommended over using sensors as signal generators with simulated conditions or overwritten values.

E. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test specific sequence is acceptable. Reset setpoint after completing test.

F. Indirect Indicators: Using indirect indicators for responses or performance is permitted only after visually and directly verifying and documenting indirect readings through control system representing actual conditions and responses over tested parameter range.

G. Perform each function and test under conditions simulating actual conditions as close as is practically possible.

1. Provide materials, system modifications, and other items or steps necessary to produce flows, pressures, and other responses to execute test according to specified conditions.
2. At completion of test, return modified equipment and systems to pretest condition.

3.5 DEFICIENCIES AND TEST APPROVALS

A. Deficiencies:

1. Commissioning Authority will record and report deficiencies to Contracting Officer.
2. Minor deficiencies may be corrected during tests at Contracting Officer's discretion. Deficiency and resolution will be documented on procedure form.
3. Failure to attend scheduled verification check, startup, or functional performance test will be considered deficiency.
4. When deficiency is identified, Commissioning Authority will discuss issue with party executing test.

    a. When party executing test accepts responsibility to correct deficiency:

        1) Commissioning Authority documents deficiency and executing party's response.
        2) Commissioning Authority submits deficiency report to Contracting Officer, Contractor, and party executing test.
        3) Party executing test corrects deficiency, signs statement of correction on deficiency form certifying equipment is ready for retesting, and submits form to Commissioning Authority.
        4) Commissioning Authority reschedules test, and test is repeated until satisfactory performance is achieved.

    b. When party executing test disputes deficiency or responsibility for deficiency:

        1) Commissioning Authority documents deficiency and executing party's response.
        2) Commissioning Authority submits deficiency report to Contracting Officer, Contractor, party executing test, and party believed to be responsible for deficiency.
        3) Commissioning Authority negotiates resolution with parties involved and refers continuing disputes to Contracting Officer for resolution according to Contract Documents.
        4) Commissioning Authority documents resolution process.
        5) When resolution is decided, appropriate party corrects deficiency, signs statement of correction on deficiency form certifying equipment is ready for retesting, and submits form to Commissioning Authority.
        6) Commissioning Authority reschedules test, and test is repeated until satisfactory performance is achieved.

B. Provide written report to Commissioning Authority before each scheduled progress meeting concerning status of each deficiency. Include explanations of disagreements with resolution proposals for each discrepancy.

    1. Commissioning Authority will retain original deficiency forms until end of Project.

C. Manufacturing Defects: When ten percent but not less than three identical pieces of equipment or equipment with only small size or capacity differences fail to perform to Contract Document requirements due to manufacturing defect, all identical units may be considered defective by Owner.

    1. Within one week of notice from Contracting Officer, examine all other identical units and record findings. Submit findings to Contracting Officer within two weeks of original notice.

2. Within two weeks of original notification, provide signed and dated written explanation of problem, cause of defect, and proposed solutions meeting Contract Document requirements. Include equipment submittals supporting solution.
3. Owner will determine whether replacement or repair of all identical units is required.
4. Install two examples of proposed solution. Contracting Officer will test installations for up to one week before deciding solution is acceptable.
5. Upon acceptance, replace or repair all identical items, at Contractor's expense. Extend warranty accordingly, when original equipment warranty had begun.
6. Complete repairs or replacements with reasonable speed beginning within one week from when parts can be obtained.

D. Test Approval: Commissioning Authority notes each satisfactorily demonstrated function on functional performance test form.

1. Commissioning Authority recommends acceptance of each test to Contracting Officer using standard form.
2. Contracting Officer gives final approval for each test using same form, providing signed copy to Commissioning Authority and Contractor.

3.6 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements contains requirements for demonstration and training.

B. Demonstrate equipment and systems and train Owner's personnel as specified in individual equipment and system Specifications.

1. Contracting Officer will interview Owner's personnel to determine special needs and areas where training will be most valuable.
2. Owner and Contracting Officer will determine type and extent of training for each commissioned piece of equipment and system.
3. Contracting Officer will communicate training requirements to Contractor for benefit of equipment and system installers and manufacturers with training responsibilities.

C. Contracting Officer will develop criteria for determining training was satisfactorily completed, including attending some training sessions.

1. Contracting Officer will make recommendation to Owner regarding approval of training.

D. Initial Mechanical, Electrical, and Plumbing Equipment Training Session:

1. Commissioning Authority or Contractor will make two hour long presentation of overall system design concept and design concept of each equipment section.
2. Presentation will include review of the following systems using simplified system schematics:
    a. Electrical system
    b. SCADA system
    c. Instrumentation and control system
    d. Pressure reducing/sustaining valve
    e. Water meter

E. For primary mechanical, electrical, and plumbing equipment training:

1. Require controls contractor to provide short discussion of equipment control and setting as part of training session.
2. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
3. Demonstrate startup, manual and automatic operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.

F. Contractor will make video recording of training sessions, catalog recordings, and furnish one set of recordings for inclusion with operation and maintenance manuals.

END OF SECTION 019100

SECTION 028213.33 - ASBESTOS ABATEMENT FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal of ACM-contaminated pipeline coatings.
2. Cutting of pipelines containing or coated with ACM.
3. Monitoring of Work area during cutting and cleaning operations.

B. Related Requirements:

1. Section 331116 - Site Water Utility Distribution Piping: Coordination of pipe, valves, and appurtenances during removal operations.

1.2 DEFINITIONS

A. ACM: Asbestos-containing material.

1.3 REFERENCE STANDARDS

A. Occupational Safety and Health Administration (OSHA):

1. 29 CFR Part 1926 - Safety and Health Regulations for Construction.
2. 40 CFR Part 763, Subpart E, Appendix E, Section 1- Polarized Light Microscopy.
3. 42 CFR Part 84, Subpart K - Non-Powered Air-Purifying Particulate Respirators.

B. U.S. Environmental Protection Agency:

1. National Emission Standards for Hazardous Air Pollutants (NESHAPs).

1.4 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information on respirators and air monitor.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Qualifications Statements:

1. Submit qualifications for contractor, on-Site representative, and disposal firm.

1.6 QUALITY ASSURANCE

A. Perform Work according to NESHAPs, OSHA, and Guam EPA standards.

1.7 QUALIFICATIONS

A. Contractor: Company specializing in repairing, modifying, cleaning, or removing AC pipe or ACM-coated pipe as specified in this Section with minimum three years' experience.

B. On-Site Representative: Person trained in performing Work of this Section with minimum three years' experience.

C. Disposal Firm: Company specializing in packaging and hauling ACM to disposal site.

D. Active Waste Disposal Site: Solid waste disposal site permitted to accept ACM waste.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Respirators Not in Use:

1. Store in sanitary location that protects respirators from dust, sunlight, heat, excessive moisture, and potentially damaging chemicals.
2. Place in plastic bags or closed containers.

PART 2 - PRODUCTS

2.1 RESPIRATORS

A. Furnish materials according to Guam EPA standards.

B. Description:

1. Comply with 42 CFR Part 84, Subpart K.

2. Type: Half-face mask; reusable after washing.
3. Maintenance: Replaceable filters and cartridges only.
4. Single-use respirators are not acceptable.

C. Filters: Top air inlet.

D. Performance and Design Criteria:

1. Application: Asbestos abatement for concentrations up to 10 times permissible exposure limit (PEL).
2. Design: Low profile.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for application preparation.

B. Perform ACM removal without damage to or contamination of adjacent Work or existing area.

C. Perform cleaning operations without taking pipeline out of service.

3.2 APPLICATION

A. Removal of Pipe:

1. Cutting and Disposal:
   a. Transport removed piping to a central staging area to cut for transport or disposal.
   b. Deposit pipeline pieces in leakproof metal collection box secured with tarpaulin covers.
   c. Transport filled boxes to an approved landfill outside of Guam.
   d. A licensed and certified asbestos supervisor will accompany transport vehicles to manage transport process.
   e. Maintain supply of fresh water near cutting operation to keep freshly cut areas of ACM damp while cutting piping.
   f. Individually wrap each joint of piping and pipe ends prior to loading.

B. Application Standards: Perform Work according to NESHAPs, OSHA, and Guam EPA standards.

END OF SECTION 028213.33

SECTION 030100 - MAINTENANCE OF CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete reinforcement repair.
2. Concrete surface repair.
3. Concrete crack repair.

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete.
2. Section 040100 - Maintenance of Masonry.

1.2 REFERENCES

A. ASTM International:

1. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
4. ASTM C33 - Standard Specification for Concrete Aggregates.
5. ASTM C109/C109M - Standard Test Method for Compressive strength of Hydraulic Cement Mortars (Using 2-in. or (50 mm) Cube Specimens).
6. ASTM C150 - Standard Specification for Portland Cement.
7. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
8. ASTM C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
9. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
10. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
11. ASTM C1042 - Standard Test Method for Bond Strength of Latex Systems Used With Concrete by Slant Shear.
12. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
13. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
14. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

B. American Welding Society:

1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.

C. Samples: Submit three color samples for patches exposed to view in finished construction and required to match existing.

D. Manufacturer's Instructions: Submit mixing and application instructions.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Accurately record actual locations of structural reinforcement repairs, type of repair, and date of repair.

C. Operation and Maintenance Data: Procedures for submittals.

1.5 QUALITY ASSURANCE

A. Perform welding work in accordance with AWS D1.4.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

B. Design reinforcement splices under direct supervision of Professional Engineer experienced in design of this Work and licensed in Guam.

1.7 MOCK-UP

A. Section 014000 - Quality Requirements: Requirements for mockup.

B. Prepare one mockup of each type of injection and patching procedure.

C. Locate where directed by Architect/Engineer.

D. Incorporate accepted mockup as part of Work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Comply with instructions for storage, shelf life limitations, and handling.

PART 2 - PRODUCTS

2.1 EPOXY ADHESIVE INJECTION MATERIALS

A. Epoxy Adhesive: Two-part epoxy adhesive containing 100 percent solids, meeting ASTM C881, Type IV, Grade 1, Class C requirements.

2.2 EPOXY MORTAR MATERIALS

A. Epoxy Mortar: Three-part epoxy binding resin and aggregate mortar mixture.

B. Epoxy Binding Resin: Two part epoxy resin containing 100 percent solids meeting ASTM C881, Type IV, Grade 1, 2, or 3, Class C requirements.

C. Aggregate: Type recommended by mortar manufacturer.

2.3 CEMENTITIOUS MORTAR MATERIALS

A. Cementitious Mortar: Packaged patching mortar meeting ASTM C1107 requirements.

B. Bonding Agent: Two part epoxy resin containing 100 percent solids meeting ASTM C881, Type V, Grade 3, Class C requirements.

2.4 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60, Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement, uncoated.

2.5 MIXING EPOXY MORTAR

A. Mix epoxy mortars to consistency for purpose intended.

B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

2.6 MIXING CEMENTITIOUS MORTAR

A. Mix cementitious mortar to consistency required for purpose intended.

B. Exclude bonding agent as additive to mix.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify surfaces are ready to receive work.

C. Beginning of installation means acceptance of substrate.

3.2 PREPARATION

A. Clean concrete surfaces of dirt, laitance, corrosion, or other contamination; wire brush using water; rinse surface and allow to dry.

B. Flush out cracks and voids with water to remove laitance and dirt.

C. Provide temporary entry ports spaced to accomplish movement of fluids between ports; no deeper than depth of crack to be filled or port size diameter no greater than thickness of crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.

D. For areas patched with epoxy mortar, remove broken and soft concrete until the concrete is sound. Sound concrete is defined as concrete showing broken aggregate faces at the surface of the concrete. Remove corrosion from steel. Clean surfaces mechanically; rinse with water.

E. Remove corrosion and/or clean exposed reinforcement steel surfaces. Mechanically cut away damaged portions of bar.

3.3 REPAIR WORK

A. Repair reinforcement in accordance with Engineers recommendations.

B. Repair exposed structural, shrinkage, and settlement cracks of concrete by epoxy injection method.

C. Repair spalling. Fill voids flush with surface.

3.4 INJECTION - EPOXY RESIN

A. Inject epoxy resin adhesive into prepared ports under pressure using equipment appropriate for particular application.

B. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port. Continue from port to port until entire crack is filled.

C. Remove temporary seal and excess adhesive.

D. Clean surfaces adjacent to repair and blend finish.

3.5 APPLICATION - EPOXY MORTAR

A. Trowel apply mortar mix flush with surrounding areas. Tamp into place filling voids at spalled areas.

B. For patching honeycomb, trowel mortar onto surface, work mortar into honeycomb to bring surface flush with surrounding area. Finish trowel surface to match surrounding area.

C. Cover exposed steel reinforcement with epoxy mortar, and complete repair in accordance with Engineers recommendations.

3.6 APPLICATION - CEMENTITIOUS MORTAR

A. Apply coating of bonding agent to concrete surfaces in accordance with manufacturer's recommendations. Provide full surface coverage.

B. Apply cementitious mortar by steel trowel flush with surrounding areas. Tamp into place filling voids at spalled areas. Work mix into honeycomb.

C. Damp cure cementitious mortar for three days.

3.7 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.

END OF SECTION 030100

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork for cast-in-place concrete.
2. Shoring, bracing, and anchorage.
3. Architectural form liners.
4. Form accessories.
5. Form stripping.

B. Related Requirements:

1. Section 032000 - Concrete Reinforcing: Reinforcing steel and required supports for cast-in-place concrete.
2. Section 033000 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frame, slabs-on-grade, and other concrete components associated with building.
3. Section 042000 - Unit Masonry:
   a. Positioning of recessed reglets for brick veneer masonry anchors.
   b. Product requirements for masonry accessories for placement by this Section.
4. Section 055000 - Metal Fabrications: Product requirements for metal fabrications for placement by this Section.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 318 - Building Code Requirements for Structural Concrete.
4. ACI 347 - Guide to Formwork for Concrete.

B. American Forest & Paper Association:

1. AF&PA - National Design Specification (NDS) for Wood Construction.

C. American Society of Mechanical Engineers:

1. ASME A17.1 - Safety Code for Elevators and Escalators.

D. APA - The Engineered Wood Association:

1. APA/EWA PS 1 - Voluntary Product Standard - Structural Plywood.

E. ASTM International:

1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

F. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard No. 17 Grading Rules for West Coast Lumber.

1.3 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with other Sections of Work in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information on void form materials and installation requirements.

C. Shop Drawings:

1. Indicate:
   a. Formwork, shoring, and reshoring.
   b. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
   c. Means of leakage prevention for concrete exposed to view in finished construction.
   d. Sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift, and height of drop during placement.
   e. Vertical, horizontal, and special loads according to ACI 347, and camber diagrams when applicable.
   f. Notes to formwork erector showing size and location of conduits and piping embedded in concrete according to ACI 318.
   g. Procedure and schedule for removal of shores and installation and removal of reshores.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for formwork, shoring and reshoring. Structural engineer shall be licensed in Guam.
2. Indicate loads transferred to structure during process of concreting, shoring, and reshoring.
3. Include structural calculations to support design.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 QUALITY ASSURANCE

A. Perform Work according to ACI 347, 301, and 318.

B. For wood products furnished for Work of this Section, comply with AF&PA.

1.6 QUALIFICATIONS

A. Licensed Professional: Professional engineer experienced in design of specified Work and licensed on Guam.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept void forms on Site in manufacturer's original packaging and inspect for damage.

C. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design, engineer, and construct formwork, shoring, and bracing according to ACI 318 to conform to design and applicable code requirements to achieve concrete shape, line, and dimension as indicated on Drawings.

2.2 WOOD FORM MATERIALS

A. Plywood:

1. Species: Douglas fir or Southern Pine.
2. Edges: Clean and true.

B. Lumber Forms:

1. Applications: Edge forms and unexposed finish concrete.
2. Boards:
    a. Description:
        1) Shiplapped or tongue and groove.
        2) Surface boards on four sides.

b. Material: "Construction" grade or better Douglas fir or Southern Pine according to WCLIB Standard No. 17.
c. Width: 8 inches.

C. Plywood Forms:

1. Application: Exposed finish concrete.
2. Description:
   a. Comply with APA/EWA PS 1.
   b. Panels: Full size, 4 by 8 feet.
   c. Label each panel with grade trademark of APA/EWA.
3. Plywood for Surfaces to Receive Membrane Waterproofing:
   a. Minimum Thickness: 5/8 inch.
   b. Grade: APA/EWA "B-B Plyform Structural I Exterior."
4. Plywood with "Smooth Finish" Indicated on Drawings:
   a. Minimum Thickness: 3/4 inch.
   b. Grade: APA/EWA "HD Overlay Plyform Structural I Exterior."

2.3 PREFABRICATED FORMS

A. Preformed Steel Forms:

1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
2. Minimum Thickness: 16 gage.

B. FRP Forms: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

C. Pan:

1. Material: Steel.
2. Configuration: Size and profile as required.

D. Tubular Column:

1. Description: Round spirally wound laminated fiber or wood.
2. Surface Treatment: Release agent, non-reusable.
3. Sizes: As indicated on Drawings.

E. Steel Forms:

1. Description: Sheet steel, suitably reinforced.
2. Design: For particular use as indicated on Drawings.

F. Form Liners: Smooth, durable, grainless, and non-staining hardboard unless otherwise indicated on Drawings.

G. Framing, Studding, and Bracing: Stud.

2.4 FORMWORK ACCESSORIES

A. Form Ties:

1. Type: Cone.
2. Material: Galvanized.
3. Length: Fixed.
4. Furnish waterproofing washer.
5. Back Break Dimension: 3/16” less than cone length.
6. Free of defects capable of leaving holes larger than 1 inch in concrete surface.

B. Spreaders:

1. Description: Standard, non-corrosive metal-form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch of concrete face.
2. Wire ties, wood spreaders, or through bolts are not permitted.

C. Form Release Agent:

1. Description: Colorless mineral oil that will not stain concrete or absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.

D. Corners:

1. Type: Chamfer
2. Size: ¾ inch
3. Lengths: Maximum possible.

E. Dovetail Anchor Slot:

1. Material: Galvanized steel.
2. Thickness: 22 gage.
3. Filling: Foam.
4. Fasten slot to concrete formwork according to manufacturer instructions, and insert foam filler to prevent concrete from entering slot during pour.

F. Flashing Reglets:

1. Material: Galvanized steel.
2. Thickness: 22 gage.
3. Lengths: Maximum possible.
4. Furnish alignment splines for joints.
5. Filling: Foam.
6. Fasten flashing reglet to concrete formwork according to manufacturer instructions, and insert foam to prevent concrete from entering reglet during pour.

G. Vapor Retarder:

1. Description: Polyethylene sheet.
2. Thickness: 8 mils.

H. Bituminous Joint Filler: Comply with ASTM D1751.

I. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify lines, levels, and centers before proceeding with formwork.

C. Verify that dimensions agree with Drawings.

D. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement, request instructions from Architect/Engineer before proceeding.

3.2 INSTALLATION

A. Earth Forms: Not permitted.

B. Formwork:

1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Camber forms where necessary to produce level finished soffits unless indicated otherwise on Drawings.
4. Positioning:
    a. Carefully verify horizontal and vertical positions of forms.
    b. Correct misaligned or misplaced forms before placing concrete.
5. Complete wedging and bracing before placing concrete.
6. Erect formwork, shoring, and bracing to achieve design requirements according to ACI 301, 318, and 347.
7. Stripping:
    a. Arrange and assemble formwork to permit dismantling and stripping.
    b. Do not damage concrete during stripping.
    c. Permit removal of remaining principal shores.
8. Obtain approval of Architect/Engineer before framing openings in structural members not indicated on Drawings.
9. Install fillet and chamfer strips on external corners of beams, joists, and columns,
10. Install void forms according to manufacturer instructions.

11. Do not reuse wood formwork more than three times for concrete surfaces to be exposed to view.
12. Do not patch formwork.
13. Leave forms in place for minimum number of days according to ACI 347.

C. Form Removal:

1. Do not remove forms or bracing until: concrete has reached a compressive strength of 2500 psi as determined by testing field cured test specimens, and form removal has been approved by the Engineer.
2. Loosen forms carefully; do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
3. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged.
4. Discard damaged forms.
5. Form Release Agent:
   a. Apply according to manufacturer instructions.
   b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
   c. Do not apply form release agent if concrete surfaces are indicated to receive special finishes or applied coverings that may be affected by agent.
   d. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.
6. Form Cleaning:
   a. Clean forms as erection proceeds to remove foreign matter within forms.
   b. Clean formed cavities of debris prior to placing concrete.
   c. Flush with water or use compressed air to remove remaining foreign matter.
   d. Ensure that water and debris drain to exterior through cleanout ports.
7. Reuse and Coating of Forms:
   a. Thoroughly clean forms and reapply form coating before each reuse.
   b. For exposed Work, do not reuse forms with damaged faces or edges.
   c. Apply form coating to forms according to manufacturer instructions.
   d. Do not coat forms for concrete indicated to receive "scored finish."
   e. Apply form coatings before placing reinforcing steel.

D. Forms for Smooth Finish Concrete:

1. Use steel, plywood, or lined-board forms.
2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
3. Install form lining with close-fitting square joints between separate sheets without springing into place.
4. Use full-sized sheets of form liners and plywood wherever possible.
5. Tape joints to prevent protrusions in concrete.
6. Apply forming and strip wood forms in a manner to protect corners and edges.
7. Level and continue horizontal joints.
8. Keep wood forms wet until stripped.

E. Architectural Form Liners:

1. Erect architectural side of formwork first.

2. Attach form liner to forms before installing form ties.
3. Install form liners square, with joints and pattern aligned.
4. Seal form liner joints to prevent grout leaks.
5. Dress joints and edges to match form liner pattern and texture.

F. Forms for Surfaces to Receive Membrane Waterproofing:

1. Use plywood or steel forms.
2. After erection of forms, tape form joints to prevent protrusions in concrete.

G. Framing, Studding, and Bracing:

1. Maximum Spacing of Studs:
   a. Boards: Maximum 16 inches o.c.
   b. Plywood: 12 inches o.c.
2. Size framing, bracing, centering, and supporting members for sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Construct beam soffits of material minimum 2 inches thick.
4. Distribute bracing loads over base area on which bracing is erected.
5. When placed on ground, protect against undermining, settlement, and accidental impact.

H. Form Anchors and Hangers:

1. Do not use anchors and hangers leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
3. Penetration of structural-steel members is not permitted.

I. Inserts, Embedded Parts, and Openings:

1. Install formed openings for items to be embedded in or passing through concrete Work.
2. Locate and set in place items required to be cast directly into concrete.
3. Install accessories straight, level, and plumb, and ensure that items are not disturbed during concrete placement.
4. Joints:
   a. Install waterstops continuous without displacing reinforcement.
   b. Heat-seal joints watertight.
5. Openings:
   a. Provide temporary ports or openings in formwork as required to facilitate cleaning and inspection.
   b. Locate openings at bottom of forms to allow flushing water to drain.
6. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.

J. Form Ties:

1. Provide sufficient strength and quantity to prevent spreading of forms.
2. Place ties at least 1 inch away from finished surface of concrete.
3. Leave inner rods in concrete when forms are stripped.
4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless indicated otherwise on Drawings.

K. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

L. Construction Joints:

1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.
2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
3. Appearance:
   a. Show no overlapping of construction joints.
   b. Construct joints to present same appearance as butted plywood joints.
4. Arrange joints in continuous line straight, true, and sharp.

M. Embedded Items:

1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

N. Openings for Items Passing through Concrete:

1. Frame openings in concrete where indicated on Drawings.
2. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.
3. Coordinate Work to avoid cutting and patching of concrete after placement.
4. Perform cutting and repairing of concrete required as result of failure to provide required openings.

O. Screeds:

1. Set screeds and establish levels for tops of and finish on concrete slabs.
2. Slope slabs to drain where required or as indicated on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms; remove freestanding water.

P. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.
2. Staking through membrane is not permitted.

Q. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Clean forms and surfaces against which concrete is to be placed.
3. Remove chips, sawdust, and other debris.
4. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances according to ACI 117.

B. Camber:

1. According to ACI 318.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Inspection:

1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.
2. Notify Construction Manager after placement of reinforcing steel in forms but prior to placing concrete.
3. Schedule concrete placement to permit formwork inspection before placing concrete.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforcing bars.
2. Welded wire fabric.
3. Reinforcement accessories.

B. Related Requirements:

1. Section 031000 - Concrete Forming and Accessories: Form materials, waterstops, and accessories required to form cast-in-place concrete.
2. Section 033000 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frame, slabs on grade, and other concrete components associated with building.
3. Section 260526 - Grounding and Bonding for Electrical Systems: Grounding concrete reinforcement.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 318 - Building Code Requirements for Structural Concrete.
4. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.
5. ACI SP-66 - ACI Detailing Manual.

B. American Welding Society:

1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

C. ASTM International:

1. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
2. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
3. ASTM A704 - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
4. ASTM A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
5. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

6. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
7. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
8. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
9. ASTM A996 - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
10. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

D. Concrete Reinforcing Steel Institute:

1. CRSI 10-MSP - Manual of Standard Practice.
2. CRSI 10PLACE - Placing Reinforcing Bars.

1.3 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with placement of formwork, formed openings, and other Work.

1.4 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings:

1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel and welded wire fabric.
2. Indicate bending and cutting schedules.
3. Indicate supporting and spacing devices.
4. Invoices showing compliance to Buy-American requirements per Section 016000 – Product Requirements.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Submit certified copies of mill test report of reinforcement materials analysis.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statement:

1. Welders: Qualify procedures and personnel according to AWS D1.1.

1.6 QUALITY ASSURANCE

A. Perform Work according to CRSI 10-MSP, ACI 301, ACI 318.

B. Prepare Shop Drawings according to ACI SP-66.

1.7 QUALIFICATIONS

A. Welders: AWS qualified within previous 12 months for employed weld types.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel:

1. Comply with ASTM A615.

2. Yield Strength: 60 ksi.
3. Reinforcement Bars: Deformed.
4. Finish: Galvanized or Uncoated.

B. Welded Plain Wire Fabric:

1. Comply with ASTM A1064.
2. Configuration: Flat sheets.
3. Finish: Galvanized.

2.2 FABRICATION

A. Fabricate concrete reinforcement according to CRSI 10-MSP.

B. Form standard hooks for 180-degree bends, 90-degree bends, stirrups and tie hooks, and seismic hooks as indicated on Drawings.

C. Form reinforcement bends with minimum diameters according to ACI 318.

D. Fabricate column reinforcement with offset bends at reinforcement splices.

E. Form spiral column reinforcement from minimum 3/8-inch-diameter continuous deformed bar or wire.

F. Weld reinforcement according to AWS D1.4.

G. Galvanized Reinforcement: Clean surfaces, weld, and re-protect welded joint according to CRSI 10PLACE.

H. Splicing:

1. If not indicated on Drawings, locate reinforcement splices at point of minimum stress.
2. Obtain approval of splice locations from Engineer of Record.

2.3 SHOP FINISHING

A. Galvanized Finish for Steel Bars:

1. Comply with ASTM A767, Class I.
2. Hot-dip galvanized after fabrication.

2.4 ACCESSORY MATERIALS

A. Tie Wire:

1. Minimum 16 gage, annealed type.

B. Chairs, Bolsters, Bar Supports, and Spacers:

1. Size and Shape: To strengthen and support reinforcement during concrete placement conditions.
2. Furnish load-bearing pad on bottom to prevent vapor retarder puncture.

C. Special Chairs, Bolsters, Bar Supports, and Spacers Adjacent to Weather-Exposed Concrete Surfaces:

1. Material: Plastic-coated steel.
2. Size and Shape: To meet Project conditions.

D. Reinforcing Splicing Devices:

1. Type: Mechanical set screw or threaded; Type 2.
2. Size: To fit joined reinforcing.

2.5 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Place, support, and secure reinforcement against displacement beyond specified placing tolerance.

B. Do not deviate from required position beyond specified tolerance.

C. Do not weld crossing reinforcement bars for assembly except as permitted by Architect/Engineer.

D. Do not displace or damage vapor retarder.

E. Accommodate placement of formed openings.

F. Spacing:

1. Space reinforcement bars with minimum clear spacing according to ACI 318 equal to one bar diameter but not less than 1 inch.
2. If bars are indicated in multiple layers, place upper bars directly above lower bars.

G. Maintain minimum concrete cover around reinforcement according to ACI 318 as follows:

1. Footings and Concrete Formed against Earth: 3 inches.
2. Concrete Exposed to Earth or Weather:
   a. No. 6 Bars and Larger: 2 inches.
   b. No. 5 Bars and Smaller: 1-1/2 inches.
3. Slabs, Walls, and Joists Not Exposed to Weather or in Contact with Ground:
   a. No. 14 Bars and Larger: 1-1/2 inches.
   b. No. 11 Bars and Smaller: 3/4 inch.
4. Beams and Columns: 1-1/2 inches.

H. Bond and ground reinforcement as specified in Section 260526 - Grounding and Bonding for Electrical Systems.

3.2 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. General: Install reinforcement within tolerances according to ACI 117.

C. Masonry Foundation Walls: Install reinforcement within tolerances according to ACI 530/530.1.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Perform field inspection and testing according to ACI 318.

C. Provide unrestricted access to Work and cooperate with appointed inspection and testing firm.

D. Reinforcement Inspection:

1. Placement Acceptance: Inspect specified and ACI 318 material requirements and specified placement tolerances.
2. Welding: Inspect welds according to AWS D1.1.
3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.
4. Weldability Inspection: Inspect for reinforcement weldability if formed from steel other than ASTM A706.
5. Continuous Weld Inspection: Inspect reinforcement according to ACI 318.
6. Periodic Weld Inspection: Inspect other welded connections.

3.4 SCHEDULE

A. Reinforcement for Foundation, Wall Framing Members, roofs, and Slabs on Grade: Deformed bars, uncoated.

B. Reinforcement for Vault Floor, Walls and Top Slab: Deformed bars, uncoated.

C. Reinforcement for Concrete Pavement: Deformed bars, uncoated.

END OF SECTION 032000

SECTION 032510 - EXPANSION AND CONSTRUCTION JOINTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the work necessary to furnish, install and complete the expansion and construction joints.

1.2 SUBMITTALS

A. Furnish certified mill certificates showing that the material meets all of the requirements specified here-in. The Contracting Officer at their option may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the Owner. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.

1.3 OBSTRUCTIONS

A. Contractor shall pay particular attention to removing all obstructions such as concrete, nails, etc., from joints when movements of floor, wall and roof sections can be expected under temperature and other conditions.

PART 2 - PRODUCTS

2.1 JOINT SEALERS

A. Joints shall be sealed with a mastic joint sealer material of uniform, stiff consistency that does not contain solvents.

B. The mastic shall adhere to primed concrete surfaces, shall remain permanently mastic and shall not contaminate potable water.

C. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.

D. The mastic joint sealer shall be an acceptable two-part, self-leveling (or gun grade), non-staining, polyurethane elastomeric sealant which cures at ambient temperature. Acceptable sealants shall conform to ASTM C-920 or Federal Specification TT-S-00227E.

E. For sloping joints, vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C-920 Class 12-1/2, or Federal Specification TT-S-0027 E(3), Type II.

F. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, or Federal Specification TT-S-0027 E(3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 25 to 35, shall be used.

G. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the sealant manufacturer.

A. Available Manufacturers:

1. SIKAFLEX -2C NS EZ Mix POLYURETHANE ELASTOMERIC SEALANT, as manufactured by SIKA CHEMICAL CORP., Lyndhurst, NJ (800-933-7452)
2. Or approved equal.

2.2 PREFORMED JOINT FILLER

A. Preformed joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise specified herein.

2.3 BACKING ROD

A. Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a ¾-inch wide joint.

PART 3 - EXECUTION

3.1 JOINT SEALERS

A. Joint sealed areas shall be sandblasted or roughened and blown clean of dust and sand with compressed air before the material may be applied.

B. Joints shall be primed (if required) and the sealant shall be applied in accordance with the manufacturer's recommendations.

END OF SECTION 032510

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. The Work of this Section includes providing finished cast-in-place structural concrete, including mixing, transporting, placing, curing, repairing and finishing.

B. The following types of concrete shall be covered in this Section:

1. Structural Concrete: Concrete to be used in all cases except where indicated otherwise.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

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.

B. Federal Specifications:

1. UU-B-790-A(Int.Amd.1) Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

C. Commercial Standards:

1. ACI 117 - Standard Tolerances for Concrete Construction and Materials
2. ACI 214 - Recommended Practice for Evaluation of Strength Test Results of Concrete
3. ACI 301 - Specifications for Structural Concrete for Buildings
4. ACI 305 - Hot Weather Concreting
5. ACI 309 - Consolidation of Concrete
6. ACI 318 - Building Code Requirements for Reinforced Concrete
7. ACI 350 - Environmental Engineering Concrete Structures
8. ASTM C 31 - Practices for Making and Curing Concrete Test Specimens in the Field
9. ASTM C 33 - Specification for Concrete Aggregates
10. ASTM C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens
11. ASTM C 40 - Test Method for Organic Impurities in Line Aggregate for Concrete
12. ASTM C 88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulphate
13. ASTM C 94 - Specification for Ready-Mixed Concrete
14. ASTM C 114 - Method for Chemical Analysis of Hydraulic Cement
15. ASTM C 117 - Standard Test Method for Materials Finer than 75-mm (No. 200) Sieve in Mineral Aggregates by Washing
16. ASTM C 131 - Test Method for Resistance Degradation of small-size coarse aggregate by abrasion and impact in the Los Angeles Machine
17. ASTM C 136 - Method for Sieve Analysis of Fine and Coarse Aggregate
18. ASTM C 143 - Test Method for Slump of Portland Cement Concrete
19. ASTM C 150 - Specification for Portland Cement

20. ASTM C 156 - Test Method for Water Retention by Concrete Curing Materials
21. ASTM C 157 - Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
22. ASTM C 192 - Method of Making and Curing Concrete Test Specimens in the Laboratory
23. ASTM C 260 - Specification for Air-Entraining Admixtures for Concrete
24. ASTM C 309 - Specifications for Liquid Membrane-Forming Compounds for Curing Concrete
25. ASTM C 311 - Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
26. ASTM C 494 - Specification for Chemical Admixtures for Concrete
27. ASTM C 618 - Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
28. ASTM C 1077 - Standard Practice for Laboratories Testing and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
29. ASTM C 1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
30. ASTM C 1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
31. ASTM C 1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
32. ASTM D 1751 - Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
33. ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate
34. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

1.3 SUBMITTALS

A. General: Submittals shall be in accordance with the requirements of Section 013300 – Submittal Procedures.

1. Mix Designs: Prior to beginning the Work and within 14 days of the notice to proceed, preliminary concrete mix designs shall be submitted which shall show the proportions and gradations of all materials proposed for each class and type of concrete. The mix shall be designed and sealed by a professional engineer registered in Guam. The mix designs shall be submitted to the Construction Manager for review and approval prior to performing trial batch testing to confirm conformance with specifications.
2. Trial Batch Testing: Supply material representative of those to be used in production batches to an independent testing laboratory, acceptable to the Construction Manager, and meeting the requirements of ASTM C1077. Submit results of trial batch testing to Construction Manager for review and approval prior to placing concrete. All costs related to such testing shall be borne by the Contractor.
3. Provide the following submittals in accordance with ACI-301:
    a. Mill tests for cement.
    b. Admixture certification. Chloride ion content must be included.
    c. Aggregate gradation and certification.
    d. Materials and methods of curing.
4. Certified Delivery Tickets: Where ready-mix concrete is used, the Contractor shall provide certified weighmaster delivery tickets at the time of delivery of each load of

concrete. Contractor's certificate with each delivery ticket shall show the total quantities, by weight of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

5. Aggregate: Submit test report indicating the aggregates proposed for use in concrete meet the requirements of ASTM C 33, Class 1N.
6. Fly Ash: If used, the Contractor shall submit Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C 618 and these Specifications together with all supporting test dates prior to the use of the fly ash, and shall also submit a copy of the Fly Ash Chemical Analysis Report. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air-entraining agents and other admixtures.
7. Concrete placement drawings identifying time between adjacent pours, and location of each type of construction joint to be used.
8. Bonding Agent:
   a. Manufacturer's Certification of Compliance, including statement that product is suitable for and will meet job requirements including surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
   b. Manufacturer's recommendations for application specific to this project. Have information available on project site.
9. Bond Breaker: Manufacturer's data, recommendations, and instructions for specific use on this project.
10. Curing Compound: Manufacture's product sheet, recommendations, and instructions for specific use on this project.
11. Contractor shall coordinate and obtain and submit to Construction Manager admixture manufacturers' certifications that state their products are compatible with other admixtures proposed to be used.

1.4 TESTING

A. General:

1. Tests on component materials and for compressive strength and water-soluble chloride ions content of concrete shall be performed by an independent laboratory meeting the requirements of ASTM C1077 and acceptable to the Construction Manager.
2. Contractor shall be responsible for field quality control testing of concrete. Construction Manager may perform Construction Quality Assurance testing to monitor the results of the Contractor's independent laboratory.

B. Compression Tests:

1. Compression test specimens shall be taken during construction from the first placement of each class of concrete indicated herein and at intervals thereafter as selected by the Construction Manager to insure continued compliance with these Specifications. Each set of test specimens shall be a minimum of 5 cylinders.

2. Compression test specimens for concrete shall be made in accordance with ASTM C 31. Specimens shall be either 6-inch diameter by 12-inch long or 4-inch diameter by 8-inch long cylinders.
3. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder shall be tested at 7 days, two test cylinders shall be tested at 28-days (3 test cylinders shall be tested at 28 days if 4x8 inch cylinders are used). The remaining cylinders shall be held to verify test results, if needed.

C. Evaluation and Acceptance of Concrete:

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318-11, Section 5.6, "Evaluation and Acceptance of Concrete," and as indicated herein.
2. A statistical analysis of compression test results shall be performed according to the requirements of ACI 214.
3. If the average compressive strength of any concrete falls below the specified strength, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the indicated compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.
5. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no additional cost to Owner.

D. Water-Soluble Chloride Ion Content Test: Test in accordance to ASTM C1218.

E. Fly Ash: For each class of fly ash, all testing and sampling procedures shall conform with these Specifications and ASTM C 311, including the restriction that one sample weighing 4 pounds shall be taken from at least each bulk shipment of fly ash delivered to Guam.

F. Construction Tolerances: Construction tolerances shall meet the requirements of ACI 117.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Cement (when packaged), air entraining agent, admixtures, curing compounds, joint filers and joint sealants, damp proofing agents, and adhesives shall be delivered in original, unbroken packages, and containers bearing the name of the manufacturer, the description of the contents, and dates of manufacture and expiration.

B. Storage: Products shall be carefully stored in a manner that shall prevent damage, segregation, and in an area that is protected from the elements. Admixtures shall be stored in accordance with the manufacturer’s recommendations.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. General:

1. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

B. All materials furnished for the Work shall comply with the requirements of ACI 301, as applicable.

C. Storage of materials shall also conform to the requirements ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand Portland cement conforming to ASTM C 150 Type II including Table 1A optional requirements. A minimum of 85 percent of cement by weight shall pass a 325 screen. Portland cement shall contain not more than 0.60 percent alkalies. The term "alkalies" referred to herein is defined as the sum of the percentage of sodium oxide and 0.658 times the percentage of potassium oxide (Na20 + 0.658 K20). These oxides shall be determined in accordance with ASTM C 114. A single brand of cement shall be used throughout the work, and prior to its use, the brand shall be acceptable to the Construction Manager. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports for each shipment of cement to be used shall be submitted to the Construction Manager regarding compliance with these Specifications.
2. Water for mixing and curing shall be potable, clean, and meet the requirements of ASTM C1602. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies.
3. Aggregates shall be obtained from pits acceptable to the Construction Manager, shall be non-reactive, and shall conform to ASTM C 33, Class 1N. Maximum size of coarse aggregate shall be as indicated herein.
    a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than 3/4-inch.
        1) Natural gravels, a combination of gravels and crushed gravels, crushed stone, or a combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
        2) Aggregates shall be free of materials or aggregate types that cause popouts, discoloration, staining, or any other defects on the surface of the concrete. Process aggregates to remove these materials or import aggregates free of these materials. Performance history showing that an aggregate source produces these problems shall also be used to reject the aggregates.

b. Fine aggregates shall be natural or manufactured sand or a combination of natural and manufactured sand that are hard and durable. The sand shall meet the fine aggregate requirements of ASTM C33.

c. Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d. The combined aggregates shall be tested for aggregate-alkali reactivity. The percentages of fine and coarse aggregate shall meet the percentages shown in the submitted concrete mix design.

1) When tested in accordance with ASTM C1260 or ASTM C1567, the maximum expansion allowed will be 0.10% after 16 days after casting.

2) When tested in accordance with ASTM C1293 the maximum expansion allowed is 0.04% after one year of testing.

4. Ready-mix concrete shall conform to the requirements of ASTM C 94.

5. Admixtures: All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations.

a. Air-entraining agent meeting the requirements of ASTM C 260, may be used.

b. Set controlling and water reducing admixtures: Admixtures may be added at the Contractor's option to control the set, effect water reduction, and increase workability. The addition of an admixture shall be at the Contractor's expense. The use of an admixture shall be subject to acceptance by the Construction Manager and shall be submitted and approved prior to use. Admixtures specified herein shall conform to the requirements of ASTM C 494.

1) Set controlling admixture shall be either with or without water-reducing properties. Where air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture shall be used in conformance with ASTM C 494, Type B, D, or G.

2) Normal range water reducer shall conform to ASTM C 494, Type A. The quantity of admixture used and the method of mixing shall be in accordance with the Manufacturer's instructions and recommendations.

3) Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

4) Provide uniform use of admixture on any one structure. Variation in finish appearance due to use of admixture is not allowed.

c. High Range Water Reducer (Superplasticizers):

1) High range water reducer (HRWR) shall conform to ASTM C 494, Type F or G.

2) If the high range water reducing agent is added to the concrete at the batch plant, it shall be a second generation type. High range water reducer shall be added to the concrete after all other ingredients, including low range water reducer, have been mixed and initial slump has been verified.

3) If the high range water reducer is added to the concrete at the job site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3 inches ± 1/2-inch prior to adding the high range water reducing admixture at the job site.

4) Hold slump of 5 inches or greater for the time required for placement into the structure.

d. Shrinkage-reducing admixture designed to reduce the surface tension of pore water, not with expansive properties may be used provided that compensation be implemented to recover the amount of compressive strength loss due to the addition of this admixture. The use of this type admixture together with associated compensation for strength loss shall be done at no additional cost to Owner.
e. Calcium Chloride: Calcium chloride will not be permitted to be used in concrete.
f. Fly ash/pozzolan shall conform to ASTM C 618 Class F, including the requirements of Table 1A, therein, and the following supplementary requirements:
    1) Loss on Ignition, Maximum: 3 percent.
    2) SO3 Content, Maximum: 3 percent.
    3) Moisture Content, Maximum: 1 percent.
    4) R = (CaO - 5%)/(Fe2O3), Maximum: 1.5.

2.2 CURING MATERIALS

A. Materials for curing concrete as indicated herein shall conform to the following requirements and ASTM C 309.

1. All curing compounds shall be water based concrete curing compound; Sodium silicate compounds shall not be allowed. Only water based curing compounds shall be used.
2. Polyethylene sheet for use as concrete curing blanket shall be white, and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 grams per square centimeter of surface.
3. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (Int. Amd. 1). The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.
4. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.
5. Curing mats for use in Curing Method 6 as indicated in Paragraph 3.10.G shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

2.3 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. Preformed joint filler for non-water retaining applications shall be a non-extruding, resilient, bituminous type conforming to the requirements of ASTM D 1751.
2. Elastomeric joint sealer shall conform to the requirements of Section 032510 – Expansion and Construction Joints.
3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and

pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants.

2.4 MISCELLANEOUS MATERIALS

A. Floor sealer/hardener shall be a colorless, aqueous solution of zinc and/or magnesium fluosilicate or of sodium silicate. The solution shall be delivered ready for use in the manufacturer's original sealed containers. Each gallon of the fluosilicate solution shall contain not less than 2 pounds of crystals.

B. Dampproofing agent shall be an asphalt emulsion.

C. Bonding agents shall be epoxy adhesives meeting the requirements of ASTM C881, Type IV or Type V.

D. Vapor Retarder (formerly Vapor Barrier): Shall comply with the requirements of ASTM E1745, Class A, and shall have a thickness of not less than 10 mils. Provide manufacturer's recommended mastics and gusset tape.

2.5 CONCRETE DESIGN REQUIREMENTS

A. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities indicated. The exact proportions in which these materials are to be used for different parts of the Work shall be determined by the Contractor during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface.

The concrete mix design shall be based on the requirements of ACI 301-10, Section 4.2.3.4.a or Section 4.2.3.4.b. If the mixes are based on the requirements of ACI 301-10 Section 4.2.3.4.b, the range of water/cementitouos materials ratio shall spread across the specified water/cementitous materials ratio. At least one mix shall be made with a water/cementitous materials below 0.40, and at least one mix shall be made with a water/cementitous materials ratio above 0.40.

The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to Owner. All changes shall be subject to review by the Construction Manager.

The trial batch shall be prepared using the aggregates, cement, admixtures, and other ingredients proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 6 compression test and one water-soluble

chloride ion specimens from each batch. The cost of laboratory trial batch tests for each indicated concrete strength will be borne by the Contractor. The Contractor shall furnish and deliver the materials in steel drums at no cost. Any additional trial batch testing required shall be performed at the expense of the Contractor at no increase in cost to Owner.

The determination of compressive strength will be made by testing test sample cylinders of the size specified; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. One test cylinder shall be tested at 7 days, and three test cylinders shall be tested at 28-days. The average compressive strength for the 3 cylinders tested at 28 days for any given trial batch shall meet the requirements of ACI 301-10, Table 4.2.3.3.b.

B. Water-Cement Ratio and Compressive Strength: The minimum compressive strength, maximum aggregate size, and maximum water/cement ratio of concrete shall be as indicated in the following table:

Type of Work	Min. 28-Day Compr. Strength (psi)	Max Size Aggregate (in)	Max W/C Ratio (by weight)
Structural Concrete:			
Roof, floor slabs,	4,000	1	0.40
Walls and all other concrete items not specified elsewhere.			
12" and thicker walls,	4,000	1½	0.40
slabs on grade and footings.			

C. High Range Water Reducer (Superplasticizers):

1. Use type as recommended by manufacturer in the applicable temperature ranges allowed.
2. Use mid-range water reducer in all concrete for this project. Use superplasticizer to obtain required properties not attainable by mid-range water reducer.
3. Accomplish variations in slump, and air content for flowable mixes by increasing or reducing superplasticizer dose at the ready-mix plant only. Adjust the slump at the jobsite by adding admixtures for a particular load when approved by the Construction Manager then the plant dose shall be adjusted to meet the specifications for the rest of the placement. This additional dosage at the jobsite shall be through an approved dispenser, supplied by the admixture manufacture.
4. Effect on slump: Maintain required slump throughout time of concrete placement and consolidation. Discontinue use of superplasticizer if it fails to maintain slump in required range.
5. Meet design strengths, slumps, water-cement ratio, and other requirements as specified at slump required for placement.
6. Use water reducers in combination with superplasticizers as required for mixing.

D. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish and the Contractor shall be entitled to no additional compensation because of such changes.

E. Fly ash/pozzolan: Fly ash/pozzolan shall be used as a partial cement replacement in concrete as follows:

1. Fly ash shall replace not more than 25 percent by weight of the Portland cement in the design mix.

F. Combined Aggregate Grading:

1. The combined aggregate gradation shall be used to calculate a coarseness factor (CF) and a workability factor (WF). The CF is described by the formula [Q/(Q+I)]x100. The large particles (Q) shall be the percent of aggregate retained on all sieves 3/8 in. and larger. The intermediate particles (I) shall be the percent of aggregate passing the 3/8 in. sieve and retained on the No. 8 sieve, or simply, the amount retained on the No. 3/8 in. sieve divided by the amount retained on the No. 8 sieve multiplied by 100. The fine particles (WF) shall be the percent finer than the No. 8 sieve when the cementitious material is 564 lbs. The WF shall be adjusted (W-adj.) by 2.5% percent for each 94 lb of cementitious materials change above or below 564 lb of cementitious materials.
2. The CF and WF shall be plotted on a chart to establish a trend line based on the formula [-(CF/7) + 43 < y < -(CF/7) + 48].
3. The CF shall not be greater than 75 nor less than 40. The plot of the WF and the CF for acceptance mixtures shall be a single point approximately four to six points above the trend line.

2.6 CONSISTENCY

A. The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein indicated to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

	SLUMP (Inches)	
Part of Work	Prior to Adding Superplasticizer	After Adding Superplasticizer
Footings and slabs	Between 2 and 5 inches	5 - 9
Other Work	Between 2 and 5 inches	5 - 9

Slump of concrete containing high range water reducing agent shall not be more than 9 inches.

2.7 WATER-SOLUBLE CHLORIDE ION LIMITATION

A. Maximum water-soluble chloride ions shall not exceed 0.06% by weight of the cementitious material in the mix.

2.8 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the Contractor and acceptable to the Construction Manager.

B. Weighing tolerances:

Material	Percent of total weight
Cement	1
Aggregates	3
Admixtures	3

2.9 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the Construction Manager and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any indicated amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in *the water line to the mixer. The operating mechanism must be such that leakage will not occur when the valves are closed.

2.10 READY-MIXED CONCRETE

A. At the Contractor's option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as indicated herein and in accordance with ASTM C 94, including the following supplementary requirements. Add admixtures at the plant only through equipment furnished and/or approved by the admixture manufacturer. Test fly ash in accordance with ASTM C 311.

B. Ready-mixed concrete shall be delivered to the site of the Work, and discharge shall be completed within 1-1/2 hours after the addition of water to the cement and aggregates or before the drum has been revolved 250 revolutions, whichever is first. This limitation may be waived by the Construction Manager if the concrete is of such slump after the 1-1/2 hour time has been reached that it can be placed without the addition of water to the batch.

C. 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.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 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 revolution of mixing.

E. Truck mixers shall meet the uniformity requirements of ASTM C94-13a, Table A1.1, when the concrete is sampled in accordance with ASTM C94-13a, Section 12.5.1.

F. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a certified weighmaster delivery ticket furnished to the Construction Manager in accordance with the paragraph in Part 1 titled "Certified Delivery Tickets."

G. 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 Construction Manager.

PART 3 - EXECUTION

3.1 PROPORTIONING AND MIXING

A. Proportioning: Proportioning of the concrete mix shall conform to the requirements of ACI 301 provided the maximum slump for any concrete shall not exceed 5 inches, except where the use of high range water reducer is permitted which increases the maximum slump to 9 inches.

B. Mixing: Mixing of concrete shall conform to the requirements of ASTM C94.

C. Slump: Maximum slumps shall be as indicated.

D. Retempering: Retempering of concrete or mortar which has partially hardened will not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. General: Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete or mud mat, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete or mud mat thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete or mud mat.

B. Joints in Concrete Up to 60 Days Old: Concrete surfaces upon or against which concrete is to be placed, where the placement of the old concrete has been stopped or interrupted so that, as determined by the Construction Manager, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, and foreign material and roughened to a minimum ¼-inch amplitude. Such

cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. Placing Interruptions: When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent work; provided that construction joints shall be made only where acceptable to the Construction Manager. Where this occurs in tankage area, a water stop shall be provided at the construction joint.

D. Embedded Items: No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the Construction Manager at least 4 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

E. All inserts or other embedded items shall conform to the requirements herein.

F. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where indicated on drawings or shop drawings and shall be acceptable to the Construction Manager before any concrete is placed. Accuracy of placement of all these items is the responsibility of the Contractor.

G. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sand-blasting (exposing aggregate). The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the Construction Manager.

H. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. No concrete shall be deposited underwater nor shall the Contractor allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the Construction Manager.

I. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

J. Openings for pipes, inserts for pipe hangers and brackets, and the setting of anchors shall, where practicable, be provided for during the placing.

K. Anchor bolts shall be accurately set, and shall be maintained in position by templates while being embedded in concrete.

L. Cleaning: The surfaces of all 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.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. General: Placing of concrete shall conform to the applicable requirements of Section 5 of ACI 301-10 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. Non-Conforming Work or Materials: Concrete which upon or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the Work. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced by the Contractor and at the no additional cost to Owner.

C. Unauthorized Placement: No concrete shall be placed except in the presence of a duly authorized representative of the Construction Manager. The Contractor shall notify the Construction Manager in writing at least 24 hours in advance of placement of any concrete.

D. Placement in Wall Forms: Concrete shall not be dropped through reinforcement steel or into any deep form, whether reinforcement is present or not, causing separation of the coarse aggregate from the mortar on account of repeatedly hitting rods or the sides of the form as it falls, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without segregation. In no case shall the free fall of concrete exceed 4 feet below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6 feet in horizontal direction. Concrete in forms shall be deposited in uniform horizontal layers not deeper than 2 feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in forms shall not exceed 5 feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of all forms so that the concrete at all places of deposit is visible from the deck or runway.

E. Casting New Concrete Against Old: An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This provision shall not apply to joints where waterstop is installed.

F. Conveyor Belts and Chutes: All ends of chutes, hopper gates, and all other points of concrete discharge throughout the Contractor's conveying, hoisting and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of an acceptable type. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered.

G. Placement in Slabs: Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the pour. As the Work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. Temperature of Concrete: The temperature of all concrete, except concrete deposited in wall or column forms, when it is being placed shall be not more than 95 degrees F without the approval of the Construction Manager.

I. Hot Weather Concrete Placement:

1. Hot weather concrete placement shall comply with ACI 305-10.
2. Hot weather is defined as any combination of high air temperature, low relative humidity and wind velocity that results in a rate of evaporation of 0.2 pounds per square foot per hour based upon the evaporation rate figure 4.2 in ACI 305-10.
3. If conditions meet the above criteria for "hot weather", the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 95 degrees F.
4. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.
5. Concrete deposited in wall or column forms shall not be allowed to exceed 100 degrees F under any conditions.
6. Fog spray shall be used during finishing operations whenever necessary to avoid surface plastic shrinkage cracking. Fog spray shall also be used after finishing and before the specified curing is commenced to avoid surface plastic shrinkage cracking.

3.4 PUMPING OF CONCRETE

A. General: 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.

B. Pumping Equipment: The pumping equipment must have 2 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.

C. The minimum diameter of the hose (conduits) shall be in accordance with ACI 304.2R.

D. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.

E. Aluminum conduits for conveying the concrete will not be permitted.

F. Proportioning: Minimum compressive strength, cement content, and maximum size of aggregates shall be as indicated herein.

G. Water and slump requirements shall conform to the requirements of this Section.

H. Cement and admixtures shall conform to the requirements of this Section.

I. Field Control: Concrete samples for slump, air content and test cylinders will be taken at the placement (discharge) end of the line.

3.5 ORDER OF PLACING CONCRETE

A. The order of placing concrete in all parts of the Work shall be acceptable to the Construction Manager. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown and as specified. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 3 days for all structures before the contiguous unit or units are placed.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

C. Limit size of each pour regardless whether slabs or walls, to allow for volume change due to shrinkage to take place.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be Group 3 (per ACI 309) high speed power vibrators (8000 to 10,000 vibrations per minute) of an immersion type in sufficient number and with a number of standby units determined by the size of the pour. As a minimum one standby unit is required.

B. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as indicated. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein indicated within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are

defined as tolerances and were indicated above. Tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

B. Formed Surfaces: No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as indicated.

1. Surface holes larger than 1/2-inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.

C. Unformed Surfaces: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation is necessary to prevent drying shrinkage cracks. The classes of finish indicated for unformed concrete surfaces are designated and defined as follows:

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the Construction Manager.
3. Finish U3 - After the floated surface (as indicated for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.
4. Finish U4 - Steel trowel finish (as indicated for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.

D. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs which are water bearing with slopes 10 percent and less	U3
Sloping slabs which are water bearing with slopes greater than	

10 percent	U4
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U3

E. Floor Sealer Hardener (Surface Applied):

1. Floors to receive hardener shall be cured, cleaned, and dry with all Work above them completed. Not less than 60 days shall have elapsed between casting floors and application of sealer/hardener. Apply zinc and/or magnesium fluosilicate evenly, using 3 coats, allowing 24 hours between coats.
2. The first coat hall be 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength. Each coat shall be applied so as to remain wet on the concrete surface for 15 minutes. If sodium silicate is used, it shall be applied evenly, using 3 coats, allowing 24 hours between coats, and the material shall be applied full strength at the rate of one gallon per 300 square feet. Approved proprietary hardeners shall be applied in conformance with the manufacturer's instruction. After the final coat is completed and dry, surplus hardener shall be removed from the surface by scrubbing and mopping with water.
3. Floor hardener shall be applied where indicated.

3.8 ETCHED FINISH

A. Graphic and Figure Finish: Apply a medium abrasive wet blasted finish (1/8" maximum) on concrete surfaces where indicated to create each graphic or figure. Texture of concrete surfaces shall be uniform after wet blasting and shall match finish as specified.

B. Perform abrasive wet blasting in as continuous an operation as possible, utilizing the same work crew to maintain a continuity of finish on each surface of area of work. Coordinate scheduling so that a minimum time elapses between blasting operations and application of water repellent sealant system.

C. Use an abrasive grit or sand of the proper type and gradation as required to remove the surface latency and define the aggregate and surrounding matrix surfaces to match approved mockup panels. The abrasive shall not affect the color of the finished surface.

D. Diameters of air and water lines and hoses shall be in accordance with the recommendations of the manufacturer of the abrasive blasting equipment.

E. Abrasive wet blast to graphic template edges carefully to maintain uniform sharp edges. Blasting shall be accompanied by an air hose to remove residues as surfaces are cut to enable examination of surfaces.

F. Protect adjacent and surrounding surfaces, finishes and assemblies from abrasive blasting operations.

G. Any areas lacking the specified appearance (consistent with the approved mockup panel) shall be replaced of re-coated to the satisfaction of the Construction Manager without additional cost.

H. Abrasive blasting operations shall be performed in accordance with the most current requirements of Guam Environmental Protection Agency.

3.9 CURING AND DAMPPROOFING

A. General: All concrete shall be cured for not less than 14 days after placing, in accordance with the methods indicated herein for the different parts of the Work, and described in detail in the following paragraphs:

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	4 or 6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically provided for elsewhere in this Paragraph	4
Slabs not on grade	6

B. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 14 days of placing the concrete, curing shall be continued in accordance with Method 6, herein.

C. Method 2: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. Method 4: The surface shall be sprayed with a liquid curing compound.

1. Curing compound shall not be used on concrete surfaces to be coated, waterproofed, moistureproofed, or where any coverings are to be bonded.
2. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film which will seal thoroughly.
3. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

4. Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
5. Where curing compound is indicated, it shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as indicated herein.
6. At all locations where concrete is placed adjacent to a panel which has been coated with curing compound, the previously coated panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.
7. Prior to final acceptance of the Work, all visible traces of curing compound shall be removed from all surfaces in such a manner that does not damage surface finish.

F. Method 5:

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4, herein. Not less than one hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint. The Contractor shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.
2. The curing blankets shall be left in place during the 14-day curing period and shall not be removed until after concrete for adjacent Work has been placed. Should the curing blankets become torn or otherwise ineffective, the Contractor shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket.

G. Method 6: This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 14 consecutive days beginning immediately after the concrete has reached final set or forms have been removed.
2. Until concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held in place to prevent being dislodged by wind or any other causes and to be substantially in contact with the concrete surface. All edges shall be continuously held in place.
4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.
5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4, herein.
6. The Contractor shall dispose of excess water from the curing operation to avoid damage to the work.

H. Dampproofing:

1. The exterior surface of all buried wall surfaces and roof slabs shall be dampproofed as follows.
2. Immediately after completion of curing the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to 1/2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the indicated material, undiluted, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as indicated herein.
3. As soon as the asphalt emulsion, applied as indicated herein, has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used which produces a uniformly coated white surface and which so remains until placing of the backfill. Should the whitewash fail to remain on the surface until the backfill is placed, the Contractor shall apply additional whitewash.

3.10 PROTECTION

A. The Contractor shall protect all concrete against injury until substantial completion as determined by Construction Manager.

B. Fresh concrete shall be protected from damage due to rain, The Contractor shall provide such protection shall be provided while the concrete is still plastic and whenever such precipitation is imminent or occurring.

3.11 BACKFILL AGAINST WALLS

A. Do not backfill against walls until concrete has obtained compressive strength equal to the specified 28-day compressive strength.

B. Place backfill simultaneously on both sides of wall where required to prevent differential pressures.

3.12 FIELD TESTS

A. Evaluation and Acceptance of Concrete:

1. Contractor shall provide all tests as specified in this Section, unless indicated otherwise. Construction Manager may make or have tests made to determine compliance with Specifications for quality assurance.
2. Evaluation will be in accordance with ACI Standard Building Code Requirements for Reinforced Concrete (ACI 318-11), Chapter 5 and these Specifications. Where the term "building official" is used, the term shall be redefined to "Construction Manager".
3. Contractor's Responsibilities:
    a. Cooperate in making of such tests by furnishing necessary labor to assist testing agencies and/or Construction Manager in obtaining, handling, and protecting and/or curing samples at jobsite.
    b. Provide concrete for testing of slump, air content, and for making cylinders from the point of discharge into forms. When concrete is pumped, samples used shall be taken from discharge end of pump hose.
    c. Contractor shall conduct segregation tests as specified hereinafter.
    d. Specimens shall be made, cured, and tested in accordance with ASTM C31 and ASTM C39.
4. Frequency of testing may be increased at discretion of Construction Manager.
5. Concrete testing shall be paid for by the Contractor.

B. Concrete Tolerances:

1. Measure and inspect walls for compliance with tolerances specified in ACI 117.

3.13 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Construction Manager. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein indicated shall be promptly executed by the Contractor at his own expense.

B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not permitted to be used to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to weaken the bond of shotcrete. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. All repairs shall be built up and shaped in such a manner that the completed Work will conform to the requirements of this Section, as applicable, using methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

3.14 PATCHING IN CONCRETE

A. Patching Cracks:

1. Leaking cracks or cracks in exposed surfaces shall be epoxy pressure-injected by qualified applicators using two-component epoxy as approved.
2. Develop patching techniques and mixes with grout manufacturer on the mockup panel, a concrete test panel at least 4 feet by 8 feet in area constructed for this purpose, or a portion of as-cast surface of concrete, requiring patching, selected by the Construction Manager for this purpose.
3. Dress surface of patches that will remain exposed to view to match color and texture of adjacent surfaces.
4. Patching of concrete shall provide an acceptable and structurally sound surface finish uniform in appearance or upgrade the finish by other means until acceptable.
5. Provide patching to correct defects due to unacceptable aggregates and other ingredients.
6. Patching material shall be certified by manufacturer, prior to use, that it contains no chlorides or other chemicals causing corrosion.

B. Concrete Finish Tolerances:

1. Where work does not meet specified tolerances, repair or replace rejected work.
2. Obtain written approval of repair method used on the mockup panels or other panels specified hereinbefore, before proceeding with work.
3. Repair work or work on an alternate finish solution is assumed to be the result of poor workmanship in not achieving specified quality of finish. No additional compensation for time or cost will be allowed for such work.

C. Sand Blasting: Concrete areas specified to receive sandblasting shall have all repair work complete prior to start of sandblasting:

D. Patching Small Holes:

1. Holes, which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.
2. Small holes in members which are water-bearing or in contact with soil or other fill material shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the Paragraph above.

3. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

E. Patching Large Holes:

1. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as indicated herein.
2. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall, unless indicated otherwise.
3. Large holes in members which are water bearing or in contact with soil or other fill, shall have a hydrophilic type waterstop material placed around the perimeter of the hole, unless there is an existing waterstop in place.
4. Prior to filling with concrete the prepared surface shall be wetted sufficiently in advance of concreting and be surface saturated dry at the time of repair.

3.15 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. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. 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 repaired or removed and replaced with acceptable concrete at the Contractor's expense.

END OF SECTION 033000

SECTION 040514 - MASONRY MORTARING AND GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes mortar and grout for masonry.

B. Related Sections:
   1. Section 042000 - Unit Masonry: Installation of mortar and grout.

C. American Concrete Institute:
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specifications for Masonry Structures.

D. ASTM International:

   1. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
   2. ASTM C91 - Standard Specification for Masonry Cement.
   3. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
   4. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
   5. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
   6. ASTM C150 - Standard Specification for Portland Cement.
   7. ASTM C199 - Standard Test Method for Pier Test for Refractory Mortars.
   8. ASTM C206 - Standard Specification for Finishing Hydrated Lime.
   9. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
   10. ASTM C387/C387M - Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   11. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
   12. ASTM C476 - Standard Specification for Grout for Masonry.
   13. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
   14. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   15. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
   16. ASTM C1142 - Standard Specification for Extended Life Mortar for Unit Masonry.
   17. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
   18. ASTM C1329 - Standard Specification for Mortar Cement.
   19. ASTM C1357 - Standard Test Method for Evaluating Masonry Bond Strength.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Design Data: Submit design mix when Property specification of ASTM C270 is to be used, required environmental conditions, and admixture limitations.

C. Test Reports:

1. Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270.
2. Submit reports on grout indicating conformance of grout to property requirements of ASTM C476.

D. Manufacturer's Installation Instructions: Submit premix mortar manufacturer's installation instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 530 and ACI 530.1.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements.

B. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than 8 mph.

PART 2 - PRODUCTS

2.1 MORTAR AND MASONRY GROUT

A. Furnish materials in accordance with ACI 530.

2.2 COMPONENTS

A. Portland Cement: ASTM C150, Type I.

B. Masonry Cement: ASTM C91, Type S.

C. Premix Mortar: ASTM C387/C387M, Type S.

D. Mortar Aggregate: ASTM C144, standard masonry type.

E. Hydrated Lime: ASTM C206, Type S.

F. Grout Aggregate: ASTM C404, fine and coarse.

G. Water: Clean and potable.

2.3 MIXES

A. Mortar Mixes:

1. Mortar For Structural Masonry: ASTM C270, Type S using Property specification.
2. Mortar For Non-Structural Masonry: ASTM C270, Type S using Property specification.

B. Mortar Mixing:

1. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.

C. Grout Mixes:

1. Grout for Structural Masonry: 2,000 psi strength at 28 days; 8-11 inches slump; mixed in accordance with ASTM C476 Fine or Coarse grout.
2. Application:
   a. Coarse Grout: For grouting spaces with minimum 4 inches dimension in every direction.
   b. Fine Grout: For grouting other spaces.

D. Grout Mixing:

1. Truck mix grout in accordance with ASTM C94/C94M, modified to use ingredients complying with ASTM C476.
2. Field mixed grout - Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476.
3. Add admixtures; mix uniformly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Request inspection of spaces to be grouted.

3.2 INSTALLATION

A. Install mortar and grout in accordance with ACI 530.1 Specifications for Masonry Structures.

3.3 FIELD QUALITY CONTROL

A. Testing Frequency: One set of specified tests for every 5,000 sf of completed wall area.

B. Testing of Mortar Mix: In accordance with ASTM C780 for compressive strength.

C. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength, and in accordance with ASTM C143/C143M for slump.

D. Test compressive strength of mortar and masonry to ASTM C1314; test in accordance with masonry unit sections specified.

END OF SECTION 040514

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Precast vent blocks

B. Related Requirements:

1. Section 032000 - Concrete Reinforcing: Product requirements for steel reinforcing in masonry for installation by this Section.
2. Section 040514 - Masonry Mortaring and Grouting: Mortar and grout.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures and Related Commentaries.

B. ASTM International:

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
3. ASTM A153- Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A153M- Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
6. ASTM A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
7. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
8. ASTM A580 - Standard Specification for Stainless Steel Wire.
9. ASTM A580M - Standard Specification for Stainless Steel Wire.
10. ASTM A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
11. ASTM A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
12. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

13. ASTM A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. ASTM A951 - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
15. ASTM A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
16. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
17. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
18. ASTM C27 - Standard Classification of Fireclay and High-Alumina Refractory Brick.
19. ASTM C34 - Standard Specification for Structural Clay Load-Bearing Wall Tile.
20. ASTM C55 - Standard Specification for Concrete Building Brick.
21. ASTM C56 - Standard Specification for Structural Clay Nonloadbearing Tile.
22. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
23. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
24. ASTM C73 - Standard Specification for Calcium Silicate Brick (Sand-Lime Brick).
25. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
26. ASTM C126 - Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
27. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units.
28. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
29. ASTM C212 - Standard Specification for Structural Clay Facing Tile.
30. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
31. ASTM C315 - Standard Specification for Clay Flue Liners and Chimney Pots.
32. ASTM C530 - Standard Specification for Structural Clay Nonloadbearing Screen Tile.
33. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
34. ASTM C652 - Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
35. ASTM C744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
36. ASTM C1261 - Standard Specification for Firebox Brick for Residential Fireplaces.
37. ASTM C1283 - Standard Practice for Installing Clay Flue Lining.
38. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
39. ASTM C1405 - Standard Specification for Glazed Brick (Single Fired, Brick Units).
40. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
41. ASTM D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
42. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
43. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.3 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with installation of window and door frame anchors, installation of structural framing supported by masonry, and application of water-repellent coatings.

1.4 PREINSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit data for masonry units, fabricated wire reinforcement, wall ties, anchors, cavity insulation, prefabricated core insulation inserts, and other accessories.

C. Manufacturer's Certificate: Certify that concrete masonry units meet or exceed specified requirements.

D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statements:

1. Submit qualifications for installer.

1.6 QUALITY ASSURANCE

A. Perform Work according to ACI 530/530.1.

1.7 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this Section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Protect concrete masonry units from rain.

1.9 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Do not store reinforcing material directly on ground. Utilize blocking and other methods to prevent rust on accessories prior to installation.

C. Hot Weather Requirements: According to ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than 8 mph.

1.10 EXISTING CONDITIONS

A. Field Measurements: Verify elevations, dimensions, and alignment of foundations and other supporting construction prior to beginning Work. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Concrete Masonry Compressive Strength (f'm): 1,500 psi; determined by unit strength method per ACI 530.1.

1. Concrete Masonry Units (CMU): 2,000 psi minimum net area compressive strength.

2.2 UNIT MASONRY ASSEMBLIES

A. Masonry Unit

1. Furnish materials according to ASTM standards.

2.3 PRECAST VENT BLOCKS

A. Manufacturer

1. Atlantic Coast Precast
2. Or approved equal

B. Description
1. Concrete
2. 4”x16”x16” size
3. Louver style openings, 56 sq in open area minimum
4. Stainless steel bug screen secured to interior and exterior side

2.4 MATERIALS

A. Hollow Load-Bearing CMU: ASTM C90; normal weight.

B. Solid Load-Bearing CMU: ASTM C90; normal weight.

C. Hollow Non-load-bearing CMU: ASTM C129; normal weight.

2.5 ACCESSORIES

A. Single-Wythe Joint Reinforcement: ASTM A951 truss or ladder type; steel; 0.188-inch diameter side rods with 0.148-inch diameter cross ties; hot-dip galvanized.

B. Multiple-Wythe Joint Reinforcement: ASTM A951; truss or ladder type; steel; with moisture drip; adjustable type; 0.188-inch diameter side rods with 0.148-inch diameter cross ties; hot-dip galvanized.

C. Reinforcing Steel: As specified in Section 032000 - Concrete Reinforcing. Reinforcing steel shall meet the requirements of ASTM A615, 60 ksi, uncoated.

D. Mortar and Grout: As specified in Section 040514 - Masonry Mortaring and Grouting.

E. Integral Flashings

F. Galvanized Steel: ASTM A653, G90 finish, 24 gage core steel.

G. Joint Filler: Closed cell PVC; oversized 50 percent to joint width; self-expanding.

H. Weeps: Preformed plastic tubes, hollow.

I. Cleaning Solution: Non-acidic, not harmful to masonry Work or adjacent materials.

J. Steel Lintels: Sizes as indicated on Drawings; hot-dip galvanized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field conditions are acceptable and ready to receive Work.

C. Verify that items provided by other Sections of Work are properly sized and located.

D. Verify that built-in items are in proper location and ready for roughing into masonry Work.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Direct and coordinate placement of metal anchors supplied to other Sections.

C. Furnish temporary bracing during installation of masonry Work. Maintain in place until building structure provides permanent support.

3.3 INSTALLATION

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.

C. Coursing of CMU:

1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches.
3. Mortar Joints: Flush.

D. Placing and Bonding:

1. Lay hollow masonry units with face shell bedding on head and bed joints.
2. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
3. Remove excess mortar as Work progresses.

E. Fire-Rated Masonry Construction:

1. Install fire-rated masonry in compliance with requirements of ASTM E119 and with the hourly rating indicated on the Drawings.

F. Joint Reinforcement and Anchorages

1. Install horizontal joint reinforcement minimum 16 inches o.c.
2. Place masonry joint reinforcement in first horizontal joint above and below openings. Extend minimum 16 inches each side of opening.
3. Place joint reinforcement continuous in first joint below top of walls.
4. Lap joint reinforcement ends minimum 16 inches.

G. Masonry Flashings:

1. Extend flashings horizontally through outer wythe at foundation walls, and turn down on outside face to form drip.
2. Turn flashing up minimum 8 inches and bed into mortar joint of masonry backing.
3. Lap end joints minimum 6 inches and seal watertight.
4. Turn flashing; fold and seal at corners, bends, and interruptions.

H. Masonry Core Insulation Inserts:

I. Install masonry core insulation inserts at masonry manufacturing plant prior to delivery to Site.

J. Do not remove inserts except where specifically noted on Drawings. Ensure that all inserts are properly installed in each course prior to installing subsequent courses.

K. Lintels:

1. Install concrete masonry bond beam lintels over openings.
2. Install reinforced unit masonry lintels over miscellaneous openings less than 12 inches wide where lintels are not scheduled or indicated.
3. Do not splice reinforcing bars.
4. Support and secure reinforcing bars from displacement.
5. Place and consolidate grout fill without displacing reinforcing.
6. Allow masonry lintels to attain specified strength before removing temporary supports.
7. Maintain minimum 8-inch bearing on each side of opening.

L. Grouted Components:

1. Reinforce bond beams as indicated on Drawings. Maintain minimum of 1 inch clearance from bottom web.
2. Lap splices bar diameters as required by code.
3. Support and secure reinforcing bars from displacement.
4. Place and consolidate grout fill without displacing reinforcing.
5. At bearing locations, fill masonry cores with grout for minimum 12 inches both sides of opening.

M. Reinforced Masonry:

1. Lay masonry units with cells vertically aligned and clear of mortar and unobstructed.
2. Place reinforcement bars as indicated on Drawings.
3. Splice reinforcement as specified in Section 032000 - Concrete Reinforcing.
4. Support and secure reinforcement from displacement.
5. Place and consolidate grout fill without displacing reinforcing.
6. Place grout according to ACI 530.1.

N. Control Joints:

1. Install control joints at the following maximum spacings, unless otherwise indicated on Drawings:
    a. Exterior Walls: 20 feet o.c. and within 24 inches on one side of each interior and exterior corner.
    b. Interior Walls: 30 feet o.c.
    c. At changes in wall height.
2. Do not continue horizontal joint reinforcement through control joints.
3. Install preformed control joint device in continuous lengths. Seal butt and corner joints.
4. Size control joint as indicated on Drawings.

O. Expansion Joints:

1. Form expansion joints as indicated on Drawings.

2. Do not continue horizontal joint reinforcement through expansion joints.

P. Built-in Work:

1. As Work progresses, install built-in metal door frames fabricated metal frames metal window frames anchor bolts plates and other items to be built in the Work and furnished by other Sections.
2. Install built-in items plumb and level.
3. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with grout or mortar. Fill adjacent masonry cores with grout minimum 8 inches from framed openings.
4. Do not build in materials subject to deterioration.

Q. Cutting and Fitting:

1. Cut and fit for chases pipes conduit sleeves grounds. Coordinate with other Sections of Work to provide correct size, shape, and location.
2. Obtain Architect/Engineer's approval prior to cutting or fitting masonry Work not indicated or where appearance or strength of masonry Work may be impaired.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Maximum Variation from Unit to Adjacent Unit: 1/16 inch.

C. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.

D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

E. Maximum Variation from Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet; 1/2 inch in 30 feet.

F. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet.

G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

H. Maximum Variation for Steel Reinforcement:

1. Install reinforcement within the tolerances specified in ACI 530.1 for foundation walls.
2. Plus or minus ½-inch when distance from centerline of steel to opposite face of masonry is 8 inches or less.
3. Plus or minus 1 inch when distance is between 8 and 24 inches.
4. Plus or minus 1-1/4 inch when distance is greater than 24 inches.
5. Plus or minus 2 inches from location along face of wall.

3.5 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Remove excess mortar and mortar smears as Work progresses.

C. Replace defective mortar. Match adjacent Work.

D. Clean soiled surfaces with cleaning solution. Coordinate with Work of specified water-repellent or surface coating.

E. Use non-metallic tools in cleaning operations.

3.6 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect exposed external corners subject to damage.

C. Protect base of walls from mud and mortar splatter.

D. Protect masonry and other items built into masonry walls from mortar droppings and staining caused by mortar.

E. Protect tops of masonry Work with waterproof coverings secured in place without damaging masonry. Provide coverings where masonry is exposed to weather when Work is not in progress. Maintain protection on tops of completed exterior walls until installation of permanent waterproof cap materials.

END OF SECTION 042000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop-fabricated metal items.
2. Bollards.
3. Ladders.
4. Structural supports for miscellaneous attachments.
5. Bolts and anchors
6. Access hatches.

B. Related Requirements:

1. Section 033000 - Cast-In-Place Concrete: Execution requirements for embedded anchors and attachments for metal fabrications specified by this Section in concrete.
2. Section 042000 - Unit Masonry: Execution requirements for embedded anchors and attachments for metal fabrications specified by this Section in masonry.
3. Section 099000 - Painting and Coating: Field-applied paint finish.

1.2 REFERENCE STANDARDS

A. American National Standards Institute:

1. ANSI A14.3 - American National Standard (ASC) for Ladders - Fixed - Safety Requirements.

B. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.
3. AWS D1.6 - Structural Welding Code - Stainless Steel.

C. ASTM International:

1. ASTM A53- Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

5. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
6. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
7. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
8. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
9. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
10. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
11. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
12. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
14. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
15. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
16. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
17. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
18. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
19. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
20. ASTM A992 - Standard Specification for Structural Steel Shapes.
21. ASTM B177 - Standard Guide for Engineering Chromium Electroplating.
22. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
23. ASTM F436 - Standard Specification for Hardened Steel Washers.
24. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.

D. Builders Hardware Manufacturers Association (BHMA):

1. ANSI/BHMA A156.20 - American National Standard for Strap and Tee Hinges and Hasps.

E. National Ornamental & Miscellaneous Metals Association:

1. NOMMA Guideline 1 - Joint Finishes.

F. Federal Specifications

1. FED TT-S-00230C - Sealing Compound, Elastomeric Type, Single Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. An ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor shall be submitted. Contractor shall submit manufacturer's recommended installation instructions and procedures for adhesive anchors. Upon review, by Contracting Officer, these instructions shall be followed specifically.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 QUALITY ASSURANCE

A. Finish joints according to NOMMA Guideline 1.

B. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.

C. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept metal fabrications on-Site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather or by ground contact.

1.6 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 BOLLARDS

A. Description:

1. Steel pipe, concrete filled.
2. Crowned cap.
3. Size: 6-inch diameter, length as indicated on Drawings.
4. Finish: Prime paint, one coat.

B. Concrete Fill:

1. Minimum Compressive Strength: 3,000 psi.
2. As specified in Section 033000 - Cast-in-Place Concrete.

2.2 LADDERS

A. Vault Access Ladder:
1. ANSI A14.3.
2. Stainless Steel Type 316-welded construction.
3. Siderails:
   a. Size: 3/8 by 3 inches.
   b. Spacing: 16 inches o.c.
4. Rungs:
   a. Solid rod.
   b. Size: 1-inch diameter.
   c. Spacing: 12 inches o.c.
   d. Knurled surface.
5. Mounting:
   a. Space rungs minimum 7 inches from wall surface.
   b. Provide stainless steel mounting brackets and attachments.
6. Finish: Mill finish.
7. Pop-up extension:
   a. On all vault ladders.
   b. Stainless steel Type 316
   c. Telescoping tubular section that locks automatically when fully extended.
   d. Upward and downward movement controlled by stainless steel spring balancing mechanism.
   e. Completely assembled with fasteners for securing to the ladder rungs in accordance with manufacturer’s instructions.

2.3 STRUCTURAL SUPPORTS

A. Other Structural Supports:

1. Description: Steel sections, shape and size as indicated on Drawings.
2. Finish: Prime paint, one coat.

2.4 BOLTS AND ANCHORS

A. Description:

1. Shape: Straight.
2. Furnish with nut and washer.
3. The length of each bolt or anchor shall be such that after tightening, the bolt extends through the entire nut, but in no case more than ½-inch beyond the nut.

B. Epoxy Adhesive Anchors:

1. Manufacturers:
   a. Simpson Strong Tie
   b. Hilti HVA
   c. Cobra Anchors
   d. Or approved equal
2. Grout: As specified in Section 040514 – Masonry Mortaring and Grouting.
3. Threaded Rod: Type 316 stainless steel.

C. Expanding-Type Anchors:

1. Type 316 Stainless steel.
2. Manufacturers:
   a. ITW Ramset/Redhead “Trubolt”
   b. Simpson Strong Tie
   c. Hilti “Kwick-Bolt”
   d. Or approved equal

2.5 ACCESS HATCHES

A. Hatches:

1. Flush mounted
2. Sizes, number of door leaves and swing direction, location as indicated. Sizes indicated are for clear opening.
3. Door leaves:
   a. Hinges located on longer dimension unless otherwise indicated.
   b. Where number of leaves is not given, openings larger than 42 inches in either direction shall have double-leaved doors.
   c. Minimum ¼-inch thick checkered pattern plate.
   d. Automatic hold-open arm with release handle.
   e. Easy opening from both inside and outside.
   f. Recessed hasp for a padlock covered by a hinged lid flush with the surface
4. Frames:
   a. ¼-inch material with an anchor flange around the perimeter.
   b. Water-tight with joint gutter and moat-type edge drain.
   c. Minimum 1 ½ inch diameter drain connection
5. Hatches: Stainless steel Type 316.
6. Hardware: Stainless steel Type 316, gutter type.

7. Design load: 300 psf for vaults protected from traffic, H-20 wheel loading in areas of traffic.

B. Hatch Fall Protection:

1. At all hatch openings.
2. Conform to OSHA requirements
3. High strength polyester netting
   a. Tested and certified to meet the current OSHA standard 1926.502 (c) (4) (i) drop test
   b. Hardware hooks and anchors of stainless steel type 316.
   c. Metal tag permanently attached with following information:
      1) Net manufacturer's name
      2) Identification of net material
      3) Date of manufacture
      4) Date of prototype test
      5) Name of testing agency
      6) Serial number.
4. Grating Panel
   a. Certified to meet the current OSHA standard 1926.502
   b. Powder coated safety orange color
   c. Hardware of stainless steel type 316
   d. 300 pound load rated or load rated consistent with access cover
   e. Hinged with positive latch to maintain upright position
   f. Lifetime warranty

2.6 MATERIALS

A. Steel:

1. Structural W Shapes: ASTM A992.
2. Structural Shapes: ASTM A36.
3. Channels and Angles: ASTM A36.
4. Steel Plate: ASTM A36.
5. Hollow Structural Sections: ASTM A500, Grade B.
6. Steel Pipe:
   a. ASTM A53, Grade B, Schedule 40.
7. Sheet Steel: ASTM A653, Grade 33 Structural Quality.
8. Bolts: ASTM A307; Grade A or B, or high strength where indicated ASTM A325; Type 1.
9. Nuts: ASTM A563; heavy-hex type.
10. Washers: ASTM F436; Type 1.
11. Welding Materials: AWS D1.1; type required for materials being welded.

B. Stainless Steel:

1. All metal tank appurtenances shall be stainless steel Type 316.
2. All anchors, bolts, nuts, and washers in the locations listed below shall be stainless steel.
   a. All buried locations.
   b. All submerged locations.

c. All locations subject to seasonal or occasional flooding.
d. Inside buried vaults, manholes, and structures which do not drain through a gravity sewer or to a sump with a pump.
e. All chemical handling areas.
f. Inside trenches, containment walls, and curbed areas.
g. Locations indicated by the Contract Documents or designated by the Contracting Officer to be provided with stainless steel bolts.

3. Bars and Shapes: ASTM A276; Type 316.
4. Tubing: ASTM A554; Type 316.
5. Pipe: ASTM A312, welded; Type 316.
6. Plate, Sheet, and Strip: ASTM A666; Type 316.
7. Bolts, Nuts, and Washers (non-corrosive application): ASTM A354.
8. Welding Materials: AWS D1.6; type required for materials being welded.

C. Bolts, Nuts, and Washers for Equipment and Piping:

1. Stainless Steel: Type 316 stainless steel, Class 2; ASTM A193 for bolts; ASTM A194 for nuts. All threads on stainless steel bolts shall be protected with an antiseize lubricant suituable for submerged stainless steel bolts, to be classified as acceptable for potable water use by NSF. Buried bolts in poorly drained soil shall be coated the same as buried pipe.

2.7 FABRICATION

A. Fit and shop-assemble items in largest practical sections for delivery to Site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.

E. Exposed Welded Joints: NOMMA Guideline 1.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

H. Fabrication Tolerances:

1. Squareness: 1/8-inch maximum difference in diagonal measurements.
2. Maximum Offset between Faces: 1/16 inch.
3. Maximum Misalignment of Adjacent Members: 1/16 inch.
4. Maximum Bow: 1/8 inch in 48 inches.
5. Maximum Deviation from Plane: 1/16 inch in 48 inches.

2.8 FINISHES

A. Steel:

1. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
2. Do not prime surfaces in direct contact with concrete or where field welding is required.
3. Prime-paint items with two coats except where galvanizing is specified.
4. Shop Primer: SSPC Paint 15, Type 1, red oxide.
5. Touchup Primer: Match shop primer.
6. Touchup Primer for Galvanized Surfaces:
   a. SSPC Paint 20, Type I - Inorganic.
   b. ASTM A780.

B. Stainless Steel:

1. Satin-Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.
2. Mirror-Polished Finish: Number 8, mirror polish with preliminary directional polish lines removed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Requirements for installation examination.

B. Verify that field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Clean and strip primed steel items to bare metal where Site welding is required.

C. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, and free from distortion or defects.

B. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.

C. Field-weld components indicated on Drawings.

D. Perform field welding according to AWS D1.1.

E. Obtain approval of Architect/Engineer prior to Site cutting or making adjustments not scheduled.

F. Coordinate with concrete work for hatches, ladders, pipe penetration, and vent pipe. Prepare rough openings and other conditions per manufacturer's recommendations.

G. Install in strict accordance with manufacturer's published instructions.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Maximum Variation from Plumb: 1/4 inch per story or for every 12 feet in height, whichever is greater, non-cumulative.

C. Maximum Variation from Level: 1/16 inch in 3 feet and 1/4 inch in 10 feet.

D. Maximum Offset from Alignment: 1/4 inch.

E. Maximum Out-of-Position: 1/4 inch.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Welding: Inspect welds according to AWS D1.1.

C. Replace damaged or improperly functioning hardware.

D. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

E. Touch up factory-applied finishes according to manufacturer-recommended procedures.

3.6 ADJUSTING

A. Section 017000 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Adjust operating hardware and lubricate as necessary for smooth operation.

END OF SECTION 055000

SECTION 081214- STANDARD STEEL FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fire rated and non-rated steel frames.

B. Related Sections:

1. Section 042000 - Unit Masonry: Masonry grout fill of metal frames and placement of anchors into masonry wall construction.
2. Section 081314 - Stainless Steel Doors.
3. Section 087100 - Door Hardware: Hardware, silencers, and weatherstripping.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:

1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. National Fire Protection Association:

1. NFPA 80 - Standard for Fire Doors, Fire Windows.
2. NFPA 105 - Standard for the Installation of Smoke Door Assemblies and other Opening Protectives.
3. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:

1. UL 10B - Fire Tests of Door Assemblies.
2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
3. UL 1784 - Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

A. Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacing, location of cut-outs for hardware, and finish.

B. Product Data: Submit frame configuration and finishes.

C. Manufacturer's Installation Instructions: Submit special installation instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Conform to requirements of ANSI A250.8.

B. Fire Rated Frame Construction: Conform to NFPA 252.

C. Installed Fire Rated Frame Assembly: Conform to NFPA 80 for fire rated class same as fire door.

D. Attach label from agency approved by authority having jurisdiction to identify each fire rated door frame.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept frames on site in manufacturer's packaging. Inspect for damage.

B. Break seal on-site to permit ventilation.

1.7 COORDINATION

A. Coordinate Work with frame opening construction, door, and hardware installation.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL FRAMES

A. Manufacturers:

1. Stainless Doors, Inc., www.stainlessdoors.com, (888) 605-DOOR. 16 gauge type 316 stainless steel, #4 satin finish, vertical grain, mitered and welded faces.
2. Substitutions: Permitted.

B. Product Description: Shop fabricated stainless steel frames, fire rated and non-rated types.

1. Frames: To suit ANSI A250.8 Grade and Model of door specified in Section 081314.

2.2 ACCESSORIES

A. Bituminous Coating: Type recommended by frame manufacturer.

B. Primer: ANSI A250.10 rust inhibitive type as recommended by frame manufacturer.

C. Silencers: Resilient rubber fitted into drilled hole.

D. Weatherstripping: Resilient rubber.

2.3 FABRICATION

A. Fabricate frames as welded unit.

B. Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.

C. Reinforce frames wider than 48 inches with roll formed steel channels fitted tightly into frame head, flush with top.

D. Prepare frames for silencers. Provide three single silencers for single doors.

E. Attach fire rated label to each fire rated frame.

F. Fabricate frames to suit masonry wall coursing with 2 inch head member.

2.4 SHOP FINISHING

A. Stainless Steel: #4 Satin

B. Coat inside of frame profile with bituminous coating to minimum thickness of 1/16 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify opening sizes and tolerances are acceptable.

3.2 INSTALLATION

A. Install frames in accordance with ANSI A250.8.

B. Coordinate with masonry wall construction for anchor placement.

C. Coordinate installation of frames with installation of hardware specified in Section 087100 and doors in Section 081314.

3.3 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edges, crossed corner to corner.

END OF SECTION 081214

SECTION 081314 - STAINLESS STEEL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes non-rated, fire rated, stainless steel doors.

B. Related Sections:

1. Section 081214 - Standard Steel Frames.
2. Section 087100 - Door Hardware.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:

1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM C1363 - Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
4. ASTM E413 - Classification for Rating Sound Insulation.

C. Hollow Metal Manufacturers Association:

1. HMMA 810 - Hollow Metal Doors.

D. National Fire Protection Association:

1. NFPA 80 - Standard for Fire Doors, Fire Windows.
2. NFPA 105 - Standard for the Installation of Smoke Door Assemblies and other Opening Protectives.
3. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

E. Steel Door Institute:

1. SDI 108 - Recommended Selection and Usage Guide for Standard Steel Doors.

F. Underwriters Laboratories Inc.:

1. UL 10B - Fire Tests of Door Assemblies.
2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
3. UL 1784 - Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

A. Shop Drawings: Indicate door elevations, internal reinforcement, closure method and finishes.

B. Product Data: Submit door configurations, location of cut-outs for hardware reinforcement.

C. Manufacturer's Installation Instructions: Submit special installation instructions.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ANSI A250.8.

B. Fire Rated Door Construction: Conform to NFPA 252.

C. Attach label from agency approved by authority having jurisdiction to identify each fire rated door.

D. Surface Burning Characteristics:

1. Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

E. Apply label from agency approved by authority having jurisdiction to identify each foam plastic insulation board.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept doors on site in manufacturer's packaging. Inspect for damage.

B. Break seal on site to permit ventilation.

C. Store doors and welded frames in an upright position with heads upper most in a dry area, under cover where they will not be exposed to or come in contact with water. Place no more than 5 doors or frames in a group. Place all material on planking or blocking at least 4 inches off the ground.

1.7 COORDINATION

A. Coordinate Work with door opening construction, door frame, and door hardware installation.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL DOORS

A. Manufacturers:

1. Stainless Doors, Inc., www.stainlessdoors.com, (888) 605-DOOR. Seamless Doors, 16 gauge type 316 stainless steel, #4 satin finish, vertical grain, polystyrene core.
2. Substitutions: Permitted.

B. Product Description:
1. Exterior Doors (Insulated): ANSI A250.8, 1-3/4 inch thick.
   a. Level 3 - Extra heavy Duty, Model 2, seamless design.
2. Interior Doors (Fire Rated): ANSI A250.8, 1-3/4 inch thick.
   a. Level 3 - Extra heavy Duty, Model 2, seamless design.

2.2 COMPONENTS

A. Face: Steel sheet in accordance with ANSI A250.

B. End Closure: Channel, inverted with seal, top and bottom.

C. Core: polystyrene.

2.3 ACCESSORIES

A. Primer: ANSI A250.10, or type recommended by door manufacturer.

2.4 FABRICATION

A. Fabricate doors with hardware reinforcement welded in place.

2.5 SHOP FINISHING

A. Stainless Steel: #4 Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify opening sizes and tolerances are acceptable.

3.2 INSTALLATION

A. Install doors in accordance with ANSI A250.8 and door manufacturer's Guide Speciation's.

B. Coordinate installation of doors with installation of frames specified in Section 081214 and hardware specified in Section 087100.

3.3 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.4 ADJUSTING

A. Adjust door for smooth and balanced door movement.

END OF SECTION 081314

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes hardware for stainless steel doors.

1. Provide door weatherstripping, seals, and thresholds.

B. Related Sections:

1. Section 081314 – Stainless Steel Doors.
2. Section 081214 – Stainless Steel Frames.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI A156.1 - Butts and Hinges.
2. ANSI A156.2 - Bored and Preassembled Locks and Latches.
3. ANSI A156.3 - Exit Devices.
4. ANSI A156.4 - Door Controls - Closures.
5. ANSI A156.6 - Architectural Door Trim.
6. ANSI A156.7 - Template Hinge Dimensions.
7. ANSI A156.8 - Door Controls - Overhead Holders.
8. ANSI A156.15 - Closer Holder Release Devices.
9. ANSI A156.16 - Auxiliary Hardware.
10. ANSI A156.18 - Materials and Finishes
11. ANSI A156 - Complete Set of 24 BHMA Standards (A156 Series) with Binder.

B. Builders Hardware Manufacturers Association:

1. BHMA Directory of Certified Products.

C. Underwriters Laboratories Inc.:

1. UL 10B - Fire Tests of Door Assemblies.
2. UL 305 - Panic Hardware.
3. UL - Building Materials Directory.

D. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.3 SUBMITTALS

A. Shop Drawings:

1. Indicate locations and mounting heights of each type of hardware, schedules, catalog cuts and connection requirements.
2. Submit manufacturer's parts lists.

B. Manufacturer's Installation Instructions: Submit special procedures, and perimeter conditions requiring special attention.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of installed cylinders and their master key code.

B. Operation and Maintenance Data: Submit data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

C. Keys: Key to Owner’s master system.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with the following requirements:

1. ANSI A156 series.
2. UL 305.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Hardware Supplier: Company specializing in supplying commercial door hardware with minimum three years documented experience.

C. Hardware Supplier Personnel: Employ qualified person to assist in work of this section.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum week prior to commencing work of this section.

B. Include persons involved with installation of doors, frames, and hardware.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually with necessary fasteners, instructions, and installation templates, when necessary; label and identify each package with door opening code to match hardware schedule.

1.9 COORDINATION

A. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.

1. Provide templates or actual hardware as required to ensure proper preparation of doors and frames.

B. Coordinate Owner's keying requirements during course of Work.

1.10 MAINTENANCE MATERIALS

A. Furnish special wrenches and tools applicable for each different and for each special hardware component.

B. Furnish maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 - PRODUCTS

2.1 DOOR HARDWARE

A. Hinge Manufacturers:

1. Stanley.
2. Hager.
3. McKinney.
4. Substitutions: Permitted.

B. Latch Set Manufacturers:

1. Schlage D Series with Rhodes lever, 630 finish.
2. NT Falcon M Series with Avalon-Gala lever, 630 finish.
3. Substitutions: Permitted.

C. Closers Manufacturers:

1. Sargent Model 1430/1431.
2. LCN Model 4041.
3. Norton Model 8300 Series.
4. Substitutions: Permitted.

D. Protection Plates, Thresholds, and Trim Manufacturers:

1. Builders Brass Works.
2. Pemko Mfg. Co.
3. Reese Enterprises, Inc.
4. Substitutions: Permitted.

2.2 COMPONENTS

A. General Hardware Requirements: Where not specifically indicated, comply with applicable ANSI A156 standard for type of hardware required. Furnish each type of hardware with accessories as required for applications indicated and for complete, finished, operational doors.

1. Templates: Furnish templates or physical hardware items to door and frame manufacturers sufficiently in advance to avoid delay in Work.
2. Reinforcing Units: Furnished by door and frame manufacturers; coordinated by hardware supplier or hardware manufacturer.
3. Fasteners: Furnish as recommended by hardware manufacturer and as required to secure hardware.
    a. Finish: Match hardware item being fastened.

B. Hinges: ANSI A156.1, full mortise type, template type, ANSI A156.7, complying with following general requirements unless otherwise scheduled.

1. Widths: Sufficient to clear trim projection when door swings 180 degrees.
2. Number: Furnish minimum three hinges to 90 inches high, four hinges to 120 inches high, five hinges to 156 inches high for each door leaf.
3. Size and Weight: 4-1/2 inch heavy weight typical for 1-3/4 inch doors.
    a. Doors Over 48 inches Wide: 5 inch extra heavy weight ball or oilite bearing.
4. Pins: Furnish nonferrous hinges with non-removable pins (NRP) at exterior and locked outswinging doors, non-rising pins at interior doors.
5. Tips: Flat button.

C. Latch Sets: Typical 2-3/4 inch backset. Furnish standard strikes with extended lips to protect trim from being marred by latch bolt verify type of cutouts provided in metal frames.

1. Bored (Cylindrical) Latch Sets: ANSI A156.2, Series 4000, Grade 1 unless otherwise indicated.

D. Closers: ANSI A156.4 surface mounted closers; full rack and pinion type with steel spring and non-freezing hydraulic fluid.

1. Adjustability: Furnish controls for regulating closing, latching, speeds, and back checking.
2. Arms: Type to suit individual condition; parallel-arm closers at reverse bevel doors and where doors swing full 180 degrees.
3. Location: Mount closers on inside of exterior doors, room side of interior doors typical; mount on pull side of other doors.
4. Operating Pressure: Maximum operating pressure as follows.
    a. Interior Doors: Maximum 5 pounds.
    b. Exterior Doors: Maximum 8.5 pounds.

E. Protection Plates, Thresholds, and Trim: Furnish as indicated in Schedule, with accessories as required for complete operational door installations.

1. Weatherstripping: Furnish continuous weatherstripping at top and sides of doors.
2. Thresholds: Stainless Steel, maximum 1/2 inch height.
3. Wall Stops: ANSI A156.1, Grade 1, 3 inch wall stop convex pad wall stop.
4. Floor Stops: ANSI A156.1 Grade 1 standard floor type; furnish with accessories as required for applications indicated.

2.3 ACCESSORIES

A. Lock Trim: Furnish levers with escutcheon plate as indicated in Schedule.

B. Through Bolts: Do not permit through bolts and grommet nuts on door faces in occupied areas unless no alternative is possible.

2.4 FINISHING

A. Finishes: ANSI A156.18; furnish following finishes except where otherwise indicated in Schedule at end of section.

1. Hinges:
   a. BHMA 630, satin finish.
2. Typical Exterior and Interior Door Hardware:
   a. BHMA 630, satin finished stainless steel.
3. Closers: Finish appearance to match door hardware on same face of door.
   a. BHMA 628, satin aluminum, clear anodized.
4. Thresholds: Finish appearance to match door hardware on exterior face of door.
   a. BHMA 630, satin finish stainless steel.
5. Other Items: Furnish manufacturer's standard finishes to match similar hardware types on same door, and maintain acceptable finish considering anticipated use and BHMA category of finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings and instructed by manufacturer.

3.2 INSTALLATION

A. Coordinate mounting heights with door and frame manufacturers. Use templates provided by hardware item manufacturer.

B. Mounting Heights From Finished Floor to Center Line of Hardware Item: Comply with manufacturer recommendations and applicable codes where not otherwise indicated.

1. Locksets: 38 inch.
2. Top Hinge: Jamb manufacturer's standard, but not greater than 10 inches from head of frame to center line of hinge.
3. Bottom Hinge: Jamb manufacturer's standard, but not greater than 12-1/2 inches from floor to center line of hinge.
4. Intermediate Hinges: Equally spaced between top and bottom hinges and from each other.
5. Hinge Mortise on Door Leaf: 1/4 inch. to 5/16 inch from stop side of door.

3.3 FIELD QUALITY CONTROL

A. Primary Hardware Manufacturer's Representatives inspect installation and certify hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.4 ADJUSTING

A. Adjust hardware for smooth operation.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not permit adjacent work to damage hardware or hardware finish.

3.6 SCHEDULES

A. The following hardware sets are intended to establish type and standard of quality when used together with this section requirements. Examine Drawings and Specifications and furnish proper hardware for door openings.

Hardware Set 1 (HW-1): Exterior Doors, Single Doors.

Hinges:	Full mortise as specified.
Lock:	Bored lock, entrance lock function.
Floor Stop:	As specified.
Closer:	Surface mounted as specified.
Weatherstripping:	As specified.
Threshold:	As specified.

END OF SECTION 087100

SECTION 092400 - PORTLAND CEMENT PLASTER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Portland cement plaster system.

1. Heavy Dash finished texture.

1.2 REFERENCES

A. ASTM International:

1. ASTM C91 - Standard Specification for Masonry Cement.
2. ASTM C150 - Standard Specification for Portland Cement.
3. ASTM C206 - Standard Specification for Finishing Hydrated Lime.
4. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
5. ASTM C847 - Standard Specification for Metal Lath.
6. ASTM C897 - Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters.
7. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster.
8. ASTM C932 - Standard Specification for Surface-Applied Bonding Agents for Exterior Plastering.
9. ASTM C933 - Standard Specification for Welded Wire Lath.
10. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
11. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
12. ASTM C1002 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases.
13. ASTM C1032 - Standard Specification for Woven Wire Plaster Base.
14. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
15. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
16. ASTM C1328 - Standard Specification for Plastic (Stucco) Cement.
17. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

B. Federal Specification Unit:

1. FS UU-B-790 - Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant).

C. National Terrazzo and Mosaic Association:

1. NTMA - Terrazzo Specifications Guide.

D. Portland Cement Association:

1. PCA - Portland Cement Plaster (Stucco) Manual.

E. South Coast Air Quality Management District:

1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

F. Underwriters Laboratories Inc.:

1. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.3 SUBMITTALS

A. Product Data: Submit data on plaster materials, characteristics and limitations of products specified.

B. Samples: Submit two samples, 12 x 12 inch in size illustrating finish color and texture.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C926. and PCA Portland Cement Plaster (Stucco) Manual.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 COMPONENTS:

A. Plaster Base Materials:

1. Cement: ASTM C150, Type I Portland cement.
2. Lime: ASTM C206, Type S.
3. Aggregate: In accordance with ASTM C897.

4. Water: Clean, fresh, potable and free of mineral or organic matter capable of affecting plaster.
5. Bonding Agent: ASTM C932; type recommended for bonding plaster to concrete, and concrete masonry surfaces.
6. Admixtures: Type recommended by manufactured.
7. Fibers: 1/2 inch nominal length alkali resistant fibers meeting requirements of ASTM C1116.

B. Plaster Finish Materials:

1. Cement: As specified for plaster base coat.
2. Lime: As specified for plaster base coat.
3. Color Pigment: ASTM C979 mineral oxide or synthetic type color, Omega Products International, ColorTek color, 404 Barn Swallow or equivalent.
4. Water: Clean, fresh, potable, and free of matter capable of affecting plaster.

2.2 MIXES

A. Dash-Bond Coat: 1 part Portland Cement and maximum 2 parts of sand, proportioned by volume.

B. Base Coats: Mix and proportion cement plaster base coat in accordance with ASTM C926, Type C.

1. Fiber Reinforcement: Add glass fibers per manufacturer's recommendations.

C. Finish Coat: Mix and proportion cement plaster finish coat in accordance with ASTM C926, Type F to achieve a heavy dash finish.

D. Mix only as much plaster as can be used prior to initial set.

E. Add color pigments to finish coat, Omega Products International, ColorTek color, 404 Barn Swallow or equivalent.

F. Mix materials dry, to uniform color and consistency, before adding water.

G. Protect mixtures from contamination, and excessive evaporation.

H. Do not retemper mixes after initial set has occurred.

PART 3 EXECUTION

3.1 EXAMINATION

A. Masonry: Verify joints are cut flush and surface is ready to receive work of this section. Verify no bituminous or water repellent coatings exist on masonry surface.

3.2 PREPARATION

A. Dampen masonry surfaces to reduce excessive suction.

3.3 INSTALLATION

A. Installation:

1. Install accessories in accordance with ASTM C1063.
2. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
3. Install door frames plumb and level in opening. Secure rigidly in place.

B. Control And Expansion Joints:

1. Install exterior expansion joints after initial set, scribed as indicated on Drawings by cutting through 2/3 of cement plaster depth, neatly, in straight lines.
2. For horizontal exterior surfaces, install control expansion joints as indicated on Drawings.
3. Establish expansion joints with back to back casing beads, set ¼ inch apart.

C. Plastering:

1. Apply plaster in accordance with ASTM C926 and PCA Plaster (Stucco) Manual.

3.4 ERECTION TOLERANCES

A. Maximum Variation from Flat Surface: 1/8 inch in 10 feet.

3.5 ADJUSTING

A. Remove damaged or defective plaster by cutting and replace with specified materials to match adjacent plaster.

B. Fog coat non-uniform or discolored plaster with finish coat materials spray applied to entire finish coat surface.

END OF SECTION 092400

SECTION 099000 - PAINTS AND COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation, furnishing, and application of paint and special protective coatings.

B. Related Sections:

1. Section 055000 - Metal Fabrications: Shop-primed items.
2. Section 260553 - Identification for Electrical Systems: Stenciling, color-coding, and identification banding.

1.2 REFERENCE STANDARDS

A. SSPC – Society of Protective Coatings: Surface Preparation Specifications

1.3 DEFINITIONS

A. Submerged Metal: Metal surfaces below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface which are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel, except reinforcing steel and the following specific surfaces.

B. Exposed Metal - Mildly Corrosive: Exposed metal surfaces, except aluminum or stainless steel, located inside or outside of structures and exposed to weather or highly humid atmosphere, such as dry well, similar areas, and where indicated.

C. Exposed Metal – Atmospheric: Exposed metal surfaces located inside or outside of structures and exposed to weather, including metal doors and frames, vents, louvers, interior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim.

D. Exposed Metal - Interior: Exposed metal surfaces, except aluminum or stainless steel, located inside structures and not exposed to weather or highly humid atmosphere.

1.4 ABBREVIATIONS

A. MDFT: Minimum Dry Film Thickness

B. MDFTPC: Minimum Dry Film Thickness Per Coat

C. Mil: Thousandths of an inch

D. SFPG: Square Feet Per Gallon

E. SFPGPC: Square Feet Per Gallon per Coat

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Paint System Data Sheet (PSDS), Material Safety Data Sheets (MSDS), Technical Data Sheets and paint colors available for each product used for each paint system. A sample PSDS form is appended to the end of this section.

C. Applicator’s Experience: List of references substantiating required experience as specified.

D. Manufacturer's Certificate: Stating that factory applied coating system(s) meet or exceed requirements specified in this Section. If manufacturer of finish coating differs from that of shop or field-applied primer, provide both manufacturers’ written confirmation that materials are compatible.

E. Manufacturer Instructions: Submit special surface preparation procedures, substrate conditions requiring special attention

1.6 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:

1. Furnish 5 gal. of each color, and type as provided for Project for building and trim coating.
2. Label each container with manufacturer's label, color, type, texture, Site location.

1.7 QUALIFICATIONS

A. Applicator’s Experience: Minimum 5 years’ demonstrated experience in application of specified products. Company shall possess a valid Territory of Guam license as required for performance of the painting and coating Work called for in this specification.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements

1. Conform to federal, state, and local requirements limiting the emission of volatile organic chemicals (VOC). Specific requirements may be secured through Guam EPA.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver products to site in unopened containers clearly labeled with name, date of manufacture, color, and name of manufacturer.

C. Store products in a protected area, which maintains temperatures and other environmental conditions within range recommended by manufacturer.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not apply paint when temperatures are outside ranges recommended by paint manufacturer, in dust, smoke-laden atmosphere, damp or humid weather.

B. Do not perform abrasive blast cleaning when relative humidity exceeds 85 percent or when surface temperature is less than 5 degrees F above dewpoint of ambient air.

1.11 SPECIAL GUARANTEE

A. Provide coating applicator’s and coating manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 2 years after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials of a paint system shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the manufacturer of the particular coating.

B. Furnish materials in accordance with the 2009 Edition of the International Building Code (2009 IBC).

C. For coatings in contact with potable water, the coating material shall be listed by the NSF International as in compliance with NSF 372 and NSF 600 according to the requirements of NSF 61.

2.2 MANUFACTURERS

A. Heavy-Duty Industrial Coatings

1. Tnemec Company
2. Ameron
3. Valspar
4. Or approved equal

2.3 PAINT MATERIALS

A. Paint products are specified in the following table. Products are referred to by code in the Paint Application Schedule.

CODE	PRODUCT	DESCRIPTION
AP	Aromatic Polyurethane	Moisture cured, Mio-zinc filled primer
AE	Acrylic Elastomer	Breathable water repellent coating for use on exterior shotcrete tank wall.
AL	Acrylic Latex	Single component, water based with fungicide additive, min solids content of 35%
CBF	Cementitious Block Filler	Multiple-component, water-based, cementitious acrylic
CE	Catalyzed Epoxy	Multiple purpose, two component epoxy suitable for immersion service system and as a prime coat for metal and galvanized surfaces
CTE	Coal Tar Epoxy	Corrosion- and chemical-resistant coating for use on steel or concrete in immersion and underground conditions.
EF	Modified Polyamine Epoxy	100% volume solids epoxy, thin film flooring
GRE	Glass Reinforced Epoxy	100% solids, glass reinforced epoxy
MTE	Moisture Tolerant Epoxy	100% solids penetrating epoxy
PE	Polyurethane Enamel	High-gloss or high semi-gloss, aliphatic polyurethane enamel
PEE	Polyethylene Encasement	Polyethylene plastic for wrapping ductile iron pipe and fittings
WBAE	Water-based Acrylic Epoxy	Non-yellowing, low odor, acrylic epoxy wall coating
WP	Water Based Polyurethane Enamel	High-gloss or high semi-gloss, water-based acrylic polyurethane
ZRP	Organic Zinc Rich Primer	Converted epoxy, or urethane type, minimum 14 lb. metallic zinc content per gallon

B. Acrylic Elastomer (AE) performance criteria:

1. Accelerated Weathering – Per ASTM C793, no signs of deterioration except for dirt accumulation after 4,000 hours exposure.
2. Chloride Iron Penetration – Per AASHTO T-259, no less than a 1500% reduction in the chloride ion content when compared to untreated concrete, average of two tests.
3. Hydrostatic Pressure Resistance – Per ASTM D751, no less than 35 psi hydrostatic pressure resistance, average of three tests.
4. Water Penetration and Leakage – Per ASTM E514, no penetration of dampness on back of test substrate after four hours continuous exposure.
5. Water Vapor Transmission – Per ASTM E96, no less than 90% retention of the permeability characteristics of brick when applied to brick, no less than 12 perms water vapor permanence, average of two tests on free film

2.4 COLORS

A. Colors: Colors shall be as selected by Owner.

B. Use colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gases likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matching color.

2.5 TESTING GAUGES

A. Furnish a magnetic type dry film thickness gauge, to test coating thickness specified in mils. Unit to be as recommended by the coating manufacturer.

B. Furnish an electrical holiday detector, low voltage, wet sponge type to test finish coat, except zinc primer, high-build elastomeric coatings, and galvanizing, for holidays and discontinuities. Unit to be as recommended by the coating manufacturer.

C. Furnish a high voltage holiday detector for elastomeric coatings in excess of 25 mils dry film thickness. Unit to be as recommended by the coating manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Surface Preparation Inspection:

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied. In the event of a conflict, the more stringent shall apply.

2. Provide Contracting Officer a minimum of 7 days advance notice prior to start of surface preparation work or coating application work.
3. Perform such work only in the presence of Contracting Officer, unless Contracting Officer grants prior approval to perform such work in Contracting Officer's absence.

B. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.

C. The intention of these Specifications is for new interior and exterior masonry, concrete, metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive prime coat only unless modified herein. Interior concrete surfaces of vaults will not be painted unless specifically indicated.

3.2 MANUFACTURER'S SERVICES

A. Coating manufacturer's representative shall be present at site as required to resolve field problems attributable to, or associated with the manufacturer's product.

3.3 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise specified or indicated on Drawings, do not paint the following items:

1. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, and stainless steel, except where:
   a. Required for electrical insulation between dissimilar metals.
   b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
   c. Color coding of equipment and piping is required.
2. Nonmetallic materials (not including wood) such as glass, PVC, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
3. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, acoustical tile, cabinets, building louvers, wall panels, etc., unless color coding of equipment is required.
4. Nonsubmerged electrical conduits attached to unpainted concrete surfaces.
5. Items specified to be galvanized after fabrication unless specifically noted or subject to immersion. Manufactured items and materials that are "factory" galvanized shall be prepared and coated as specified hereinafter for the exposure condition of the item and for architectural purposes unless otherwise specified herein. Repair of damaged galvanized surfaces is required.

3.4 PROTECTION OF SURFACES NOT TO BE PAINTED

A. Protect all surfaces adjacent to, or downwind of work area from overspray. Contractor shall be responsible for any damage resulting from overspray.

B. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

C. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

D. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

E. Mask openings in motors to prevent paint and other materials from entering.

3.5 APPLICATION SAFETY

A. Perform painting in accordance with recommendations of the following:

1. Paint manufacturer’s instructions.
2. Federal and local agencies having jurisdiction.

B. Contractor will be solely and completely responsible for conditions of the jobsite, including safety of all persons (including employees) and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. Safety provisions will conform to U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal and local laws, ordinances, and codes.

C. Contractor will comply with all safety training requirements promulgated or required for this project.

3.6 PAINT MIXING

A. Prepare and mix paint and coatings in accordance with manufacturer's instructions.

B. Prepare multiple-component coatings using all of the contents of the container for each component as packaged by the paint manufacturer. No partial batches will be permitted. Do not use multiple-component coatings that have been mixed beyond their pot life. Provide small quantity kits for touch-up painting and other small areas. Mix only the components specified and furnished by the paint manufacturer. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

C. Keep paint materials sealed when not in use.

D. Alternate colors to provide a visual reference where more than one coat of a material is applied within a given system.

3.7 SURFACE PREPARATION

A. Metal Surfaces

1. Remove oil, grease, welding flux and other surface contaminants using steam, open flame, hot water, or cold water with detergent additives followed with clean water rinsing. Small areas may be cleaned using suitable solvents.
2. Round all sharp edges and grind smooth burrs, jagged edges and surface defects.
3. Prepare welds so that there is: (a) no undercutting or reverse ridges on weld bead; (b) no weld splatter on or adjacent to weld; and (c) no sharp peaks or ridges along weld bead.
4. Prepare metal surfaces as specified in accordance with SSPC Specifications as follows:
   a. SP1 – Solvent Cleaning
   b. SP2 – Hand Tool Cleaning
   c. SP3 – Power Tool Cleaning
   d. SP5 – White Metal Blast Cleaning
   e. SP6 – Commercial Blast Cleaning
   f. SP7 – Brush-Off Blast Cleaning
   g. SP8 – Pickling
   h. SP10 – Near-White Blast Cleaning
   i. SP11 – Power Tool Cleaning to Bare Metal
   j. SP12 – High Pressure Water Jetting
5. Wherever “solvent cleaning”, “hand tool cleaning”, “wire brushing”, “blast cleaning”, or similar metal surface preparation methods are specified or used in paint manufacturer's instructions, conform to SSPC Specifications listed above.
6. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Follow coatings manufacturer’s recommendations for wet blast additives and first coat application.
7. Blast Cleaning Requirements: Comply with applicable federal and local, air pollution and environmental control regulations for blast cleaning and disposition of spent aggregate and debris.
8. Clean surfaces of all dust and residue from surface preparation operations by air blast cleaning or other dry method prior to painting. Paint surfaces the same day they are prepared; do not allow surfaces to rust prior to painting.

B. Concrete Surfaces

1. Wait at least 30 days after concrete has been placed before preparing surface.
2. Remove all grease, oil, dirt, salts or other chemicals, loose materials and other foreign matter by solvent, detergent or other suitable cleaning method.
3. Brush-off blast clean all concrete surfaces per ASTM D4259 to remove loose concrete and to provide a tooth for binding. Surface profile shall be as recommend in writing by the coating manufacturer. If brush-off blasting is impractical, surface may be acid etched with muriatic acid solution. Approval subject to producing desired profile. Acid etching of vertical or overhead surfaces or surfaces in the wet well will not be accepted.
4. Unless otherwise required for proper adhesion, surfaces shall be dry prior to painting. Verify dryness by testing for moisture per ASTM D4263.

C. Masonry Surfaces

1. Cure masonry construction for at least 14 days before starting surface preparation work. Surface preparation shall comply with ASTM D4261.

2. Remove all oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of all mortar and grout spillage and other surface deposits using either (a) nonmetallic fiber brushes and commercial muriatic acid followed with rinsing with clean water; or (b) brush-off blasting; or (c) water blasting.
4. Avoid damage to the masonry mortar joints or adjacent surfaces.
5. Unless otherwise required for proper adhesion, surfaces shall be dry prior to painting.
6. Masonry surfaces which are to be painted shall have a uniform texture and be free of surface imperfections which would impair the intended finished appearance.
7. Masonry surfaces which are to remain uncoated, or are specified to receive a clear coating, shall be free of discolorations and be uniform in texture after cleaning.

D. Plastic: Hand sand with medium grit sandpaper to provide tooth for coating system. Large areas may be power sanded provided excess material is not removed.

3.8 APPLICATION OF PAINT

A. General

1. Inspection: Schedule with Contracting Officer in advance for cleaned surfaces and all coats prior to succeeding coat.
2. Apply coatings in accordance with manufacturer's recommendations. Allow sufficient time between coats to assure drying of previous coat.
3. Fusion bonded coatings may be applied using electrostatic, fluidized bed, or flocking method.
4. Paint units to be bolted together or to structure prior to assembly or installation.
5. Extent of Coating (Immersion): Coatings shall be applied to all internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.

B. Shop Primed or Factory Finished Surfaces

1. Inspection: Schedule with Contracting Officer in advance for shop primed and factory finished items.
2. Repair chipped, peeled or abraded coatings to satisfaction of Engineer by hand or power sanding, feathering the edges, and spot priming with specified primer. Prepare and prime holdback areas for welding as required for specified paint system after welding is completed. Apply all coatings in accordance with manufacturer's instructions.
3. Remove all factory-applied bituminous or asphaltic varnishes from ductile iron pipe prior to application of specified coatings.

C. Manufacturer Applied Paint Systems: Repair abraded areas in accordance with equipment manufacturer's directions. Blend repaired areas into original finish. Provide appropriate liquid repair kits for field repair of fusion bonded coatings.

D. Film Thickness:

1. Number of Coats:

a. Minimum required irrespective of coating thickness.
b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturer's products, and atmospheric conditions.

2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with the Specifications.
   c. All coats will be subject to inspection by Contracting Officer and coating manufacturer's representative.
4. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thickness are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to complete hiding of underlying coats. The hiding shall be so complete that the addition of additional coats would not increase the hiding.
7. Thickness Testing:
   a. After repaired and recoated areas have dried sufficiently, final tests will be conducted by the Contracting Officer.
   b. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
   c. Test finish coat, except zinc primer, galvanizing, and elastomeric coatings, for holidays and discontinuities with an electrical holiday detector, low voltage, wet sponge type as specified.
   d. Holiday detect coatings with high voltage units when recommended by the coating manufacturer.
   e. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after applications of coating.

E. Porous Surfaces, Such as Concrete, Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat:
   a. May be thinned to provide maximum penetration and adhesion.
   b. Type and Amount of Thinning: Determined by paint manufacturer and dependent upon surface density and type of coating.
3. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

F. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Repair fusion bonded coatings as recommended by original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by coating manufacturer.
4. Apply finish coats, including touchup and damage-repair coats, in a manner which will present a uniform texture and color-matched appearance.

G. Unsatisfactory Application:

1. If item has improper finish color or insufficient film thickness, clean and top coat surface with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
3. Repair defects in coating system per written recommendations of coating manufacturer.
4. Leave all staging up until Contracting Officer has inspected surface or coating. Replace staging removed prior to approval by Contracting Officer.

3.9 CLEANING

A. Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

B. Remove paint spatters from adjoining surfaces. Repair any damage to coatings or surfaces caused by cleaning operations.

3.10 PAINT APPLICATION SCHEDULE

A. Unless otherwise shown or specified in these Specifications, paint or coat the work in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the Contracting Officer before starting work in question.

APPLICATION	SURFACE PREPARATION (paragraph 3.7)	PRIMER Paint Material (paragraph 2.3), No. Coats, and Min. Cover	FINISH Paint Material (paragraph 2.3) No. Coats, and Min. Cover
Submerged Metal	SP 5	CE, 1 coat 5.0 mils	CE, 2 coats 5.0 mils, each coat
Exposed Metal – Mildly Corrosive	SP 10	CE, 1 coat 5.0 mils	PE, 2 coats 2.0 mils, each coat

APPLICATION	SURFACE PREPARATION (paragraph 3.7)	PRIMER Paint Material (paragraph 2.3), No. Coats, and Min. Cover	FINISH Paint Material (paragraph 2.3) No. Coats, and Min. Cover
Exposed Metal – Atmospheric	SP 6	CE, 1 coat 5.0 mils	WP, 2 coats 2.0 mils, each coat
Exposed Metal – Interior (Apply primer to all surfaces; finish coat need only be applied to surfaces exposed when construction is complete.)	SP 6 or SP 8	AP, 1 coat 2.5 mils	WP, 2 coats 2.0 mils, each coat
Buried Ductile Iron Pipe and Fittings	Manufacturer's Applied Coating	None	PEE, 1 layer with 1" minimum overlap, 8 mils min thick, secure with polyethylene tape
Buried Steel Casing Pipe	SP 10	CE, 1 coat 5.0 mils	CTE, 2 coats 20.0 mils, each coat
Galvanized surfaces requiring painting.	SP 1 followed by ASTM D6386	CE, 1 coat 3.0 mils	PE, 1 coat 2.5 mils
Repair of galvanized metal	SP 1 followed by SP 2, or ASTM D6386	none	ZRP, 1 coat 2.5 mils
Interior concrete floors in the Control Building	Concrete	EF, 1 coat 6.0 mils	EF, 1 coat 6.0 mils
Aluminum and cementitious or dissimilar metal insulation.	SP 1	CE, 1 coat 5.0 mils	CE, 1 coat 5.0 mils
CMU Walls – Interior (Painted)	Masonry	CBF, 1 coat 80 sq. ft./gal	WBAE, 2 coats 4.0 mils, each coat
CMU Walls – Exterior	Masonry	AL, 1 coat 2 mil	AL, 2 coats 3 mils, each coat

END OF SECTION 099000

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 -GENERAL

1.1 SCOPE OF WORK

Provide labor, materials, equipment, transportation and perform operations necessary or incidental to the proper execution and completion of the electrical work, whether specifically mentioned or not, and as directly indicated or reasonably implied by the Drawings and Specifications. This work includes calibrating, adjusting, testing, documenting, and starting up the electrical system, as well as training the Owner's personnel.

A. Work specified in these divisions:

1. Section 260519: Low-Voltage Electrical Power Conductors and Cables
2. Section 260526: Basic Electrical Materials, Methods and Grounding
3. Section 260533: Raceway and Boxes
4. Section 260553: Electrical Equipment Identification
5. Section 262200: Low-Voltage Transformers
6. Section 262416: Panelboard and Circuit Breaker
7. Section 262726: Wiring Devices
8. Section 262826: Enclosed Transfer Switches
9. Section 263213: Engine Generators
10. Section 264313: Surge Protective Devices
11. Section 265000: Lighting

1.2 WORK NOT INCLUDED

A. Refer to the specific Division 26 Sections for a detailed listing of work that is not included in this Contract.

B. In any case, cooperate with the other trades who may or may not be party to this Contract for the purpose of coordinating the electrical requirements and installation of equipment, materials, and furnishings provided by those other trades, including the Owner.

1.3 CODES AND STANDARDS

A. Provide equipment and materials which conform to, and perform the installation thereof in accordance with the following codes and industry standards. The applicable version of each shall be that in effect as of the date of the Contract:

1. National Electrical Code (NEC).
2. American National Standards Institute (ANSI).
3. Underwriters' Laboratories (UL).
4. National Electrical Manufacturers' Association (NEMA).
5. Institute of Electrical and Electronics Engineers (IEEE).
6. National Electrical Safety Code (NESC).
7. Electrical Safety Orders.
8. Other applicable local codes and ordinances.

B. Where the authority-having-jurisdiction makes an interpretation or decision, as is their prerogative in accordance with the Code, such direction shall be considered a part of these Contract Documents as if contained herein. With respect to completing the intent of the Contract Documents, comply with any and all requirements of the authority-having-jurisdiction and utility company field inspectors, at no additional cost.

C. The above referenced codes and standards are considered to be absolute minimum requirements. The Drawings and Specifications shall take precedence over the above referenced codes and standards where materials or workmanship of higher quality or larger size is indicated. Nothing in these Drawings or Specifications shall be construed to allow work not conforming to the applicable codes and standards.

1.4 REVIEW OF CONTRACT DOCUMENTS

A. Examine all relevant Contract Documents including Drawings, Specifications, and Shop Drawings in order to become acquainted with the Work of other installers whose activities will adjoin or be affected by the Electrical Work.

1.5 PERMITS, LICENSES, AND FEES

A. Procure and pay for all permits, licenses and fees that are required to carry out and complete the Electrical Work.

B. Pay for building department or utility company imposed inspection fees.

C. Pay utility company charges for normal or after hours shutdowns, service calls, repairs, and cable locating that are directly related to the installation of the Electrical Work.

1.6 SITE VERIFICATION OF INFORMATION

A. Visit the project site prior to submitting a bid and verify the condition, location and dimensions of buildings, equipment, and facilities. Become acquainted with conditions under which the Work is to be performed and which may affect the cost thereof.

B. Verify at the project site, the accuracy of information shown on the Drawings regarding existing equipment, materials, and facilities. This includes but is not limited to: size, type, rating, quality, age, and serviceability. No allowance will be made on behalf of the Contractor for extra expenses resulting from the failure to discover conditions affecting the Work.

1.7 WORKING SPACE

A. Maintain adequate work space around, and access to, electrical and mechanical equipment in strict accordance with the applicable Codes. Verify during the course of construction that sufficient space will be available for the installation equipment, fixtures, etc.

1.8 MATERIALS AND SUBSTITUTIONS

A. Materials shall be new, high quality, free from defects, of standard make, and of the brand or grade as shown on the Drawings or specified herein. Specific trade names are used in the Drawings and

Specifications in order to establish the standard grade and characteristics of said items. This does not imply the right upon the part of the Contractor to use other materials or methods without the approval of the Owner's Representative.

B. Electrical materials and equipment shall bear the label of, or be listed by, the Underwriters' Laboratories (UL) wherever standards have been established and label service is regularly furnished by that agency. Comply with the installation and application requirements of UL as documented in their published directories.

C. Unless specifically noted, equipment and systems shall be the product of a manufacturer who has been in the manufacture of, and has nationally distributed catalogs covering the ratings and specifications of, said equipment or systems, for a period of not less than five (5) years.

D. Maintain uniformity throughout the Project by making use of only one make or brand of material for each material or system used.

E. Substitutions of materials or methods will only be allowed if such items are approved in writing by the Owner's Representative as equal in quality and utility to the specified items. Submit a list of proposed substitutions within thirty (30) days of the award of the Contract. Include on the list the original manufacturer's name and model number, the proposed manufacturer's name and model number, catalog cut sheets, ratings, sizes, performance curves, shop drawings, and other data as may be required to demonstrate equality to the specified item.

F. The approval of a substitution does not authorize any deviation from the utility, size, function, or durability of the specified item unless specifically pointed out and requested in the proposed substitution list, and said deviation is approved in writing by the Owner's Representative. Responsibility of the Contractor for dimensional considerations or space conflicts is not relieved by the approval of a substitution.

G. If requested by the Owner's Representative, submit samples of materials and equipment for approval prior to installation.

1.9 SUBMITTALS

A. General Submittals

1. See the General Conditions for conditions of submittal approval and general requirements for submission of shop drawings.
2. Submit electrical shop drawings and manufacturer's cut sheets for equipment and materials as noted in each Division 26 specification section per Section 013300 – Submittal Procedures. Bind the submittals as complete volumes according to classification of equipment such as power, lighting, fire alarm, etc. When possible, make all electrical submittals at the same time.
3. Submit shop drawings and supporting data as instruments of the Contractor. Stamp each item in the submittal documents with the Contractor's stamp, thereby stating that the equipment meets all requirements and conditions of the Drawings and Specifications. In particular, certify that the items shown on the shop drawings conform to the dimensional, environmental, and space restrictions as pertains to all work under this Contract and the work of other parties in conjunction with this Project.

4. Provide a blank space on the title page of each submittal classification for the Owner's Representative's approval stamp and comment field. The minimum size of such space shall be eight inches wide by five inches high.
5. In addition to the schedule requirements herein, the Contractor is responsible for providing submittals in a timely manner as required to meet the overall project schedule.
6. Should any item which deviates from these Specifications be included, the deviation shall be clearly indicated and explained at the time of submittal.
7. Submittals shall be complete, neat, orderly, and indexed. The Contractor shall check submittals for number of copies, adequate identification, correctness, and compliance with the Drawings and Specifications, and shall initial all copies.
8. Revise and resubmit all submittal information until acceptable to the Engineer.
9. Review of submittal information by the Engineer shall not relieve the Contractor of responsibility for meeting the requirements of the Drawings and Specifications or for errors and omissions in submittals.

B. Product Submittals

1. Product submittals shall be submitted within 45 days after the Notice to Proceed. In addition, no products shall be fabricated or shipped until the applicable submittals have been reviewed by the Engineer.
2. As-built copies of product submittals shall be included in the O&M manuals.
3. Before any material is fabricated or shipped, furnish to the Engineer full details, shop drawings, dimensions, catalog cuts, schematic (elementary) diagrams, wiring diagrams, and other descriptive matter as required to fully describe the equipment specified under this Section.
4. Submittals shall show that the products furnished meet the applicable UL standards for its intended use.
5. Electrical Drawing Requirements:
    a) Arrange panelboard submittals to show bussing, circuit numbering, and branch circuit protective devices similar to the schedules on the Drawings. Show elevations of switchboards, motor control centers, and distribution centers indicating the layout of devices, meters, handles, etc. Provide device ratings, circuit numbers, and nameplate descriptions in table form. Include terminal strip mounting arrangements on elevations for terminal cabinets.
    b) Electrical drawings and data shall be complete and shall represent the equipment proposed for this project. Drawings and data shall be adequate to demonstrate that the equipment meets the requirements of the Contract Drawings and Specifications, and to be used by the Owner for operation, maintenance, and troubleshooting of the facility.
    c) Provide electrical schematic diagrams and connection (wiring) diagrams that show locations and wiring for items specified in this Section, and also show interface wiring between items specified in this Section and other items on this project.
    d) Electrical schematic diagrams, sometimes referred to as elementary diagrams or control diagrams shall show complete control logic and interfaces for all systems furnished under this Section. Electrical schematic diagrams shall show circuits and device elements in ladder-diagram form without regard to physical location. "Typical" schematic diagrams are not acceptable; provide separate diagrams for multiple pieces of equipment.
    e) Wiring diagrams shall show wire-by-wire, device-by-device, terminal-to-terminal, connections between devices within enclosures. Devices are arranged not by their

schematic relationship, but instead by their physical relationships. Wiring diagrams shall show each device within an enclosure, with each connection, annotated with wire numbers and terminal numbers throughout. Provide wiring diagrams for each enclosure, control panel, and unique item of equipment.

f) For all external connections, provide explicit references to interconnection diagrams, such that the user of the drawings can navigate from the enclosure to field wiring.

g) For electrical schematic and wiring diagrams, manufacturer's standard drawings may be used, provided that they show the information described and are annotated to reflect the configuration for this project. For example, equipment numbers and descriptions unique to this project should be used, options not included should be stricken, signal interfaces with systems outside this package should be marked up to depict the actual interfaces on this project, information and detail should be added to meet the requirements above, and other standard and optional provisions should be annotated to match this project.

h) Interconnection diagrams shall show interconnection between devices and enclosures. Provide complete project-specific interconnection diagrams, which show the following for all power, control, signal, and communications interconnection:

i. Terminal identification
ii. Wire numbers
iii. Conductor size, quantity
iv. Intermediate terminations
v. Conduit/raceway designations
vi. References to corresponding enclosure wiring diagrams
vii. Pullboxes, handholes, manholes and enclosures

i) Include terminal numbers and wire numbers which match terminal numbers and wire numbers on wiring diagrams, and on schematic diagrams. Include references to corresponding wiring diagrams.

j) Provide complete drawings and descriptive data, both mechanical and electrical, for control panels.

6. This information shall be submitted to the Engineer prior to the startup of any equipment and shall be included in the Operation and Maintenance Manual.

C. Testing Submittals

1. Submittal requirements for testing, test plans, and test reports are covered under the Article(s) referring to TESTING.

D. Field Wiring Interconnection Diagram Submittals

1. Prior to the Functional Acceptance Test (FAT) and within 15 days after completion of installation of field interconnection wiring, the Contractor shall submit a complete interconnection wiring diagram.
2. An as-built interconnection diagram shall be included in the O&M manual.
3. The interconnection diagram shall show all electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components; all component and panel terminal board identification numbers; and external wire and cable numbers. This diagram shall include all intermediate terminations between field elements and panels, such as terminal junction boxes and pull boxes. Diagrams, device designations, and symbols shall be in accordance with NEMA ICS 1-101.

4. The Contractor shall determine which member or members of the Contractor's team shall provide this drawing(s).
5. The supplier(s) and/or subcontractor(s) supplying the equipment and systems covered under this and other Sections of this Specification shall provide to the Contractor complete information required by the Contractor for installation of field interconnection wiring and for preparation of field interconnection wiring diagrams. As a minimum, this information shall include the following items for all equipment and systems covered under this and other Sections of this Specification:
    a) Tabulation of interconnection wiring, with recommended wire and conduit sizes
    b) Equipment terminal points
    c) Internal wire identifications

1.10 DRAWINGS AND SPECIFICATIONS

A. The data and information contained on the Drawings is as accurate as was reasonably possible at the time they were produced, but absolute accuracy is not guaranteed. Exact locations, distances, elevations, etc., will be dictated by the actual building and the conditions at the site.

B. The layout of electrical equipment, wiring, and accessories is shown in a diagrammatic fashion (not pictorially) in order to achieve clarity and legibility. Although the size and location of electrical equipment is drawn to scale wherever possible, refer to all data in the Contract Documents and field verify this information as the project progresses. Examine architectural, structural, mechanical, and other drawings to determine the exact location of conduits, outlets, fixtures, and equipment and to note any conditions which may affect the electrical work.

C. The Drawings and Specifications may be superseded by later detail drawings and specifications prepared by the Owner's Representative. Conform to such detail drawings, specifications, addenda, change orders, other reasonable changes as if they are contained herein. See the General Conditions for change order cost considerations.

D. Because the Electrical Drawings may be distorted for clarity of representation, it may be necessary to field verify the exact location of electrical outlets, lights, switches, etc. in order to conform to other site elements. The Owner's Representative reserves the right to make minor changes to the locations of equipment, devices, and wiring shown on the Drawings, at no additional cost, providing the changes are ordered before the rough-in of conduit, boxes, or related items is completed, and no extra material are required.

E. For dimensional and locational purposes, the Civil Drawings take precedence over the Electrical Drawings. Determine the appropriate location of lighting fixtures, outlets, wall-mounted devices, etc. by studying the reflected ceiling plans, building sections, and interior elevations. Report conflicting conditions to the Owner's Representative before rough-in for adjustments to the locations.

F. Conduit quantities, sizes, termination points, and wiring are depicted on the Electrical Drawings. However, not all conduit bends or routing details are necessarily shown. Route conduit so as to conform to the structural conditions, avoid obstructing other trades, maintain space restrictions and keep circulation areas and access openings clear.

G. Thoroughly examine the Contract Documents prior to submitting a bid in order to determine electrical requirements which are not necessarily indicated on the Electrical Drawings. Include sufficient allowance in the bid sum to cover the costs of these other requirements.

H. Should the Contractor perceive that the Drawings and Specifications do not sufficiently define the intent of electrical work, contact the Owner's Representative for clarification or additional information. The absence of such contact will be considered as evidence of understanding, on the part of the Contractor, of the intended Electrical Work and the required installation thereof.

1.11 WORKMANSHIP

A. Constantly supervise the work personally or through an authorized and competent representative. Keep the same foreman or supervisor on the project from commencement through completion.

B. Perform the Electrical work using the highest caliber craftsman available. Workmanship shall be first class and of the best quality available to insure a long and trouble free service life. Allow only experienced and competent workmen on the job.

1.12 COOPERATION AND COORDINATION

A. Consult with the other installers and trades in coordinating the Work so as to avoid conflicts, omissions and delays. Cooperate with other contractors, third parties, and the Owner in order to expedite the project and provide for the proper execution of the building as a whole. Work performed without regard to other trades or the overall project scheme, may necessarily be required to be moved at the Contractor's expense.

1.13 GUAM POWER AUTHORITY COORDINATION

A. This project requires new electric service(s). This article describes requirements for coordination and execution.

B. For each site, coordinate with GPA on GWA's behalf. Coordination includes, but is not limited to, the following:

1. Meet GWA/GPA representatives on site prior to application submission.

2. Prepare service applications, draft, on GWA's behalf.

3. Coordinate with GWA and GPA on locations, routing; including details associated with staying within rights-of-way and avoiding utility conflicts.

4. For each site, coordinate with GPA on GWA's behalf. Coordination includes, but is not limited to, the following:

5. Meet GWA/GPA representatives on site prior to application submission.

6. Prepare service applications, draft, on GWA's behalf.

7. Coordinate with GWA and GPA on locations, routing; including details associated with staying within rights-of-way and avoiding utility conflicts.

8. The contract drawings are based on preliminary GPA coordination, prior to receipt of final GPA internal engineering design. Receive GPA's engineered drawings. Reconcile any differences with the contract drawings.

9. Prior to purchasing vaults and electric service provisions, obtain GPA's written approval and formally submit.

10. Coordinate all GPA inspections and approvals.

11. Schedule activities anticipating reasonable lead times.

C. Furnish and install all "customer-furnished" provisions shown on GPA's drawings and as required by GPA. Conform to GPA standards. Provisions generally include the following:

1. Riser and provisions at service pole.

2. Concrete-encased secondary conduit.

3. Secondary splice box.

4. Concrete-encased conduit from splice box to service.

5. Service provisions.

D. GPA fees will be paid by GWA. Coordinate and assist GWA in the process of assessing and paying the fees.

E. Temporary construction power is the Contractor's sole responsibility. Should the Contractor wish to obtain temporary GPA electric service(s), all costs of services and ongoing charges are the Contractor's to bear.

1.14 MANUFACTURER'S DIRECTIONS

A. Adhere to the manufacturer's directions regarding the proper installation and configuration of electrical equipment where those directions cover points not included in these Drawings and Specifications.

1.15 PROTECTION AND STORAGE

A. Deliver electrical materials to the site new, and in unbroken packages. Provide for the temporary storage of such materials, equipment, and construction tools in accordance with the General Conditions. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.

B. During shipping storage and handling protect electrical materials from damage of any type including dust, water, over-spray, and temperature. Avoid damage during construction to the work and

materials of other trades as well as the electrical work and material. Repair or replace, at the Contractor's expense, defective or damaged items such that the entire Work is completed in a condition satisfactory to the Owner's Representative.

1.16 EXCAVATION, CUTTING, PATCHING, AND REPAIR

A. Perform excavation and backfill required for the installation of electrical sub-structures. Restore grounds, walkways, roadways, curbs, walls, and other existing underground facilities to their original condition.

B. Conform to the applicable requirements of Division 2, Earthwork for Utilities, in the selection, placement, and compaction of backfill material and finished surfaces.

C. Cut, core-drill, and demolish existing walls, floors, ceilings and other building surfaces as required for the installation of Electrical Work. Obtain the approval of the Architect prior to performing any operation which may affect any structural elements of the building.

D. Patch and repair wood, plaster, tile, or concrete surfaces which have been damaged by the installation of the Electrical Work so that the finished surface matches the surrounding conditions.

1.17 FLASHING, WATERPROOFING AND SEALING

A. In general, install in an approved watertight manner, Electrical Work which pierces exterior walls or waterproofing membranes. Flash and counter-flash roof and wall penetrations in a manner described in other applicable sections of this Specification and as approved by the Architect.

B. Fit conduits passing through finished walls with steel escutcheon plates of brass, chrome, or painted finish as directed by the Architect. Grout penetrations of floor slabs, concrete or masonry walls with an approved grout or silicone elastomeric caulk. Seal below grade penetrations with Link Seal or approved equal mechanical seal on the accessible side and silicone elastomeric caulk on the exposed side.

1.18 CLEANING, ADJUSTING, AND TOUCH-UP

A. Remove on a daily basis electrical debris, scraps, packaging material and other rubbish. Dispose of such items off-site in an approved manner and debris. Maintain the site free from physical hazards at all times in accordance with OSHA regulations. See the General Conditions and Section 017419 – Construction Waste Management and Disposal for additional requirements.

B. After installation, completely clean electrical equipment, fixtures, and materials of excess paint, over-spray, plaster, cement, insulating products, and other foreign matter. Leave the Electrical Work in a clean, finished, dry, level, like new condition.

C. Touch-up paint scratches and scuffs on electrical equipment and lighting fixtures with paint recommended by the manufacturer and matching the original item finish.

D. Make setting, adjustments, and programming in accordance with the manufactures' operating and installation instructions. Settings and program variables will be issued by the Architect prior to commissioning of the electrical system.

1.19 AS-BUILT DRAWINGS

A. Throughout the project, maintain accurate and current record documents. Show on the record drawings deviations from the Electrical Drawings, locations of underground conduits and pull-boxes, and concealed equipment which is not readily apparent. Dimension the record drawings using permanent, readily identified benchmarks such as column or wall lines.

B. At the completion of the project, present one clearly legible set of the record drawings to the Owner.

1.20 INSPECTIONS AND TESTING

A. Arrange for the inspection of the Work at various stages of completion by the Authority Having Jurisdiction, utility company representatives, the Owner, and the Owner's Representative. Comply with all directions and remedial measures issued thereby. Any objections to these orders on the part of the Contractor must be presented to the Owner's Representative in writing within forty eight (48) hours of the inspection report.

B. Coordinate the installation of the Work so that observation of all rough-in, concealed, or underground Work can take place by the Owner's Representative. Provide a minimum of seventy two (72) hours' notice to the Owner's Representative prior to covering up the work. Uncover Work that has not been properly observed and make repairs to restore the Work and adjoining surfaces to their proper condition at no additional cost.

C. Perform tests of the electrical system during the course of the project and at project completion to ensure safe and proper function in accordance with the Contract Documents, manufacturers' recommendations, and applicable codes. Provide complete documentation of all test results to the Architect prior to project completion. Testing shall include, but not necessarily be limited to, the following:
   1. Test for short circuits, open circuits, neutral leakage, and improper grounds on feeders and branch circuits. Perform this test with mains in disconnect from feeders, branch circuits closed, fixtures and devices permanently connected, lamps removed from sockets and wall switches closed.
   2. Provide insulation resistance tests of all phase and neutral circuit conductors using a 500 Volt Megger for circuits of 240 Volt rating and below, and a 1000 Volt Megger for circuits of 277 volts and above. Minimum acceptable insulation resistance is one (1) megohm.
   3. Perform a ground resistance test of each main grounding electrode system, ground rod, and supplemental grounding electrode. Utilize a calibrated, direct reading, earth ground test set and make the tests using the "Three-terminal, Fall-of-Potential" method. The maximum allowable earth ground resistance is 10 ohms.
   4. Test for proper phase-to-phase and phase-to-neutral operating voltage on the main service and on each separately derived system. Perform this test at full load and at no load. With all circuits at full operating conditions, test the phase and neutral load currents using a clamp-on ammeter.
   5. Tests as required by other sections of these Specifications.
   6. Tests as prescribed by individual equipment manufacturers whether or not described in these Specifications.

D. At project completion, demonstrate to the Owner that the entire installation is complete, in proper operation condition and that the Contract has been properly and fully executed. Activate all circuits, lights, devices, and controls under full load and normal operating conditions. Identify faulty items

and immediately replace or repair defective equipment, workmanship, and materials to like new condition and retest in the presence of the Owner.

E. At the completion of the Project, demonstrate to the Owner that the entire electrical system is free from short circuits and improper grounds, or upon request of the Owner anytime, make necessary tests under the observation of the Owner which will ensure that electrical equipment, materials and installation methods are as specified.

F. Tests and test plans shall be in the cause and effect format. The person conducting the test shall initiate an action (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

G. Tests and test plans shall be integrated across equipment and systems. The Contractor shall coordinate and integrate the documentation and efforts of suppliers and subcontractors to achieve unified tests and test plans.

H. Coordinate the testing specified herein with the work covered in Section 409636: Process Control Integration.

1.21 OPERATIONAL READINESS TEST (ORT)

A. Prior to startup, all equipment and systems specified under this Section shall be inspected and tested to show that they are ready for operation.

B. The test shall be performed from a test plan prepared by the Contractor.

C. The ORT shall include the following:

1. Perform a detailed point-to-point wire check of interconnection wiring. After installation, termination, and identification of conductors, perform a point-to-point wire check to verify that all wiring has been properly installed and identified, and that there are no shorts between wires, shields, and ground. Lift wires from terminals as required to perform this test.

2. Insulation Test:

a. Protect voltage-sensitive equipment during insulation testing. Follow manufacturer's recommendations regarding disconnection of phase and neutral wires of sensitive equipment such as surge protective devices (SPD's) and motor protective relays during insulation testing. Reconnect equipment after testing.

b. Perform a megger test on all control and power wiring. Use a 1,000-volt megger on 480-volt wiring applications, and use a 500-volt megger on wire and cable used for applications 240V and below.

c. Insulation resistance measurements of each branch power circuit shall be made with loads connected and contactors, if any, blocked closed to give complete circuits. Insulation resistance of the complete circuit shall be measured from the circuit breaker load terminals with the breaker open. The Contractor shall witness and make

a record of these values and shall submit it to the Engineer. Values of resistance of less than 10 megohms are not acceptable.

d. The Engineer shall be notified at least 1 week prior to the insulation test so that he may witness the test if he chooses.

D. In addition, the ORT shall demonstrate that the complete interconnected systems specified under this Section meet the requirements of the Drawings and Specifications.

E. After completion of the ORT, the Contractor shall prepare a test report and shall submit it for review. The ORT shall be successfully completed and the test report submitted to and reviewed by the Engineer before the FAT (Functional Acceptance Test) is performed. As a minimum, the ORT test report shall include the following:

1. Written confirmation by the Contractor that the ORT has been completed.

2. Calibration data for each instrument and device, where applicable.

3. Record of insulation test values.

1.22 FUNCTIONAL ACCEPTANCE TEST (FAT)

A. Once the facility has been started up and is operating, and after written confirmation by the Contractor that the ORT has been completed, a witnessed FAT shall be performed on the equipment and systems specified under this Section to demonstrate that they are operating as specified and meet the requirements of the Specifications.

B. The FAT shall be performed by the Contractor and may be coordinated with testing of equipment and systems covered under other Sections of these Specifications.

C. The Contractor shall prepare a test plan for the FAT and shall submit it for review at least 30 days before the FAT is performed. As part of the test plan, the Contractor shall list the personnel who will be present to assist with and witness the FAT. This list shall include any Contractor's personnel, subcontractors, suppliers' representatives, and other necessary personnel.

D. Each function shall be demonstrated. The FAT shall operate all equipment and systems over the full operating range, shall demonstrate proper operation of alarms and indicators, and, in general, shall demonstrate that the equipment and systems meet the requirements of the Drawings and Specifications.

E. If any equipment or system fails the FAT, the Contractor shall correct the problem and shall repeat the test until it is successful.

F. The FAT shall be performed in the presence of the Architect or Engineer, and the Owner.

G. After completion of the FAT, the Contractor shall prepare a test report and shall submit it for review. The system will not be accepted before the FAT is successfully completed and the test report submitted to and reviewed by the Engineer.

1.23 FINAL ADJUSTMENTS

A. Upon completion of the FAT, final adjustments shall be made to the equipment as necessary.

1.24 GUARANTEE

A. In accordance with Division 1 requirements.

1.25 WARRANTIES, CERTIFICATES, AND OPERATING MANUALS

A. Properly fill out and deliver to the Owner, all warranties, guarantees, certificates, etc. for equipment and materials that are furnished and installed under Division 26 and this Section of the Work. The effective date on each item shall be the date of acceptance of the work by the Owner.

B. Deliver to the Owner, a minimum of two (2) copies of the manufacturers' operating and maintenance manuals for major items of equipment.

PART 2 PRODUCTS - Not used.

PART 3 EXECUTION - Not used.

END OF SECTION 260500

SUBSECTION 260519 - LOW-VOLTAGE ELECTRCIAL POWER CONDUCTORS AND CABLE

PART 1 GENERAL

1.1 SUMMARY

A. This section covers all labor, material, tools, equipment and services required to install building wire and cable, service entrance cable, control cables, wiring connectors and connections.

1.2 RELATED SECTIONS

A. Section 260526 – Basic Electrical Materials, Methods and Grounding

B. Section 260533 – Raceway and Boxes

C. Section 271513 - Communications Copper Horizontal Cabling

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A.	ASTM B3	Soft or Annealed Copper Wire
B.	ASTM B496	Compact Round Concentric-Lay-Stranded Copper Conductors
C.	ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
D.	ANSI C2	National Electrical Safety Code – latest edition
E.	IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
F.	IEEE 399	Recommend Practice for Industrial and Commercial Power System Analysis.
G.	NECA	(National Electrical Contractors Association) - Standard of Installation.
H.	NEMA WC-26	Wire and Cable Packaging
I.	ANSI/NETA ATS	National Electrical Testing Association Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
J.	NFPA 70	National Electrical Code – latest edition.
K.	UL 83	Thermoplastic-Insulated Wires and Cables.
L.	UL 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors.
M.	UL 510	Polyvinyl Chloride, Polyethylene and Rubber Insulating Tapes.

1.4 SYSTEM DESCRIPTION

A. The applications for cable, wire and connectors required, but not limited to, are as follows:

1. Power distribution circuitry.
2. Lighting circuitry.
3. Appliance and equipment circuitry.
4. Wiring for motors of mechanical equipment
5. Wiring from the motor(s) of mechanical equipment to the disconnect switches or junction boxes, including wiring for pushbuttons, pilot lights, interlocks and similar devices as directed, shown, or specified.
6. Wiring from the motors of mechanical equipment to motor starters, including other auxiliary wiring as may be required, directed, or shown.
7. Line voltage wiring as required by other Divisions 2 thru 15, and interlocking to motor starters.
8. Control wiring for motors, mechanical equipment, relays and switches, and similar mechanical-electrical devices.
9. Line voltage wiring to thermostats, alarm systems and other miscellaneous equipment.

1.5 PROJECT CONDITIONS

A. All wire and cables shall be minimum No. 12 AWG copper conductor unless otherwise shown on drawings.

B. All conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is diagrammatic unless dimensioned.

D. Route wire and cable as required to complement project conditions.

E. The contractor shall be responsible for any and all raceways and raceway/cable supports in accordance with all other sections of these specifications.

1.6 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for the purpose specified and shown.

1.7 CONTRACTOR SUBMITTALS

A. Product Data:
1. Submit manufacturer’s catalog cuts and technical data for building wire and cables.

B. Field Test Report:
1. Measure overall insulation resistance to ground. Provide certified test report for Owner’s Representative’s Review.

1.8 CLOSEOUT SUBMITTALS

A. Product Data: For each type of product.

B. Provide project record documents showing actual locations of components and circuits.

C. Submit final certified test reports of all insulation resistance tests.

1.9 QUALIFICATIONS

A. Manufacturer shall be a Company specializing in manufacturing products specified in this section with a minimum of five (5) years experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products on site in accordance with Division 1 requirements.

B. Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.

C. Store and protect cable and accessories from the environment in accordance with manufacturer’s published instructions. Provide adequate heating and ventilation to prevent condensation.

D. Damaged items shall be replaces at no additional cost to Owner.

1.11 COORDINATION

A. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

B. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 feet of length shown.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Domestic manufacturer regularly engaged in the manufacture of Building Wire and Cable products for at least five (5) years as follows:

1. American Wire and Cable.
2. Cerro Wire and Cable Co.
3. General Cable Corp.
4. Okonite Co.
5. Or Approved Equal.

2.2 BUILDING WIRE AND CABLE

A. Building wire and cable shall be UL83 compliant, insulated, single conductor, copper, solid or stranded, rated for 600-volts AC. The insulation shall be thermoplastic material rated for 90 degrees Celsius dry locations, 75 or 90 degrees Celsius wet locations, THW, THHN/THWN, RHW or XHHW, per ANSI/NFPA 70.

B. For Interior Dry Location: Use only building wire, THHN/THWN insulation rated 90 degree Celsius, in raceway.

C. For Exterior Wet or Dry Locations: Use only XHHW insulation rated for 90 degree Celsius, in raceway.

D. For Underground Dry or Wet Locations: Use only XHHW insulation rated 90 degree Celsius, in raceway.

E. For connections to electrical equipment, coordinate wire type with equipment manufacturer.

2.3 SERVICE ENTRANCE CABLES

A. Service entrance cables shall be insulated, single conductor, copper, stranded, rated for 600-volts AC, type XHHW insulation.

B. Overhead Service entrance cables shall be insulated, single conductor, copper, stranded, rated for 600-volts AC, type SE insulation.

2.4 INSTRUMENTATION AND CONTROL CABLES

A. Instrumentation cables for field mounted equipment and devices shall be minimum two (2) conductor No. 16 AWG, tin-coated copper, stranded, shielded twisted pair, 80 degree Celsius, PVC insulation foil shield with overall heavy duty polyethylene jacketing, rated for 600-volt AC. Belden No. 8719 meets these requirements.

B. Control cables to field mounted equipment and devices shall be a single conductor, insulated, No. 12 AWG minimum, copper, solid or stranded, rated for 600-volts AC. The insulation shall be thermoplastic material rated for 90 degrees Celsius dry locations, 75 degrees Celsius wet locations, THHN/THWN or XHHW, per ANSI/NFPA 70 and compliant with UL 83.

C. Multi-conductor control cables for field mounted equipment and devices shall consist of several single conductor, insulated No. 12 AWG minimum, copper, solid or stranded, rated for 600-volts AC with an overall protective PVC jacket. The insulation shall be thermoplastic material rated for 90 degrees Celsius dry locations, 75 degrees Celsius wet locations, THHN/THWN or XHHW, per ANSI/NFPA 70 and compliant with UL 83. Circuit identification shall consist of Method 1 - color coding in accordance with ICEA S-66-524, Appendix K Table K-2.

D. Instrumentation and control cable connected to equipment or devices within control panels shall be sized per requirements of equipment manufacturer (minimum #16 AWG).

2.5 INDUSTRIAL ETHERNET CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirement, provide products by one of the following:

1. Belden, Inc.
2. Merk-Tek Leviton.
3. General Cable; General Cable Corporation.
4. Southwire Company.
5. CommScope, Inc.

C. Standard: Comply with TIA-568-C.2 for Category 5e cables, UL 444, RoHS 2 (2011/65/EU)

D. Conductors: 100-ohm, 24 AWG solid.

E. Shielding / Screening: Aluminum Foil 100% Coverage with Tinned Copper Braid 70% Coverage.

F. Cable Rating: CMR.

G. Jacket: Colored Teal or Blue made of Industrial Grade PVC, TPU, or TPE.

2.6 WIRING CONNECTORS

Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

A. Split Bolt Connectors:

1. FCI Burndy Corp.
2. Cooper Crouse Hinds.
3. O.Z./Gedney Co.
4. Thomas & Betts Co.
5. 3-M Co.

B. Solderless Pressure Connectors:

1. FCI Burndy Corp.
2. Ideal Industries Co.
3. Thomas & Betts Co.
4. 3-M Co.

C. Spring Wire Connectors:

1. Ideal Industries Co.
2. 3-M Co.

D. Compression Connectors:

1. FCI Burndy Corp.
2. Thomas & Betts Co.
3. 3-M Co.

2.7 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

2.8 WIRE COLOR CODE

A. Color-code all conductors:

1. Wire sizes No. 10 AWG and smaller shall have integral color-coded insulation.
2. Wire sizes No. 8 AWG and larger may have black insulation but shall be identified by color-coded electrical tape at all junction, splice, pull, or termination points.
3. Color tape shall be applied to at least 3 inches of the conductor at the termination ends and in junction or pull boxes or where readily accessible.
4. Conductors for all systems shall not change color at splice points.
5. Where there are two or more neutrals in one conduit, each shall be individually identified with the proper circuit.
6. For No. 4 AWG and larger ground conductors, identify with green tape at both ends and all visible points, included in all junction boxes.
7. Each phase wire shall be uniquely color-coded as indicated below:

120/240-Volts	120/208-Volts	277/480-Volts
Phase A - Black	Phase A – Black	Phase A - Brown
Phase B – Red	Phase B – Red	Phase B - Orange
Neutral - White	Phase C – Blue	Phase C - Yellow
Ground - Green	Neutral – White	Neutral - White or Natural Gray
	Ground - Green	Ground - Green

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

C. Verify that raceway installation is complete and supported as required by the specifications.

3.2 PREPARATION

A. Test raceway with a mandrel and thoroughly swab out to remove foreign material before pulling cables.

B. For conduits sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel.

C. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. Then draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel.

3.3 EXISTING WORK

A. Disconnect and remove exposed and/or abandoned wire and cable. Patch surfaces where removed cable pass through building finishes.

B. Disconnect abandoned circuits and remove wire and cable. Remove abandoned boxes if wire and cable servicing them is abandoned and/or removed. Provide blank cover for abandoned boxes that are not removed.

C. Ensure access to existing wiring connections which remain active and which require access. Modify installation or provide access panel as appropriate.

D. Extend existing circuits using materials and methods and compatible with existing electrical installations, or as otherwise specified.

E. Tag and repair existing wire and cable that remain or are being reused.

3.4 INSTALLATION

A. General:

1. Install wire and cable in accordance with manufacturer's instructions and NECA “Standard of Installation”.
2. Route wire and cable as required to meet project conditions.
3. Identify and color code wire and cable. Identify each conductor with its circuit number or other designation indicated.
4. Protect exposed cable from damage.
5. Pull all conductors into raceway at same time.
6. Use suitable wire pulling lubricant for building wire No. 4 AWG and larger. Lubricant shall not be deleterious to the cable sheath, jacket or outer covering.
7. Do not exceed cable manufacturer’s recommended pulling tension limits when installing wire or cable.

8. Support cables above accessible ceiling using standard support methods to support cables from structure. Do not rest cable on ceiling panels.
9. Neatly train and lace wiring inside boxes, equipment, and panelboards

B. Conductor material applications:

1. Feeders: Copper, stranded. Aluminum by prior approval only.
2. Branch Circuits: Copper, stranded. Aluminum not allowed.

C. Cable and Wire Size:

1. Conductor sizes are based on copper unless specifically indicated as aluminum or “AL”.
2. Use conductor no smaller than No. 12 AWG for power and lighting circuits.
3. Use conductor no smaller than No. 14 AWG for control circuits.
4. Use No. 10 AWG conductors for 20 ampere, 120-volt branch circuits longer than 75 feet.
5. Use No. 10 AWG conductors for 20 ampere, 277-volt branch circuits longer than 200 feet.
6. Use stranded conductor for all feeders, branch and control circuits.

D. Installation of conductors and cables:

1. Install conductors/cables in raceways as indicated, unless otherwise indicated.
2. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Connections

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
2. Make splices, terminations, and taps that are compatible with conductor material
3. Wiring at Outlets: Install conductor at each outlet, with at least 6 of slack.

F. Cable Identification

1. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
2. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

G. Sleeve and sleeve-seal installation for electrical penetrations

1. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

H. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors. Where an anti-oxidation lubricant is used, apply liberally, coating all exposed conductor surfaces.
2. Use suitable cable fittings and connectors.
3. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
4. Use split bolt connectors for copper conductor splices and taps, No. 8 AWG and larger.
5. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, No. 8 AWG and smaller.
6. Tape un-insulated conductors and connector with two layers of half-lapped rubber insulating compound tape and two layers of half-lapped, 7-mil electrical tape, Scotch 33+, or equal.
7. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, No. 10 AWG and smaller.
8. Stranded conductors for control circuits shall have fork or ring terminals crimped on for all device terminations. Bare stranded conductors shall not be placed directly under the screws.

3.5 INSTRUMENTATION CABLE INSTALLATION

A. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.

B. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

C. Separation from EMI Sources:

1. Installation of Control-Circuit Conductors: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: minimum 5- inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: minimum 12-inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: minimum 24- inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: minimum 2- 1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: minimum 6-inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: minimum 12- inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: minimum 3-inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: minimum 6- inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: minimum 48-inches.
6. Separation between Communications Cables and Fluorescent Fixtures: minimum 5-inches.

3.6 FIELD QUALITY CONTROL

A. Field inspection and test shall be performed under provisions of ANSI/NETA ATS Section 7.3.2 - Low Voltage Cables, 600-Volt Maximum as follows.

1. Visual and Mechanical Inspection:
   a. Compare cable data with drawings and specifications.
   b. Inspect exposed sections of cable for physical damage and correct connection in accordance with single-line diagram.
   c. Inspect all bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohm-meter in accordance with ANSI/NETA section 7.3.2.2 (Electrical Tests).
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data from ANSI/NETA ATS Table 100.12.
   d. Inspect compression-applied connectors for correct cable match and indentation.
   e. Verify cable color coding with applicable specifications and National Electrical Code.
2. Electrical Tests

   Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.

   Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable, in accordance with Section 7.3.2.1 (Visual and Mechanical Inspection).

   Perform continuity test to insure correct cable connection.

   Correct malfunctions and/or deficiencies immediately as detected at no additional cost to the District, including additional verification testing.

   Subsequent to final wire and cable terminations, energize all circuitry and demonstrate functional adequacy in accordance with system requirements.
3. Test Values

   Compare bolted connection resistance to values of similar connections.

   Bolt-torque levels should be in accordance with ANSI/NETA ATS Table 100.12 unless otherwise specified by the manufacturer.

   Micro-ohm or milli-volt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer’s published data. If manufacturer’s data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

   Minimum insulation-resistance values should not be less than 50 meg-ohms.

   Investigate deviations between adjacent phases.

END OF SECTION 260519

SECTION 260526 - BASIC ELECTRICAL MATERIALS, METHODS AND GROUNDING

PART 1 GENERAL

1.1 SUMMARY

A. This section includes:

1. Furnishing of grounding electrodes and conductors; equipment grounding conductors; grounding of chain link fences and gates; bonding methods and materials; conduit and equipment supports; anchors and fasteners; sealing and fireproofing of sleeves and openings between conduits and wall.
2. Inspection and testing of the Grounding and Bonding System; and Ground-Fault Protection Systems.

1.2 RELATED SECTIONS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables

B. Section 260533 - Raceway and Boxes

C. Section 260553 - Electrical Equipment Identification

D. Section 262416 - Panelboard and Circuit Breaker

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The standards referenced herein, except as modified in the Contract Documents, shall have full force and effect as though included in these Specifications. These standards are not furnished to the Contactor since manufacturers and trades involved are assumed to be familiar with these requirements. The Contractor shall obtain copies of reference standards direct from publication sources as needed for proper performance and completion of the work.

1. ASTM B187 Specifications for Copper Bus, Rod, and Shapes.
2. ASTM A653 Standard Specifications for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by Hot Dip Process
3. IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
4. IEEE 1100 Recommended Practice for Powering and Grounding Electronic Equipment.
5. NECA (National Electrical Contractors Association) – Standard of Installation.
6. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
7. NFPA 70 National Electrical Code (NEC). Latest edition adopted by the State of California (CEC).
8. UL 467 Electrical Grounding and Bonding Equipment.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

1.5 SYSTEM DESCRIPTION

A. Grounding electrode system consist of the following elements:

1. Metal underground water pipe
2. Metal frame of the building
3. Concrete encased electrode
4. Metal underground gas piping system
5. Rod electrodes
6. Service equipment
7. Enclosures
8. Separately derived systems.

B. Anchor and fasten electrical products to building elements and finishes as follows:

1. Concrete Structural Elements: Provide preset inserts.
2. Concrete Surfaces: Provide epoxy or expansion anchors.
3. Interior Structural Steel: Provide appropriate size beam clamps.
4. Solid Masonry Walls: Use expansion anchors and preset inserts.
5. Sheet Metal: Provide sheet metal screws.

1.6 DESIGN REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for purpose specified and shown.

B. Grounding shall be in accordance with the National Electrical Code (NEC). Where size, type, rating and quantities indicated or specified are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Select materials, sizes, and types of anchors, fasteners, and supports to carry at least twice the loads of equipment and raceway, including weight of wire and cable in raceway.

1.7 CONTRACTOR SUBMITTALS

A. Product Data:

1. Submit product data for grounding electrodes and connections for fastening components; fire stopping material; and fireproofing sealants.

B. Test Report:

1. Power System Study: Provide five (5) bound copies of the short circuit fault study, equipment interrupting and withstand capabilities, and a protective device coordination study for Owner's Representative's Review.
2. Grounding & Bonding: Provide certified test report for Owner's Representative's Review.
3. Ground-Fault Protection System: Provide certified test report for Owner's Representatives Review.

1.8 CLOSEOUT SUBMITTALS

A. Record actual locations of components and grounding electrodes.

B. Submit final one (1) electronic copy on CD-ROM and certified, five (5) bound copies of the Power System Study report.

C. Submit final certified five (5) copies of the test reports of all grounding tests and ground-fault protection systems.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five (5) years' experience.

B. Installer: A firm with at least five (5) years of installation experience on projects with electrical grounding work similar to that required for this project.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

B. Field testing shall be performed by a third party testing firm with certification from a recognized testing agency, with a minimum of five (5) years of testing experience.

PART 2 PRODUCTS

2.1 GROUNDING SYSTEM

A. Except as indicated elsewhere, provide materials for electrical grounding system, including, but not limited to, cables, wires, connectors, terminals (solderless lugs) and exothermic welds, grounding rods and electrodes, bonding jumper and braided straps, and other items and accessories required for a complete installation. Where more than one type of material or equipment meets indicated requirements, selection shall be at Installer's option. Where materials or components are not otherwise indicated, provide products as recommended by the accessories manufacturers and in compliance with the NEC and established industry standards.

B. All grounding materials required shall be furnished new and undamaged in accordance with the requirements of these specifications.

2.2 WIRE

A. Service Equipment Grounding Electrode Conductor: Bare, soft-drawn copper, Class AA stranding, ASTM B8. Size per NEC Table 250-66, unless otherwise noted.

B. Electrical Equipment Grounding Conductor: Insulated, soft-drawn copper, Class B stranding or solid, with green colored polyvinyl chloride insulation per Section 260519. Size per NEC Article 250-122, unless otherwise noted.

C. Uninsulated Conductors: Bare Copper wire or cable, suitable for direct burial unless otherwise required by applicable Code or authorities having jurisdiction. Aluminum not acceptable.

D. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction. Aluminum not acceptable.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.

2.3 BUS AND BARS

A. Silver plated, soft copper with cross section not less than 1 square inch per 1,000 ampere rating, but in no case less than 1/4-inch thick by 1-inch wide, ASTM B187. Rating shall be per the NEC, unless otherwise noted.

2.4 EXOTHERMIC WELD CONNECTIONS

A. Exothermic materials, accessories and tools for preparing and making permanent field connections between grounding system components. Molds, cartridges, materials, and accessories as recommended by the manufacturer of the molds for the items to be welded.

B. Manufacturer:

1. Cadweld (Erico Products) "Exolon" Low Emission. Molds and powder shall be furnished by the same manufacturer.
2. Acceptable equal.

2.5 MECHANICAL CONNECTORS

A. Mechanical connectors shall be permitted only when exothermic weld connections are not suitable or recommended by the manufacturer.

B. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolt-on bronze connectors, suitable for grounding and bonding applications in configurations required for the particular installation.

D. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

E. Pipe Connectors: Clamp type, sized for pipe.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

G. Compression Grounding Conductors: Compression grounding connectors shall be suitable for the intended use; shall be suitable for direct-burial and embedded applications; and shall be designed for connecting to copper and copper-clad conductors, both stranded and solid, and to copper-clad, galvanized, and stainless steel ground rods.

H. Connectors shall be pre-filled with corrosion-inhibiting compound, which is compatible with the conductors being joined.

I. Connectors shall meet the requirements of IEEE standard 837 (latest revision), and shall meet UL standards for direct burial in earth and embedment in concrete.

J. Connectors shall be selected and installed according to the recommendations of the manufacturer.

K. Compression grounding connectors shall be Burndy “Hyground”, or equal.

L. Manufacturer

1. Burndy Corp.
2. Anderson
3. Thomas & Betts
4. 3-M Co.

2.6 FLUSH GROUND PLATES

A. Cadweld B-162 series, B-164 series, or acceptable equal.

2.7 FLEXIBLE JUMPER STRAP

A. Flexible flat conductor, 480 strands of 30-gauge, bare copper wire; ¾-inch width, 9-1/2-inch-long; 48.25 kcMil, minimum. Protect braid with copper bolt-hole ends with holes sized for 3/8-inch diameter bolts.

2.8 BONDING PLATES, CONNECTIONS, TERMINALS AND CLAMPS

A. Provide electrical bonding plates, connectors, terminals and clamps, and accessories as recommended by the manufacturer for the specific applications. Components shall be high-strength, high-conductivity copper alloy.

2.9 UFER GROUND

A. In accordance with the latest edition of the National Electrical Code.

2.10 ROD ELECTRODES

A. Copper-clad steel, 5/8-inch minimum diameter, 10 feet long, coupling type unless otherwise noted.

2.11 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches NPS (DN200) by maximum 12 inches (300-mm) long, precast concrete or fiberglass pipe with belled end.

B. Well Cover: Cast iron, high impact traffic rated cover with legend "GROUND" embossed on outer face.

2.12 ANCHORS AND FASTENERS

A. Indoor Locations: Epoxy type anchors and heavy-duty, galvanized steel screws and bolts.

B. Outdoor Locations: Epoxy type or Red Head anchor bolts and stainless steel screws and bolts.

2.13 SUPPORT CHANNEL

A. All conduit and electrical equipment support channels for interior, exterior, wet and corrosive areas shall be galvanized steel or 316 Stainless steel.

B. Support channels for free standing electrical equipment such as switchgear, switchboard and motor control centers, shall be:

1. Indoors: galvanized steel channel and hardware, minimum 12 gauge, ASTM A653 Grade 33 sheet steel, zinc coated by hot dip process, or 316 Stainless steel if supporting stainless steel equipment.
2. Outdoors: 316 Stainless steel

2.14 SEALING AND FIREPROOFING

A. Furnish UL listed products or products tested by a nationally recognized independent testing laboratory. Select products with rating not less than the rating of the wall, ceiling or floor being penetrated.

B. Manufacturers:

1. 3M CP 25WB + Caulk
2. 3M FS 195 wrap or strip with restricting collar
3. 3M CS 195 composite sheets
4. Proset Systems fire rated floor and wall penetrations
5. Dow Corning Fire Stop System
6. Substitutions not permitted.

C. Use stamped steel, chrome plated, hinged, split ring escutcheons or floor/ceiling plates for covering openings in occupied areas where conduit is exposed.

D. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the cored opening or a water-stop type wall sleeve.

E. At non-rated interior wall or floor openings use Tremco Fyre-Sil, Sika Corp. Sikaflex la, Sonneborn Sonolastic NPT, or Mameco Vulkem 116 urethane caulk or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

3.2 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

B. Extend existing grounding system using materials and methods as specified.

C. Install temporary wiring and connections to maintain existing grounding systems in service during construction.

D. Perform work on energized equipment or circuits with experienced and trained personnel following all safety rules and procedures.

E. Remove, relocate, and extend existing installations to accommodate new construction.

F. Repair adjacent construction and finishes that are damaged during demolition and extension work.

G. Remove exposed and/or abandoned grounding and bonding components, fasteners, supports and electrical identification labels. Cut embedded support elements below surface of walls and floors. Patch surfaces damaged by removal of existing components to match surrounding finishes.

3.3 GROUNDING AND BONDING INSTALLATION:

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

B. Install grounding well with cover at rod locations as indicated on Drawings. Install well top flush with finished grade.

C. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

F. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Use exothermic-welded connectors for outdoor locations; but if a disconnect-type connection is required, use a bolted clamp.

G. Installation:

1. Remove paint, rust, mill-oils, and surface contaminants at connection points.
2. Install grounding electrode conductor and connect to reinforcing steel in slab or foundation.
3. Bond together metal siding not attached to grounded structure; bond to ground.
4. Bond together reinforcing steel and metal accessories.
5. Connect to site grounding system.
6. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
7. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panel boards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
8. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel in accordance with IEEE 1100.
9. Accomplish grounding of electrical system by installing insulated grounding conductor with each feeder and branch circuit conductor in conduit. Install separate insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Size grounding conductor in accordance with the NEC.
10. Install grounding conductor from ground bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes, and metal enclosures of service equipment.
11. Bond all metallic conduits to grounding bus at service panel by means of grounding bushings using minimum No. 12 AWG conductor.
12. Ground electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC. Bond together each metallic raceway, pipe, duct and other metal object entering enclosures and exiting slabs.
13. Permanently bond all equipment, grounding conductors, lightning protection system and grounding system prior to energizing equipment.

3.4 GROUND CONDUCTORS

A. Insulated conductors: Install solid for 6AWG and smaller and stranded conductors for 4AWG and larger unless otherwise indicated.

B. Uninsulated conductors: Install stranded #4/0 for ground grid. Install #2/0 for bonding conductors' equipment-to-ground grid.

C. Grounding conductors shall be located and connected as indicated on drawings or as required by Code.

D. Ground conductors under buildings or structures shall be buried with at least 6 inches of earth cover. Buried grounding conductors extending beyond the foundations of buildings or structures shall have at least 18 inches of earth cover.

E. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to dominant surfaces.

F. Conductors routed over concrete, steel, or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not to exceed 3 feet.

G. Conductors passing through floor slabs shall be installed in conduit sleeves that extend above the floor slab, a minimum of 1-1/2 inches to provide protection. Sleeves shall be sealed to maintain fireproof integrity.

H. Provide isolated grounding conductor for circuits supplying equipment and systems as shown on the drawings.

I. Provide a separate equipment-grounding conductor for low voltage distribution systems, single or three phase feeder circuit and each branch circuit with single or three phase protective devices. Install a grounding conductor in conduit with phase and neutral conductors. Single-phase branch circuits for 120 and 277 volt lighting, receptacles, and motors shall have a phase, neutral, and ground conductors installed in the common conduit. Provide suitable bonding jumpers and approved grounding type bushings for flexible conduits used for equipment connection utilized in conjunction with the above branch circuits. Single-phase circuits for equipment and all branch circuits installed in non-metallic or flexible conduits shall be provided with a separate grounding conductor.

J. Ground the neutral of separately derived systems with a bare copper conductor, installed in conduit, from the neutral directly to the building interior cold water pipe or nearest solidly grounded structural reinforcing steel, in accordance with the provisions of NEC Article 250-24. Use bolted accessible connections to the ground system so that the neutral ground can be disconnected for test. Ground the system ground conduit as detailed on drawing. Size the grounding electrode conductors in accordance with the NEC Table 250-66, or as indicated.

3.5 CONNECTIONS

A. All connections shall be made by the exothermic welding process, except where otherwise indicated. The manufacturer's instructions on the use of exothermic welding materials shall be followed in all

details. Powder and molds shall be kept dry and warm until use. Worn or damaged molds shall not be used.

B. All surfaces to be joined by the welds shall be thoroughly cleaned. Paint, scale, and other deleterious substances shall be removed from surfaces of ungalvanized structural steel members by grinding. Galvanized steel surfaces shall be cleaned with emery paper.

C. All exothermic welded connections shall successfully resist moderate hammer blows. Any connection which fails such test or which, upon inspection, indicates a porous or deformed weld, shall be remade.

D. All exothermic welds shall encompass 100 percent of the ends of the materials being welded. Welds, which do not meet this requirement, shall be remade.

E. Worn, damaged, incorrectly sized, or improperly shaped molds which, in the opinion of the Owner's Representative, do not make satisfactory welds, shall be removed from the jobsite after being physically rendered inoperable.

F. All contact surfaces of bolted and screwed connections shall be thoroughly cleaned and coated with oxide inhibitor before being securely tightened.

3.6 CONDUIT GROUNDING

A. All grounding bushings within all enclosures, including equipment enclosures, shall be wired together and connected internally to the enclosure grounding lug or grounding bus with a bare copper conductor. Grounding bushings shall be grounded with conductors sized in accordance with NEC, but not smaller than No. 8 AWG.

3.7 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Comply with NEC 250, except where larger sizes or more conductors are indicated.

1. All electrical equipment shall be connected to the grounding system with an insulated, green, stranded or solid copper equipment-grounding conductor.
2. Terminate each end on suitable lug, bus, or bushing. The term "electrical equipment", as used in this article, shall include, but not be limited to, all enclosures containing electrical connections or bare conductors, except that individual devices, such as solenoids, pressure switches, and limit switches, shall be exempt from this requirement, unless the device requires grounding for proper operation.
3. Large equipment, such as metal-clad or metal-enclosed switchgear, will be furnished with a grounding bus that shall be connected to the grounding system.
4. Most other equipment will be furnished with grounding pads and/or grounding lugs which shall be connected to the grounding system. All ground connection surfaces shall be cleaned immediately prior to connection.
5. Contractor shall furnish all grounding material required, if not furnished with the equipment.

C. Install equipment grounding system such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits will operate continuously at ground potential and provide a low impedance path for possible ground fault currents.

D. Where grounding system extension stingers are indicated on the drawings to be provided for connection to electrical equipment, the Contractor shall connect the bare grounding conductor to the equipment ground bus, pad, or lug. Except where otherwise indicated on the drawings, all equipment ground conductors that are not an integral part of a cable assembly, shall be sized in accordance with the requirements of NEC. All ground conductors installed in conduit shall be insulated.

E. Suitable grounding facilities, acceptable to the Owner's Representative, shall be furnished on electrical equipment not so equipped. The grounding facilities shall consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

F. The conduit system is not considered to be a grounding conductor, except for lighting fixtures. No grounding conductor shall be smaller in size than No. 12 AWG, unless it is a part of an acceptable cable assembly.

3.8 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.9 GROUND SYSTEM RESISTANCE

A. Ground resistance of the system shall be no greater than five (5) ohms.

3.10 ANCHORS, FASTENERS AND SUPPORT

A. Installation:

1. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
2. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
3. Do not use spring steel clips and clamps.
4. Do not use powder-actuated anchors.
5. Do not drill or cut structural members.

B. Supports:

1. Fabricate supports from structural steel or formed steel members. Rigidly weld members or install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface-mounted cabinets and panel board with minimum of four (4) anchors.
3. Use steel channel supports to stand cabinets and panel boards one (1) inch off wall.
4. Use sheet metal channel to bridge studs above and below cabinets and panel boards recessed in hollow partitions.

3.11 SEALING AND FIREPROOFING

A. Fire-Rated Surface:

1. Where conduit penetrates fire rated surface, install fire-stopping product in accordance with manufacturer's published instructions.
2. All openings through fire rated wall, floor, ceiling or roof must be sealed.
3. Install galvanized sheet metal sleeves (minimum 12-gage) through opening and extending beyond minimum of one (1) inch on each side of building element.
4. Pack void between sleeve and building element with backing material.
5. Seal ends of sleeve with UL listed fire-resistive silicone compound to meet fire rating of structure penetrated.

B. Non-Rated Surfaces:

1. Opening through a non-fire rated wall, floor, ceiling or roof must be sealed using an approved type of material.
2. Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.
3. Install escutcheons or floor/ceiling plates where raceway, penetrates non-fire rated surfaces in occupied spaces.
4. Install rubber links of mechanical seal tightened in place and sized for the pipe, in exterior wall openings below grade, in accordance with the manufacturer's instructions.
5. All pipe penetrations at interior partitions and/or walls, laboratory spaces, telephone, data and communication rooms and similar spaces where the room pressure or odor transmission must be controlled, shall be sealed. Sealant shall be applied to both sides of the penetration in such a manner that the annular space between the pipe sleeve and the pipe is completely filled.

3.12 ACCEPTANCE TESTING

A. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

B. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

C. Grounding and Bonding: Perform inspections and tests as outlined below (ANSI/NETA ATS Section 7.13 – Grounding Systems).

1. Visual and Mechanical Inspection
   a. Verify ground system is in compliance with drawings and specifications.
2. Electrical Tests
   a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Ground System." on the main grounding electrode or system. Instrumentation utilized shall be as defined in section 12 of the above guide and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that the plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.

b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
c. When sufficient spacing of electrodes per Electrical Tests is impractical, perform ground impedance measurements utilizing either the intersecting curves method or the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81).
d. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.
e. Test shall be performed after a minimum of ten (10) calendar days of dry weather so that the ground is not wet.

3. Test Values
   a. The resistance between the main grounding electrode and ground shall be greater than five (5) ohms for commercial or industrial systems and one (1) ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference: ANSI/IEEE Standard 142.) Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.
   b. Investigate point-to-point resistance values which exceed 0.5 ohm.

END OF SECTION 260526

SECTION 260533 - RACEWAYS AND BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes all raceways not limited to conduit and tubing, surface and buried raceways, wireways, outlet boxes, pull boxes, junction boxes, hand holes and concrete manholes.

1.2 RELATED SECTIONS

A. Section 260500: Common Work Results for Electrical

B. Section 260519: 600-Volt Power Conductors and Cables

C. Section 260526: Grounding and Bonding for Electrical Systems

D. Section 260553: Identification for Electrical Systems

1.3 REFERENCES - CODES AND STANDARDS

A. ANSI C80.1 Rigid Steel Conduit, Zinc Coated.

B. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.

C. ANSI C80.6 American National Standard for Electrical Intermediate Metal Conduit.

D. ASTM A48 Standard Specification for Grey Iron Castings.

E. NECA (National Electrical Contractor's Association) – "Standard of Installation."

F. NEMA FB 1 (National Electrical Manufacturers Association) – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

G. NEMA OS 1 (National Electrical Manufacturers Association) – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

H. NEMA OS 2 (National Electrical Manufacturers Association) – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

I. NEMA RN 1 (National Electrical Manufacturers Association) – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

J. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Conduit.

K. NEMA TC 3 (National Electrical Manufacturers Association) – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

L. NEMA TC 6 - Non-Metallic Conduit.

M. NEMA TCB 2(National Electrical Manufacturers Association) - Guidelines for the Selection and Installation of Underground Nonmetallic Raceways

N. NEMA 250 (National Electrical Manufacturers Association) – Enclosures for Electrical Equipment (1,000 Volts Maximum).

O. NETA (International Electrical Testing Association) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

P. NFPA 70 National Electrical Code (NEC). Latest approved edition

Q. NICET (National Institute for Certification in Engineering Technologies).

R. UL 1 Flexible Metal Conduit

S. UL 6 Rigid Metal Conduit

T. UL 514B Conduit, Tubing and Cable Fittings.

U. UL 651 Rigid Non-Metallic Conduit

V. UL 797 Electrical Metallic Tubing

W. UL 1242 Intermediate Metal Conduit

1.4 SYSTEM DESCRIPTION

A. Raceway, boxes and manholes located as indicated on drawings and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway, boxes and manholes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

C. In Slab above Grade: Provide galvanized rigid steel conduit. Provide cast or concrete-tight sheet metal boxes.

D. Exposed Dry Locations: Provide galvanized rigid steel conduit. Provide cast metal boxes.

E. Concealed Dry Locations: Provide electrical metallic tubing. Provide cast or sheet metal boxes.

F. Locations subject to Corrosive Atmospheres (chemical storage rooms, coastal areas, highly alkaline environments, etc.): Provide PVC coated, galvanized rigid steel or intermediate steel conduit. Provide PVC coated cast or sheet metal boxes.

G. Hazardous Locations (Per NEC Article 500): PVC Coated rigid metallic conduit. Cast malleable iron boxes with threaded hubs for conduit entry. Provide properly installed conduit seals at hazardous boundaries.

1.5 CONDUIT APPLICATION

A. Acceptable raceway systems and their limitations of use are summarized in the following table:

Location	**RMC**	**SSRC**	**RNC**	**LFMC**
Exterior locations: Wet or subject to physical damage.	Yes	Yes	No	No (note 3)
Exterior locations: Damp and not subject to physical damage.	Yes	Yes	No	Yes
Interior locations: Wet or subject to physical damage.	Yes	Yes	No	No (note 3)
Interior locations: Exposed and not subject to physical damage.	Yes	Yes	No	Yes
Interior locations: Totally concealed.	Yes	No	No (note 4)	Yes
Underground:	Yes	No	Yes	No

B. Notes for Conduit Application Table:

1. RMC = rigid metallic conduit, SSRC = stainless steel rigid conduit; RNC = rigid nonmetallic conduit, LFMC = liquid-tight flexible metal conduit.
2. For the purposes of these specifications, locations subject to physical damage include, but are not limited to, those areas less than 6 feet above the finished floor or grade.
3. Stainless steel conduit is required in vaults and exposed aboveground areas on the reservoirs.
4. Liquid-tight flexible metal conduit may also be use in wet or damp, exterior or interior locations not subject to physical damage, where used for flexible equipment connections in lengths not exceeding 3 feet.
5. Rigid nonmetallic conduit may also be used above grade, where totally concealed in walls, for transitions from underground up to a height of 24 inches above the concrete sill.
6. The use of liquid-tight flexible metal conduit is limited to lengths not exceeding 6 feet for flexible connections to equipment and lighting fixtures, or where necessitated by structural obstacles and explicitly approved by the Owner's Representative.

1.6 BOX APPLICATION

A. Provide raceway, boxes and manholes located as indicated on drawings and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements and for a complete wiring system.

1.7 CONDUIT SIZE

A. Minimum acceptable conduit sizes are summarized in the following table:

	Minimum Size
Underground, site wiring	1”
Underground • Building wiring Aboveground • Equipment or panel feeders • Telecommunications	3/4”
Aboveground • Lighting or branch circuit wiring • Fire alarm • Security	3/4”
Other	3/4”

1.8 SUBMITTALS

A. Manufacturer’s Installation Instructions: Submit application conditions and limitations of use stipulated by product testing agency having jurisdiction. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

B. Submit detailed conduit routing plan, for review and approval, prior to installation as follows:

1. Exposed and/or concealed in building walls for conduits larger than 2-inch outside diameter.
2. All underground conduits (3/4-inch and larger) whether run alone or in duct banks; concealed in floor slabs, equipment pads and concrete slabs.

C. Product Data: Submit for the following:

1. Rigid Metallic Conduit.
2. Stainless steel rigid conduit
3. Liquid tight flexible metal conduit (LFMC).
4. Nonmetallic conduit.
5. Raceway fittings.

6. Conduit bodies.
7. Surface raceway.
8. Pull boxes, junction boxes and manholes.

D. Manufacturer's Installation Instructions:
1. Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
2. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
3. In accordance with Division 01 submittal procedures.

1.9 CLOSEOUT SUBMITTALS

A. Project Record Documents:

1. Accurately record actual routing of conduits. Provide record (as-built) drawings marked in red to show actual routing of the underground raceway and cable when different from the original contract drawings. Prepare on new, clean set of contract drawings.
2. Record actual locations and mounting heights of outlet, pull boxes, junction boxes and manholes.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect all raceways and conduits from corrosion and entrance of debris by storing above grade with adequate support to prevent sagging or bending over time and provide appropriate covering from weather and direct sunlight.

PART 2 PRODUCTS

2.1 CONDUIT

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Rigid Metallic Conduit (RMC), couplings and elbows shall be hot-dip galvanized, rigid mild steel in accordance with ANSI C80.1 and UL 6A. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent overcoat of enamel, lacquer, or zinc chromate. Conduit shall be formed with continuous welded seams with a uniform wall thickness, in minimum 10-foot lengths, with threaded ends.

C. Stainless Steel Rigid Conduit (SSRC), couplings and elbows shall be 316L stainless steel conduit to ASTM A312, to meet the demands of a corrosive environment in accordance with ANSI C80.1 and UL 6A. The conduit interior and exterior surfaces shall be polished to a standard "brite" finish to increase corrosion resistance. Conduit shall be formed with continuous welded seams with a uniform wall thickness, in minimum 10-foot lengths, with standard NPT threaded ends.

D. Liquid-Tight Flexible Metal Conduit (LFMC) shall be plastic-jacketed, galvanized steel, "Sealtite" Type EF for general service areas or Type HC for high-temperature when used under raised floor or in air plenums. LFMC shall not be used as a substitute for factory made elbows, or field made bends expected of a journeyman electrician. Conduit shall be UL listed.

E. Non-Metallic Conduit shall be as follows:

1. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Schedule 40: Conduit shall be 90 degree Celsius, polyvinyl chloride in conformance with NEMA TC-2 and UL 651 requirements.
3. Spacers used in duct bank installations shall be high impact plastic, interlocking bases, and intermediate type spacers. Place spacers between 6 and 10 feet apart.

F. Rigid aluminum conduits and flexible aluminum or non-metallic conduits are not permitted on this project, unless specifically required by the Authority Having Jurisdiction.

2.2 RACEWAY FITTINGS

A. Couplings and Thread Protectors. Each length of threaded conduit shall be provided complete from the manufacturer with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage, and shall remain intact on threads until conduit is installed.

B. Metal Conduit Fittings shall conform to the requirements of UL 514B where this standard applies. Galvanized malleable iron or galvanized steel fittings shall be used with steel conduit. Threaded fittings shall engage a minimum of five threads made up wrench-tight and be compatible with conduit. EMT fittings shall be steel compression type, UL approved for rain tight applications and setscrew type with insulated throat for indoor applications.

C. Liquid-Tight Flexible Conduit (LFMC) Fittings shall be galvanized steel, T&B 53XX series insulated throat, and shall bear the UL label. Die-cast malleable fittings are not acceptable.

D. Flexible Metal Conduit (FMC) Fittings shall be galvanized steel similar to T&B “Tite-Bite”.

E. Non-Metallic Conduit Fittings shall be of same material and strength characteristics as the conduit and shall be solvent welded as recommended by manufacturer. End bells shall be plastic, high impact, tapered to fit. Where conduit transition from non-metallic to metallic is required, provide non-metallic female “terminal” adapter. Non-metallic “male” adapters are not acceptable.

F. Special Fittings. Conduit sealing, explosion proof, dust proof, and other types of special fittings shall be provided as required and shall be consistent with the area and equipment with which they are associated. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction. Hazardous area fittings and conduit sealing shall conform to NEC requirements for the area classification.

G. Bushings shall be provided for the termination of all conduits not terminated in hubs, couplings or insulated throat connectors. Grounding type insulated bushings with insulating inserts in metal housings shall be provided for conduit 1-1/4 inches and larger. Standard bushings shall be galvanized steel or malleable iron in all sizes.

H. Locknuts. One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond with the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

I. Connectors and other fittings used for raceway entrances into enclosures shall meet the minimum requirements of the NEMA rating of the enclosure.

J. Unions. Watertight conduit unions shall not be used without approval by the Owner's Representative.

K. Raintight Conduit terminating hubs, where indicated on the drawings or required by these specifications, shall be Myer's rigid conduit hubs, or approved equal.

2.3 CONDUIT BODIES

A. Aluminum conduit bodies shall be die-cast copper-free aluminum alloy A360. Aluminum conduit bodies shall be finished with powder-coated paint. Cover shall be die-cast or stamped aluminum or steel.

B. Malleable iron conduit bodies shall be malleable iron Form 5 or Form 7 with tensile strength meeting ASTM A48, Class 30A requirements. Malleable iron conduit bodies subject to corrosive atmospheres (chemical storage rooms, coastal areas, highly alkaline environments, etc.) shall be finished with an epoxy powder coating. Cover shall be malleable iron.

C. All conduit bodies' entrances shall be machined NPT threads with a smooth, rounded, internal conduit stop bushing.

D. All conduit bodies shall be equipped with a sealed and gasketed cover. Cover shall be secured using stainless steel captive machine screws or stainless steel camming type securing.

E. Conduit bodies shall be selected and installed to provides the most readily accessible cover access.

2.4 CONDUIT SUPPORTS

A. Conduit supports shall be furnished and installed in accordance with other section of these specifications. Conduits shall be supported so that fittings are accessible. Support systems shall be limited to supporting electrical raceways, conduits, and electrical boxes and apparatus only.

B. Hanger rods shall be 3/8-inch diameter galvanized threaded steel rods, minimum. Stainless steel threaded rods shall be used in areas subject to corrosive atmospheres (chemical storage rooms,

coastal areas, highly alkaline environments, etc.). Conduit racks over 18-inch wide, over one level, or supporting 2-inch RSC or larger, shall be 1/2-inch diameter rod minimum.

C. Conduit Clamps. Conduits in single runs or groups of two shall be supported by steel clamps and clamp backs. They shall be galvanized malleable iron or approved equal cast ferrous metal for steel conduit or tubing.

D. Support Channels. Supports for more than one raceway or conduit shall be constructed of formed steel support channels of minimum 1-5/8 inch depth and width (Unistrut, Kindorf, Superstrut, B-Line, Power Strut or approved equal) with associated bolted-type conduit or tubing straps. Support channels shall be zinc plated steel or hot-dip galvanized after fabrication with galvanized steel clips for steel conduit or tubing.

E. Wall Penetrations. All conduits, raceways, cables and sleeve penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed with a UL-approved fire stopping system, in accordance with specification Section 260526 – Basic Electrical Materials and Methods.

2.5 OUTLET BOXES AND SWITCH BOXES

A. Manufacturers: Firms regularly engaged in the manufacturing of electrical raceways of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1 and UL 514A, galvanized flat rolled sheet steel outlet wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.

C. Outlet boxes used in wet outdoor locations, surface mounted shall comply with NEMA FB 1, be cast metal (FS or FD type) with mounting lugs and gasketed covers secured with stainless steel fasteners.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported, per NEC requirements.

F. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, weatherproof cable strain reliefs, and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and meeting requirements of individual wiring situations.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

2.6 PULL BOXES, JUNCTION BOXES, HANDHOLES AND MANHOLES

A. Sheet Metal Boxes shall be NEMA OS 1, NEMA rating as indicated on drawings. Minimum 16 gauge galvanized steel construction with stainless steel hinged cover and neoprene gasket. Cover shall be secured to the body with a continuous, full length, piano type hinge and stainless steel pin on one side and captive stainless steel screw on the other side. Door shall be equipped with padlock hasp with sealing hole provisions.

1. Provide #10-32 tapped collar studs for optional ground lug kit.
2. Provide 3/8-16 tapped collar studs for mounting optional panel.
3. Provide external mounting feet for secure wall mounting.
4. Finish: Wash and phosphate undercoat with ANSI 61 gray polyester power finish.

B. Surface-Mounted Cast Metal Box: NEMA 250, NEMA Type 3R or 4 as indicated, flat-flanged, surface- mounted junction box:

1. Material: Malleable iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

C. Stainless Steel Boxes: NEMA 4X. minimum 14 gauge, 316 stainless steel, continuously welded and gasketed. Electro polish surface resistant to impacts of up to 7 Nm. Continuous closed cell neoprene gasket. All hardware shall be 316 Stainless Steel.

D. Concrete pull boxes, vaults and hand holes for power, lighting, controls and telecommunications shall be pre-cast concrete boxes, sized as indicated on the drawing. Pull boxes shall be equipped with a concrete cover for non traffic rated locations OR cast-in frame, galvanized steel, adjustable, high impact traffic cover (H-20 load rated), sump, lifting lugs, and conduit knock-outs as indicated on the drawings. Knockout location and sizes shall be coordinated with the duct bank for each location. Cover shall be engraved with the words - – “POWER”, “LIGHTING”, “CONTROLS”, COMM/DATA”, “TELEPHONE” or similar as applicable.

E. Concrete manholes for buried power (MH-P-xx) and control (MH-C-xx) conduits shall be pre-cast concrete vault. Hand hole or splice box for buried power (MH-P-xx) and control (MH-C-xx) conduits shall be pre-cast concrete Fiberglass-Reinforced-Plastic box.

1. Manufacturer: Utility Vault, Oldcastle, or approved equal.
2. Size shall be indicated on the drawings.
3. Pull boxes, Vaults and Manholes shall be equipped with:
    a. Galvanized steel covers for non-traffic rated locations and cast-in frame, galvanized steel, adjustable, high impact traffic cover (H-20 load rated) for traffic rated locations.
    b. Sump, lifting lugs, conduit knock-outs, pick holes, bolt down holes in cover plate, and pull irons. Knockout location and sizes shall be coordinated with the duct bank for each location. HDG cable racks shall be provided as required to support the cables in the pull box. Cover shall be engraved with the words “POWER”, “LIGHTING”, or “CONTROLS” as applicable.

2.7 CLOSURE FOAM

A. All conduit, raceways, cables and sleeves penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed by closure foam as in Dow Corning #3-6548 silicone RTV, GR RTV 850 silicone foam, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough in.

3.2 EXISTING WORK

A. Extend existing raceway and box installations using materials and methods compatible with and consistent to existing electrical installations, or as indicated on drawings.

B. Clean and repair existing raceway and boxes that are to remain, or to be reused, or are to repurposed.

3.3 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: RMC. Galvanized Rigid Steel Conduit or IMC by permission of the Construction Manager.
2. Concealed Conduit, Aboveground: RMC or IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4X.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: RMC.
2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
3. Boxes and Enclosures: NEMA 250, Type 1.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 1.

2. Stainless steel rigid conduit: Use threaded stainless steel conduit fittings or malleable cast steel fittings unless otherwise directed. Ensure materials will not be electrolytically incompatible.
3. Liquid-tight Flexible Conduit: Use only fittings listed for use with Liquid-tight flexible metal conduit. Comply with NEMA FB 1 and UL 514B.

3.4 INSTALLATION OF RACEWAYS

A. Routing

1. Install raceway and boxes in accordance with NEC 110-12 Mechanical Execution of Work including but not limited to complying with those standards mentioned in the Informational Note. Accepted industry practices are described in ANSI/NECA 1-2006, *Standard Practices for Good Workmanship in Electrical Contracting,* and other applicable ANSI-approved installation standards
2. Conduit routing shown on drawings is diagrammatic only. Contractor shall field route conduit and raceways between equipment and devices as required to obtain a complete wiring system installed in accordance with industry standards.
3. All exposed conduits shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings.
4. Conduit shall not be installed on the outside face of exposed beams, girders, and columns, but shall be routed on the web or on the inside of a flange. When a round, box, or rectangular beam or column is encountered, conduit shall route along the side most protected from damage and least intrusive, with consideration given to minimizing unnecessary bends and fittings.
5. Except where prevented by the location of other work, a single conduit or a group of conduits shall be centered on structural members.
6. Conduit shall be located at least 6 inches from hot water or steam pipes and from other hot surfaces
7. Complete raceway installation before starting conductor installation.
8. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
9. Raceways Embedded in Slabs:
    a. Run conduit larger than 1-inch (25-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
    b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
    c. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
    d. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.
10. Stub-ups to Above Recessed Ceilings:
    a. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
11. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel

box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

12. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    b. Where an underground service raceway enters a building or structure.
    c. Where otherwise required by NFPA 70.

B. Moisture Pockets

1. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a "T-type" conduit body shall be provided at the low point of the conduit run, and a removable plug shall be installed in a downward facing hub.

C. Couplings and Unions

1. Metal conduit shall be joined by threaded conduit couplings, with the conduit ends butted.
2. The use of running threads, Erickson type couplings, split couplings or similar unions are not permitted.

D. Conduit Bodies

1. Conduit bodies shall meet the volume sizing requirements of NEC, and the minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.

E. Bends and Offsets

1. Changes in direction of conduits shall be made with fittings or bends.
2. Conduit bends shall meet the requirements of NEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
3. Field bends shall be made using appropriate tools or mechanical equipment. The use of a pipe tee, pipe vise, or other makeshift methods for bending conduit or tubing will not be permitted.
4. For non-metallic conduit or PVC coated rigid metallic conduit, approved factory bends and offsets shall be used.
5. Conduits or tubing that is cambered, deformed, or crushed in any way including from improper storage or handling shall be removed from the job site and shall not be permitted to be installed.
6. Install no more than the equivalent of three 90 degree bends between conduit bodies, pull boxes, junction boxes, or outlets.
7. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Cutting and Threading

1. The plane of all conduit ends shall be cut square with the centerline. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

2. Where threads are required, they shall be cut and cleaned only after the conduit has been reamed to industry standards.
3. The ends of all conduit and tubing shall be reamed and deburred to remove all rough edges.
4. Cutting oil shall be used in threading operations; the dies shall be kept sharp, and provisions shall be made for chip clearance.
5. Threads on conduits and fittings shall be lubricated and protected with a UL listed thread sealing compound suitable for use on electrical fittings and raceway.
6. All threaded conduit shall be re-galvanized after threading with "Galvanizing Powder M-321" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; "Zincilate 810" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or other cold-galvanized zinc-rich coating. The Contractor shall supply this protective material and shall apply it in the field.

G. Connections to Boxes and Cabinets

1. Install raceways square to the enclosure and terminate at enclosures with locknuts.
2. Conduit shall be securely fastened to all boxes and cabinets.
3. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit.
4. The locknuts, both inside and outside, shall then be tightened sufficiently to bond the conduit securely to the box.
5. Locknuts on connectors shall be tightened securely to bond the connectors.
6. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path

H. All conduits entering enclosures outdoors or in wet areas shall enter through Myer’s hubs, or approved equal, or threaded openings.

I. Cleaning

1. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit.
2. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned and pass inspection by the Owner/Owner’s Representative or, where such accumulation cannot be removed by methods acceptable to the Owner /Owner’s Representative, the conduit shall be replaced.
3. Mandrel all conduits and raceways using mandrels compliant with mandrel table found in NEMA TCB-2, latest edition. After which, draw a stiff bristle brush through the conduit to remove debris, then using a clean swab, clean the conduit until it is clear of particles of foreign materials and a fresh swap drawn through remains clean.

J. Empty Conduit

1. All conduits installed for future use shall have a polypropylene pull line with a minimum tensile strength of 200 lbs., Jet Line, Cat. No. 232, polyolefin, or approved equal. Pull line shall be secured at both ends to ensure future accessibility. Leave at least 12 inches (300

mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

K. Rooftop Conduits

1. Provide manufactured Unistrut supports anchored to concrete roof as indicated for all conduit runs exposed on roofs.

L. Identification

1. All conduits shall be identified in accordance with other section of these specifications.

M. Grounding

1. All conduits shall be grounded in accordance with specification Section 260526 – Basic Electrical Materials and Methods and NFPA 70, Article 250.
2. A solid or stranded bare copper or green insulated copper ground wire shall be provided in all conduits and raceways.

N. Galvanized Rigid Metallic Conduit (RMC)

1. RMC shall be installed in areas exposed to weather, vehicle traffic, in hazardous classified areas, for penetrations through foundations, and 10 feet before transition from below grade to 8 feet above grade, unless otherwise noted on the drawings.
2. RMC in contact with earth shall be protected by UL Listed 10 mil PVC tape applied in double thickness using 50 percent lap turns to 4 inches above grade and 4 inches beyond transition.
3. Expansion joints shall be used where required.

O. Rigid Aluminum Conduit

1. Not acceptable on this project, except where required by the Authority Having Jurisdiction.

P. Stainless steel rigid conduit (SSRC)

1. SSRC shall be installed instead of RMC within vaults and exposed on reservoirs.
2. Compatible expansion joints or LMFC sections shall be used where required.

Q. Liquid-Tight Flexible Metal Conduit (LFMC)

1. LFMC shall be steel. Aluminium flexible conduit shall not be used.
2. LFMC inserts not greater than 30 inches in length, shall be installed in all conduit runs, which are supported by both building steel and by structures subject to vibration, thermal expansion, or otherwise appreciable movement. This shall include locations where conduit supported by building steel enters or becomes supported by isolated structures on separate foundations.
3. LFMC shall be installed in conduit runs, which cross expansion joints. The sections of liquid-tight flexible conduit shall include a threaded coupling and a straight fitting of the same size as the raceway at each end of the section.

4. Special areas, such as plant office control rooms in which external noise is to be minimized, shall have LFMC in conduit runs where the runs cross from the main building framing to the control room or office framing.
5. LFMC shall be installed as the last section of raceway connecting to all equipment and devices, which move in relation to the supply conduit due to vibration, from the normal operation of the mechanism, or as needed to allow for thermal expansion.
6. LFMC shall be used to connect to pressure switches, thermocouples, solenoids, and similar devices. Liquid-tight flexible conduit shall be installed adjacent to the motor terminal housing for motors requiring 4-inch and smaller conduit.
7. LFMC inserts not greater than 6 feet in length may be installed as the last section of raceway connecting to light fixtures.
8. LFMC shall be used for connections to motors and transformers, in areas exposed to weather, moisture or oil, and under raised floors.

R. Non-Metallic Conduit

1. Schedule 40 shall be used for all power, signal feeders and branch circuits, in earth or encased in concrete, unless otherwise noted on the drawings. Conduits must be covered to depth in accordance with NFPA 70, or as indicated on drawings, whichever is greater.

S. Conduit Support

1. Fasten conduit supports to building structures and surfaces in accordance with Section 260526 – Basic Electrical Materials and Methods.
2. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
3. Do not use wire, ceiling support wires or perforated pipe straps to support conduit. Remove any temporary installation support wire.
4. Support conduit within 12 inches of enclosures to which attached.

T. Spacing of Supports

1. All conduit runs shall be rigidly supported, except where buried in concrete,.
2. Each conduit shall be supported within one (1) foot of junction boxes and fittings.
3. Spacers used in duct bank installations shall be placed no more than 6 to 10 feet apart.
4. Support spacing along conduit runs shall be as follows.

Conduit Size	Maximum Distance Between Supports
½ inch through 1-1/4 inch	5 feet
1-1/2 inch and larger	8 feet

U. Ground and bond raceway and boxes in accordance with Section 260526 – Basic Electrical Materials and Methods and NFPA 70, Article 250.

3.5 CABINET AND BOX INSTALLATION

A. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

B. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and in compliance with drawings and regulatory requirements.

C. Locate boxes and conduit bodies so as to ensure ready accessibility of electrical wiring, maintain headroom and to present neat mechanical appearance.

D. Locate boxes so that cover or plate will not span different building finishes.

E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. In inaccessible ceiling areas, install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire, with cover facing towards direct access.

F. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Use flush mounting outlet boxes in finished areas.

1. Do not install flush mounting boxes back-to-back in walls.
2. Provide minimum 6-inch separation between adjacent boxes.
3. Provide minimum 24-inch separation in acoustic rated walls.
4. Use stamped steel bridges to fasten flush mounting outlet box between studs.
5. Secure flush mounting box to interior wall and partition studs.
6. Accurately position boxes and plaster rings to make flush within 1/8 inch of surface finish.
7. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
8. Use adjustable steel channel fasteners for hung ceiling outlet box.
9. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a rain tight connection between box and cover plate or supported equipment and box.

G. Support boxes independently of conduits.

H. Use code sized gang box where more than one device is mounted together. Do not use sectional box. Use code sized gang box with plaster ring for single device outlets.

I. Use cast outlet box in exterior locations where exposed to the weather and wet locations (interior or exterior).

J. Coordinate installation of electrical boxes and fittings with cable and raceway installation work. Provide knockout closures to cap unused knockout holes where blanks have been removed.

K. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections where fastened with a locknut or bushing on rounded surface.

A. Fasten boxes rigidly to substrate or structural surfaces to which they are being mounted, or solidly embed electrical boxes in concrete or masonry as appropriate. Do not support boxes by conduits.

L. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be centered on structures.

M. Conduit openings in boxes shall be made with a knockout punch and not a hole saw. Hole saws may be used only to provide a pilot hold for subsequent use of a knockout punch.

N. Cabinets and boxes shall be rigidly mounted.

1. Mounting on concrete shall be secured by self-drilling anchors, or wedge style anchors such as Hilti Kwik-Bolt or similar. Drop-in anchors that are set with a hammer and tool may be used for equipment mounted on floors only.
2. Mounting on steel shall be by drilled and tapped screw holes, through drilled holes where a nylock nut can be installed and accessed after installation, by special support channels welded to the steel, or by a combination of these methods.
3. Cabinets shall be leveled and fastened to the mounting surface with not less than ¼-inch air space between the enclosure and mounting surface.
4. All mounting holes in the enclosure shall be used.

O. Large Pull Boxes - Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.

1. Interior Dry Locations - Use hinged enclosure.
2. Other Locations - Use surface mounted box of appropriate location classification.
3. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

3.6 ANCHORS

A. Where supports for raceways, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with self-drilling tubular expansion shell anchors with externally split expansion shells, single-cone expanders, and annular break-off grooved chucking cones. Anchors shall be Phillips "Red Head", Hilti “Kwik-Bolt” or approved equal.

3.7 PULL BOX AND VAULT INSTALLATION

A. Openings or “knockouts” in precast concrete vaults shall be located as shown on the drawings and shall be sized sufficiently to permit passage of the largest dimension of pipe and/or flange.

B. Upon completion of installation, all voids or openings in the vault walls around pipes shall be filled with 3,000 psi non-shrink grout.

C. After the structure and all appurtenances are in place and approved, backfill shall be placed to the original ground line or to the limits designated on the plans.

D. All joints between precast concrete vault sections shall be made watertight. The plastic joint sealing compound shall be installed according to the manufacturer's recommendations to provide a watertight joint which remains impermeable throughout the design life of the structure. The outside of the entire structure shall be coated with an approved water proofing material.

E. Access doors shall be built up such that the hatch is flush with the surrounding surface unless otherwise specified on the drawings or by the District. The Contractor is responsible for placing the cover at the proper elevation where paving is to be installed and shall make all necessary adjustments so that the cover meets these requirements.

F. Ladders shall be installed using Type 316 stainless steel capsule anchors.

G. Ladders shall be attached a minimum of 3 places to the vault wall.

H. Ladder shall be centered under access door opening.

3.8 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.9 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.10 QUALITY CONTROLS

A. All testing, by Contractor and Owner or their assigned agent shall be in accordance with the NETA ATS. The Owner may impose the requirement the Agent conducting testing be a Member Company of NETA or alternatively that NETA ATS be followed but the Agent may be an separately engaged testing contractor such as one regularly engaged in the business of Acceptance Testing; and that their field personnel must include at least one technician with a current Level-3 Certification from either NETA or NICET.

3.11 ADJUSTING

A. Install knockout closures in unused openings in boxes.

3.12 CLEANING

A. Clean interior of boxes with a wet vac and damp towel to remove dust, debris, and other material.

B. Clean exposed surfaces using a damp towel and when necessary restore manufacturer's finish using manufacturer's OEM finish product.

END OF SECTION 260533

SECTION 260553 - ELECTRICAL EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. The extent of the electrical systems and equipment requiring identification is shown on the drawings, and the extent of identification required is specified herein and in individual sections of work requiring identification. The types of electrical identification specified in this section include the following:

1. Exposed conduit color banding.
2. Buried cable warnings.
3. Cable/conductor identification.
4. Operational instructions and warnings.
5. Danger signs.
6. Equipment/system identification signs, including:
    a. Pull/Terminal box labels
    b. Panels labels
    c. Wiring device labels

1.2 REFERENCES - CODES AND STANDARDS

A. ANSI Z535.1 - Safety Color Code

B. ANSI Z535.4 for safety signs and labels.

C. APWA ULCC - Uniform Color Code for Buried Utilities.

D. NFPA 70 National Electrical Code (NEC). Latest approved edition.

E. ANSI A13.1. - Scheme for the Identification of Piping Systems

F. 29 CFR 1910.144 - Safety color code for marking physical hazards and 29 CFR 1910.145 - Specifications for accident prevention signs and tags.

1.3 SYSTEM DESCRIPTION

A. Identify all electrical equipment as stated below:

1. All transformers shall be identified by 1-inch high block letters cut in stencil and applied with yellow paint on a flat-black background. The transformer number, primary and secondary voltages, and the kVA shall be shown.
2. All Metal-Clad Switchgear, Metal-Enclosed Switchgear, Switchboards, Distribution Panelboards, Power and Lighting Panels, Motor Control Centers, Local Control Panels, and

all electrical equipment enclosure shall be identified using laminated plastic nameplates. The equipment number, voltage rating, current rating, number of phases, connection type, short circuit interrupting rating, and circuit number shall be shown

3. Identify all receptacles and lighting switches, by the circuit number shown on the drawings using ¼-inch high white characters on ½-inch wide black stick-on tape placed on the wall directly above the device if the device is wall mounted. Place the tape on the device enclosure if the device is not wall mounted.
4. All motors, starters, disconnect switches, and control devices shall be identified by circuit number, with ¼-inch high white characters on a ½-inch wide black stick-on tape.
5. All branch circuits in outlet boxes shall be identified with circuit number using wrap-around labels (T&B, BRADY or 3M).
6. All underground raceway or cable shall be marked with buried warning tape along its entire length.
7. All exposed raceway longer than 10 feet in length shall be identified.
8. Panelboard Directories: Furnish all panelboards with a complete 8-1/2-inch by 11-inch typewritten directory mounted in the inner door under a clear plastic cover set in a metal frame.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.5 SUBMITTALS

A. Catalog data for nameplates, labels, and markers.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70 – National Electrical Code.

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, approved testing and listing agencies as suitable for the purpose specified and shown.

C. Comply with ANSI A13.1.

D. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

E. Comply with ANSI Z535.4 for safety signs and labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates

1. Engraved three-layer laminated plastic, white letters on black background for normal power and white letters on red background for emergency power. Communications and control cabinets shall be labeled with white letters on green background.
2. Locations
   a. Each electrical distribution and control equipment enclosure.
   b. Communication cabinets.
   c. Motor control centers, including each combination module.
3. Letter Size
   a. Use 1/8-inch letters for identifying individual equipment and loads.
   b. Use ¼-inch letters for identifying grouped equipment, loads, panelboards, and transfer switch.
   c. Use ½-inch letters for identifying the main switchboard, motor control centers, and large distribution switchboards.

B. Labels

1. Embossed adhesive tape, with 3/16-inch black letters on clear background. Use only for identification of individual wall switches and receptacles, control device stations, and multi-outlet devices.
2. Thickness
   a. 1/16-inch for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.

2.2 WIRE MARKERS

A. Manufacturers

1. Brady
2. Thomas & Betts
3. 3-M Co.

B. Description: Cloth, tape, split sleeve, or tubing type wire markers, self-adhesive.

1. Self-laminating Marker:
   a. White area, 0.5" high x 1.0" wide for wire number to be typed or printed; with clear plastic over wrap.
   b. Manufacturer: Panduit PSWMS-1015, or W.H. Brady Catalog No. DAT-34-292, or Tyton-Hellerman TAG63L-105, or approved equal.
2. Heat-shrinkable Marker:
   a. White, suitable for typing, computer printing, or pen; sized for conductor size range AWG or kcmil.
   b. Manufacturer: Raychem Shrinkmark or Permark-FB or approved equal
3. Sleeve Marker:
   a. White, suitable for typing, or printing; sized for conductor size range AWG or kcmil.
   b. Manufacturer: Raychem, type TMS or approved equal.

C. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, control panels, motor controllers and starters, and each load connection.

D. Legend

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on contract drawings.
2. Control Circuits: Control wire number indicated on shop drawings.
3. Neutral Conductors: Clearly indicate the branch circuit or feeder number the neutral serves. In multi-wire circuits where the neutral is shared, mark the neutral with the circuit number of the “A” phase.

2.3 PULL BOX AND TERMINAL BOX LABELS

A. Vinyl marker; yellow background; 1" high black legend

1. Manufacturer: Panduit Cat. # PVL100BY series, or approved equal

2.4 PANEL LABELS

A. As described by panel label detail attached at end of this section.

1. Two-ply plastic labels with clear exterior surface and white back.
2. Manufacturer: Gravoply, or Lamicoid, or approved equal. Fasten to panels with foam tape.
3. Laser engrave panel label tags as shown.

2.5 WIRING DEVICE LABELS

A. Self-Laminating Laser printed tags: print on clear polyester label material for receptacle device plates; print on white polyester for communication patch panels.

1. Manufacturer: Tyton-Hellerman Part No.: TAGPP1-788C, or approved equal.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.7 FIELD MOUNTED INSTRUMENTS

A. Stainless steel tags shall be used for field mounted instruments.

B. Use "Style D" and letter size "7" for instruments in enclosures.

1. Use Local Control Panel Label Size table, Drawing E-503, as a reference.
2. Laser engrave instrument identification number in surface of stainless steel tag.
3. Drill 1/8" hole at one end of label.
4. Attach tag to instrument using stranded stainless steel wire and compression clamp.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.9 CONDUIT MARKERS

A. Provide manufacturer's standard preprinted, flexible or semi-rigid, permanent, plastic-sheet conduit markers, minimum of 3 mils thick and 1-1/2-inch wide extending 360 degrees around conduits; designed for self-adhesive attachment to conduit. Except as otherwise indicated, provide lettering that indicates the voltage of the conductor(s) in the conduit. Provide 8-inch minimum length for 2-inch and smaller conduit, 12-inch minimum length for larger conduit.

B. Identify conduits containing conductors above 600-volts with the following alternating markers

1. DANGER - HIGH VOLTAGE
2. The voltage, as applicable (i.e. – 12-kV, 4.16-kV, 480-Volts, 240-Volts, etc.)

C. Location: Furnish markers for each conduit longer than 10 feet.

D. Spacing: 20 feet on center.

E. Color: Unless otherwise indicated or required by governing regulation, provide orange markers with black letters.

1. Telephone System: Green w/yellow letters.
2. Data/Communication. System: White w/black letters.
3. Emergency System: Orange w/black letters.

F. Legend:

1. 15-kV System: Nominal 14.4-kV, 13.8-kV, 13.2-kV, 12.5-kV
2. 480 Volt System: Normal 480/277-volts.
3. 240 Volt System: Nominal 120/240-volts.
4. Fire Alarm System: Fire alarm.
5. Telephone System: Telephone.
6. Data/Communication System: Data/communications.

2.10 FASTENERS

A. Secure all labels and nameplates with self-tapping stainless steel screws. Use contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.11 BAKED ENAMEL DANGER SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14-inch by 10-inch size except where 10-inch by 7-inch is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording (e.g. HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH).

1. At each entry doors of 15-kV Metal-Clad Switchgear enclosure: “DANGER HIGH VOLTAGE – KEEP OUT, AUTHORIZED PERSONNEL ONLY”
2. At each entry doors of Electrical Rooms: “DANGER HIGH VOLTAGE – KEEP OUT, AUTHORIZED PERSONNEL ONLY”
3. At Engine-Generator Unit enclosures: “CAUTION – USE HEARING PROTECTION”
4. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
5. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.12 LETTERING AND GRAPHICS

A. 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.

2.13 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.14 UNDERGROUND WARNING TAPE

A. Three-inch minimum width, 5 mil thickness, foil bonded polyethylene tape, detectable type, with suitable continuous warning legend describing buried electrical lines. Tape color shall conform to APWA uniform color code using ANSI Z535.1 safety colors. Text shall be black, 2-inch minimum letters.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Degrease and clean surfaces to receive nameplates and labels.

D. Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

E. Regulations: Comply with governing regulations and the requests of governing authorities for the identification of electrical work.

3.2 APPLICATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws, rivets, or adhesive appropriate to the location and substrate.

C. Secure nameplate to outside moveable surface of door on panelboard.

D. Conduit Identification:

1. Where electrical conduit is exposed in spaces with exposed mechanical piping, which is identified by a color-coded method, apply color-coded identification on the electrical conduit in a manner similar to the piping identification. Except as otherwise indicated, use orange as the coded color for conduit.
2. Paint red band or provide red tape on each fire alarm conduit longer than 10 feet, minimum 20 feet on center.

E. Cable/Conductor Identification:

1. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where the wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided.
2. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.

F. Operational Identification and Warnings

1. 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 the prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.

G. Danger Signs

1. In addition to the installation of danger signs required by governing regulations and authorities, install appropriate danger signs at the locations indicated and at locations subsequently identified by the Installer of electrical work as constituting similar dangers for persons in or about the project.
2. High Voltage
   a. Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
   b. Critical Switches/Controls
   c. Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

H. Equipment/System Identification Signs

1. Install an engraved plastic-laminate sign on each major unit of electrical equipment in the building; including the central or master unit of each electrical system and the communication/signal systems, unless the unit is specified with its own self-explanatory identification or signal system.
2. Except as otherwise indicated or specified, provide single line of test, ½-inch high lettering on 1-1/2-inch high sign (2-inch high where two lines are required), white lettering in black field.
3. Provide text matching terminology and numbering of the contract documents and shop drawings.
4. Provide signs for each unit of the following categories of electrical work
   a. Major electrical switchboard
   b. Electrical substation
   c. Motor control center
   d. Fire alarm control panel and annunciators.

I. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrata with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrata.

J. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

K. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   a. Color shall be factory applied.
   b. Colors for 120/240-V Circuits:

      1) Phase A: Black.
      2) Phase B: Red.

   c. Colors for 208/120-V Circuits:

      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.

   d. Colors for 480/277-V Circuits:

      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.

B. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels, Baked-enamel warning signs, or Metal-backed butyrate warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Adhesive film label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Enclosed switches.
e. Remote-controlled switches, dimmer modules, and control devices.
f. Monitoring and control equipment.

END OF SECTION 260553

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes dry-type, single-phase and three-phase general purpose, individually mounted, dry-type transformers of the two-winding type, self-cooled transformers rated 600 V and less, with capacities up to 1000 kVA.

1.2 RELATED SECTIONS

A. Section 260526 – Grounding and Bonding for Electrical Ssytems

B. Section 260553 – Electrical Equipment Identification.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS.

A. ANSI C57.96 – Guide for Loading Dry-Type Distribution and Power Transformers.

B. UL 506 – Specialty Transformers

C. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

D. NEMA ICS 6 – Enclosures

E. NEMA ST 1 - Specialty transformers

F. NEMA ST 20 - Dry type transformers for general applications

G. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

I. NFPA 70 - National Electrical Code

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H. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

I. NFPA 70 - National Electrical Code

1.5 DESIGN REQUIREMENTS

A. Transformers shall be designed, manufactured, and tested in accordance with the latest applicable ANSI, NEMA and IEEE standards. All 600-volt class transformers 2 kVA through 750 kVA shall be UL listed and bear the UL label.

B. Transformers shall be designed for continuous operation at rated kVA for 24 hours a day, 365 days a year operation with normal life expectancy as defined in ANSI C57.96.

C. Transformers shall be of the energy efficient type, meeting the requirements of NEMA TP 1.

1.6 SUBMITTALS

A. In accordance with Division 1 requirements

B. Product Data:

1. Submit outline and support point dimensions of enclosure and accessories, unit weight, voltage, kVA, impedance rating, characteristics, insulation system type, rated temperature rise, winding configurations, terminations at primary and secondary connection points.
2. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
3. Report on all factory tests and results. Factory test data on a prototypical unit of identical size and features is not acceptable.

C. Shop Drawings: Indicate dimensions and weights.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Submit calculations and anchoring methods (anchor bolt size, embedment and assembly details) to meet California Seismic Zone IV requirements.

D. Manufacturer Seismic Qualification Certification:

1. Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

2. Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
3. Manufacturer's Certificate. Certify that products meet or exceed specified requirements.

E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.8 DELIVERY, STORAGE AND HANDLING

A. Store, protect and handle products in accordance with NEMA standards.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Accept transformers on site and inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure and finish.

1.9 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACME Electric Corporation; Power Distribution Products Division.
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Controlled Power Company.
4. Eaton Electrical Inc.; Cutler-Hammer Products.
5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
6. General Electric Company.
7. Hammond Co.; Matra Electric, Inc.
8. Magnetek Power Electronics Group.

9. Micron Industries Corp.
10. Myers Power Products, Inc.
11. Siemens Energy & Automation, Inc.
12. Sola/Hevi-Duty.
13. Square D; Schneider Electric.
14. Or approved equal.

2.2 STANDARD DRY-TYPE TRANSFORMERS

A. NEMA ST 20 Class AA dry-type transformer. Transformer shall be suitable for connection to 75 degrees C wire loaded to the 75 degrees C ampacity. All three-phase transformers shall have three-winding primaries and three-winding secondary. Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Core and coil assemblies:

1. The transformer core shall be constructed with high grade, non-aging, grainoriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point.
2. The transformer core volume shall allow sufficient transformer operation at 10 percent above the highest tap voltage.
3. The core laminations shall be tightly clamped and compressed.
4. Coils shall be wound of electrical grade copper or aluminum with continuous wound construction, terminations brazed or welded.
5. On units rated below 3 kVA, the core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock resistant seal. The core and coil encapsulation system shall minimize the sound level.
6. On units rated 3 kVA and above, the core and coil assembly shall be impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads.

C. Taps

1. For transformers 25 kVA and larger, provide primary windings with 6 taps; two 2-1/2 percent increments above full-rated voltage and four 2-1/2 percent increments below full-rated voltage.
2. For transformers below 25 kVA, provide two taps at 5 percent increments below full-rated voltage.
3. For transformers below 1 kVA, no taps are required.

D. Provide terminal enclosure with screw cover to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector.

1. Provide terminal board with mechanical compression type connectors. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C.
2. Provide wiring connections suitable for stranded copper wiring, rated 75 degrees C, and loaded to the 75 degrees C ampacity.

E. Basic Impulse Level

1. 10-kV for transformers less than 300-kVA
2. 30-kV for transformers 300-kVA and larger.

F. Grounding

1. Ground core and coil assembly to enclosure by means of a visible flexible copper-grounding strap. Provide grounding in accordance with Section 260526 – Basic Electrical Materials, Methods and Grounding.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Totally enclosed, nonventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

K. Wall Brackets: Manufacturer's standard brackets.

2.4 ENCLOSURE

A. The enclosure shall be made of heavy gauge steel and shall be degreased, cleaned, primed, and finished with ANSI 61 color weather-resistant enamel. 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 C. The core of the transformer shall be grounded to the enclosure.

B. On units rated below 3 kVA, the enclosure construction shall be totally enclosed, nonventilated, NEMA ICS 6, Type 3R with lifting eyes as required.

C. On units rated 3 kVA and above, the enclosure construction shall be fully ventilated NEMA ICS 6, Type 1 or as indicated on drawings, with lifting lugs as required. All ventilation openings shall be protected against falling dirt and water.

2.5 IDENTIFICATION DEVICES

A. Provide manufacturer nameplate that includes transformer connection data and overload capacity based on rated allowable temperature rise.

B. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Section 260553 "Electrical Equipment Identification."

2.6 SOUND LEVELS

A. Transformer sound levels shall not exceed the following:

1. Up to 9-kVA 40 db
2. 10 to 50 kVA 45 db
3. 51 to 150 kVA 50 db
4. 151 to 300 kVA 55 db
5. 301 to 500 kVA 60 db
6. 501 to 700 kVA 62 db
7. 701 to 1000 kVA 64 db

2.7 SOURCE QUALITY CONTROL

A. The following factory test results shall be provided for each transformer:

1. Ratio tests at the rated voltage connection and at all tap connections
2. Polarity and phase relation tests on the rated voltage
3. Applied potential tests
4. Induced potential test
5. No-load and excitation current at rated voltage on the rated voltage connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

C. Brace wall-mounting transformers as per manufacturer requirements for the installation seismic zone.

D. Use liquid-tite flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Where mounted on a structural flooring, mount transformers on vibration isolating pads (minimum 0.75-inch thick) suitable for isolating the transformer noise from the building structure.

F. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, and seismic codes applicable to Project.

G. Provide grounding and bonding in accordance with Section 260526 – Basic Electrical Materials, Methods and Grounding.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters as outlined below:

1. Dry Type Air-Cooled Transformers, 600 Volt and Below – All Single-Phase and Three-Phase.
    a. Visual and Mechanical Inspections
        1) Compare equipment nameplate data with drawings and specifications.
        2) Inspect physical, electrical and mechanical condition.
        3) Verify that resilient mounts are free and that any shipping brackets have been removed.
        4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data or NETA ATS Table 10.12.
    b. Electrical Tests
        1) Perform resistance measurements through all bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with NETA ATS Table 10.5.
        3) Calculate polarization index.
        4) Perform turns ratio tests at all tap positions.

5) Verify that as-left tap connections are as specified.

c. Test Values

1) Compare bolted connection resistances to values of similar connections.
2) Bolt-torque levels should be in accordance with NETA ATS Table 10.12 unless otherwise specified by manufacturer.
3) Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values that deviate from similar connections by more than 50 percent of the lowest value.
4) Insulation-resistance test values at one minute should not be less than the values calculated in accordance with the formula in NETA ATS Table 10.5. Results shall be temperature corrected in accordance with NETA ATS Table 10.14.
5) The polarization index shall be greater than 1.0 and shall be recorded for future reference.
6) Turns-ratio test results should not deviate more than one-half percent from either the adjacent coils or the calculated ratio.

2. Dry Type Air-Cooled Transformer, Above 600 Volt and 600 Volt and below – Greater than 167 kVA Single-Phase and 500 kVA Three-Phase. The following tests shall be in addition to those listed in above.

a. Visual and Mechanical Inspection

1) Verify that control and alarm settings on temperature indicators are as specified.
2) Verify that cooling fans operate and that fan motors have correct overcurrent protection.
3) Perform specific inspections and mechanical tests as recommended by manufacturer.
4) Verify that the core, frame, and enclosure groundings are correct.
5) Verify the presence of transformer surge arresters.

b. Electrical Tests

1) Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.
2) Perform an excitation-current test on each phase.
3) Measure the resistance of each winding at each tap connection.
4) Measure core insulation resistance at 500 volts dc if core is insulated and if the core ground strap is removable.
5) Perform an overpotential test on all high- and low-voltage windings-to-ground.
6) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

c. Test Values

1) CH and CL dissipation-factor/power-factor values will vary due to support insulators and bus work utilized on dry transformers. The following is expected on CHL power factors:
    a) Power Transformers: one percent or less
    b) Distribution Transformers: three percent or less
2) Consult transformer manufacturer or test equipment manufacturer's data for additional information.
3) Winding resistance test results, after factoring in temperature corrections, should compare within one percent of factory obtained results except in instances of extremely low resistance values.

4) Typical excitation current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading.
5) Core insulation resistance values should be comparable to factory obtained results but not less than one megohm at 500 volts dc.
6) AC overpotential test shall not exceed 75 percent of factory test voltage for one-minute duration. DC overpotential test shall not exceed 100 percent of the factory RMS test voltage for one-minute duration. The insulation shall withstand the overpotential test voltage applied.

C. Energize primary circuit at rated voltage and frequency from normal power source and test transformer, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance otherwise, remove and replace with new units and proceed with re-testing.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.3 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262200

SECTION 262416 - 600-VOLT RATED PANELBOARDS AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards and circuit breakers.

1.2 RELATED SECTIONS

A. Section 260500 - Common Work Results for Electrical.

B. Section 260526 – Basic Electrical Materials, Methods and Grounding.

C. Section 260553 – Electrical Equipment Identification.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. IEEE C2 – National Electrical Safety Code.

B. NECA - Standard of Installation.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 6 - Enclosures

E. NEMA PB 1 - Panelboards.

F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

H. NFPA 70 – National Electrical Code.

1.4 CONTRACTOR SUBMITTALS

A. In accordance with Division 1 requirements.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals. For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017000 Execution and Closeout Requirements include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.10 MAINTENANCE MATERIALS

A. Furnish two of each panelboard key. Panelboards keyed alike to District’s current keying system.

B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 PRODUCTS

2.1 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

A. Description: NEMA PB 1, circuit breaker type distribution, lighting and appliance branch circuit panelboard.

B. Manufacturers:

1. Eaton
2. Schneider
3. ABB/General Electric
4. Siemens

C. Service Conditions:

1. Temperature: 104 degrees F (40 degrees C) ambient
2. Altitude: 100 feet (35 m) above sea level.

D. Panelboard Bus

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Copper current carrying components, ratings as indicated on drawings
3. Furnish copper ground bus in each panelboard, bonded to box

E. Minimum integrated short circuit rating

1. Panelboards rated 240-Volts - 10,000 amperes RMS symmetrical, or as indicated on drawings.
2. Panelboards rated 480-Volts - 22,000 amperes RMS symmetrical, or as indicated on drawings.
3. Fully rated to interrupt symmetrical short-circuit current available at terminals.

F. Enclosure: NEMA ICS 6, Type 1, gasketed, steel construction, minimum 6 inches deep, 20 inches wide suitable for flush or surface mounting as indicated on drawings.

1. Flush or surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock keyed alike.
2. Fully hinged door with flush lock and metal directory frame inside panelboard door, with transparent card holder.
3. Finishes:
4. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
5. Back Boxes: Same finish as panels and trim.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.

H. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.2 MOLDED CASE CIRCUIT BREAKERS

A. Comply with UL 489, with interrupting capacity to meet available fault currents.

B. NEMA AB 1, bolt-on type thermal magnetic and instantaneous magnetic trip circuit breaker. Circuit breaker thermal elements shall be of the bimetallic type and shall be capable of withstanding sustained overload and short-circuit currents without injury and without affecting the calibration of the bimetallic element. The thermal element shall have inverse time characteristics. The instantaneous elements shall trip the circuit breaker at the minimum standard trip setting.

C. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

E. Provide common trip handle for multiple pole circuit breakers.

F. Provide type SWD circuit breakers for lighting circuits, type HACR circuit breakers for air conditioning equipment circuits and type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits..

G. Class A ground fault interrupter circuit breakers as indicated on drawings.

H. Trip rating as indicated on drawings.

I. Circuit breaker interrupting rating shall meet or exceed the panel interrupting rating. Series rated circuit breakers are not acceptable.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Disconnect and remove abandoned panelboards. Verify all branch circuits are no longer in use before disconnecting.

E. Maintain access to existing panelboard that remain active and require access. Modify installation or provide access panel.

F. Clean and repair existing panelboards to remain or to be reinstalled.

3.2 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and NECA "Standard of Installation", NFPA 70 and IEEE C2.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Install panelboards plumb and rigid without distortion of box.

D. Install recessed panelboards flush with wall finishes.

E. Mounting height: 6 feet (1,800 mm) to top of panelboard. Install panelboards taller than 6 feet (1,800 mm) with bottom no more than 4 inches (100 mm) above floor.

F. Install filler plates for unused spaces in panelboards.

G. Install overcurrent protective devices and controllers not already factory installed.

H. Provide typed circuit directory for each panelboard. Revise directory to reflect circuiting changes to balance phase loads.

I. Install engraved plastic nameplates in accordance with Section 260553 – Electrical Equipment Identification.

J. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

K. Ground and bond panelboard enclosure according to Section 260526. Connect equipment ground bars of panels in accordance with NFPA 70.

L. Comply with NECA 1.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS as outlined below:

1. Visual and Mechanical Inspection:
    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
    d. Inspect all doors, panels, and sections for corrosion, dents, scratches, fit, and missing hardware.
    e. Verify that fuse and/or circuit breaker sizes and types correspond to drawings.
    f. Perform circuit breaker inspections and operation test.

3.4 ADJUSTING

A. Rearrange circuits in panelboard to balance phase loads to within 20 percent of each other.

B. Maintain proper phasing for multi-wire branch circuits.

C. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Wall-switch.
3. Weather-resistant receptacles.
4. Snap switches.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 01 (General Requirements) Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the

following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with FS W-C-596, NEMA WD 1, NEMA WD 6, UL 498, and UL 943 Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cooper; GF20.
   b. Pass & Seymour; 2084.

2.5 FINISHES

A. Device color:

1. Wiring Devices Connected to Normal Power System: As selected by Owner or Architect unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate: Brushed stainless steel.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.7 SWITCHES

A. Comply with NEMA WD 1, FS W-S-896 and UL 20.

B. Switches, 120 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
2. Provide auto on-off switch.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262826 - ENCLOSED TRANSFER SWITCHES

PART 1 GENERAL

1.1. SUMMARY

A. Section includes automatic and manual transfer switches in individual enclosures.

1.2. RELATED SECTIONS:

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

1.3. REFERENCES - CODES AND STANDARDS

A. NEMA ICS 6 - Enclosures.

B. NEMA ICS 10 - AC Transfer Switch Equipment.

C. NFPA 110 - Emergency Standby Power Systems.

D. NFPA 70 - National Electrical Code.

E. ANSI/NETA ATS (International Electrical Testing Association) – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. UL 1008 - Automatic Transfer Switches.

1.4. SUBMITTALS

A. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short- circuit ratings, dimensions, and enclosure details.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces expected in installed region.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts

from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

2. Dimensioned Drawings of Equipment Unit:Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based.

D. Test Reports: Provide five (5) copies of results of manufacturer's certification of performance testing.

E. Manufacturer's Field Report: Indicate inspections, findings, and recommendations.

1.5. CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions and service manuals for normal operation and routine maintenance. List special tools, maintenance materials, and replacement parts.

B. Manufacturer's Field Report: Indicate inspections, findings, performance and recommendations.

1.6. QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 70.

D. Comply with NFPA 99.

E. Comply with NFPA 110.

F. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.7. QUALIFICATIONS

A. Manufacturer: Company shall specialize in manufacturing the products specified in this section with minimum five (5) years' experience and with service facilities within 50 miles of project site.

B. Supplier: Authorized distributor of specified manufacturer with minimum five (5) years' experience.

1.8. MAINTENANCE SERVICE

A. Provide service and maintenance (parts and labor) for a period of two (2) year from Date of Substantial Completion.

1.9. WARRANTY

A. Furnish two (2) year manufacturer's warranty from date of substantial completion for defective parts and labor to install the part.

PART 2 PRODUCTS

2.1. AUTOMATIC TRANSFER SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:
   a. Automatic Switch Co. (ASCO) 300 Series.
   b. GE Zenith Controls.
   c. Caterpillar; Engine Div
2. Transfer Switches Using Molded-Case Switches or Circuit Breakers:
   a. AC Data Systems, Inc.
   b. Eaton Electrical Inc.; Cutler-Hammer.
   c. Hubbell Industrial Controls, Inc.
   d. Lake Shore Electric Corporation.

B. Product Description: NEMA ICS 10, automatic transfer switch suitable for use in standby systems as described in NFPA 70 and shall conform to NFPA 110. Manual operator conforming to UL 1008 shall be provided and switch shall be designed for safe operations under full load conditions.

C. Configuration: Electrically operated, mechanically held in both operating positions.

D. Rating: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated. Voltage and current rating shall be as indicated on drawings, continuous duty, three (3) poles with solid neutral. Neutral contact continuous current rating shall be not less than twice the rating of main or phase contacts.

E. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

F. Interrupting Capacity: 100 percent of continuous rating. Shall be adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

G. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Withstand Current Rating: 30,000 RMS symmetrical amperes when used with molded case circuit breaker. Contacts shall be non-welding when used with upstream feeder overcurrent device of available fault current specified.

J. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

K. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

L. Service Conditions: NEMA ICS 10

1. Temperature: -40 to +50 degrees C
2. Relative Humidity: up to 95 percent
3. Altitude: 50 feet (15 meters) above sea level

M. Product Features: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
4. Main transfer switch contacts shall be visible for inspection without disassembly and/or removal of any parts or barriers. Indicating Lights: Mount on front panel of switchboard to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE and switch position.
5. Test Switch: Mount on front panel of switchboard to simulate failure of normal source.
6. Return to Normal Switch Mount on front panel of switchboard to initiate manual transfer from alternate source to normal source.
7. Auxiliary Contacts: Provide the following discrete output signals, rated at no less than 10 amps at 120 volts, 60 Hz.
   a. Loss of utility power
   b. Preferred source active
   c. Alternate source active
   d. Any additional control signals as required to control a standby engine generator and as indicated on drawings.
8. Preferred Source Monitor: Monitor normal source voltage and frequency; sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent. Initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
9. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
10. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
11. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for

each switch position, rated 10 A at 240-V ac.

12. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
13. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
14. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
15. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available
16. Alternate Source Monitor: Monitor alternate source voltage and frequency. Inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
17. In-Phase Monitor: Inhibit transfer until source and load are within 10 electrical degrees.
18. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
19. Switched Neutral:
    a. Over-lapping contacts for transfer switches rated 400-amperes or less.

N. Automatic Sequence of Operation:

1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
2. Time Delay to Start Alternate Source Engine Generator: 0 to 30 seconds, adjustable and factory set at 1 second.
3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
4. Time Delay before Transfer to Alternate Power Source: 0 to 300 seconds, adjustable, and factory set at 3 seconds.
5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
6. Time Delay before Transfer to Normal Power: 0 to 30 minutes, adjustable; and factory set at 5 minutes. Time delay shall be automatically defeated in the event of alternate source failure, provide normal source is available.
7. Time Delay before Engine Shutdown: 0 to 30 minutes, adjustable, of unloaded operation factory set at 10 minutes.
8. Engine Exerciser: Provide a generator exerciser timer. Run times shall be user programmable.

The exerciser shall be selectable between load transfer and engine run only and shall have a fail-safe feature that will retransfer the switch to preferred source during exercise period. Bypass exerciser control when normal source fails during exercising.

9. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

O. Enclosure:

1. Indoor Enclosure: General-purpose NEMA 250, Type 12, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

P. Finish:

1. Manufacturer's standard light gray enamel (ANSI 61) over external surfaces. Coat internal surfaces with a minimum of one coat of corrosion-resistant paint, or plate with cadmium or zinc.

2.2. SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 EXECUTION

3.1. INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.

B. Switch shall be installed in accordance with approved manufacturer's instructions.

C. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support.

D. Install concrete pad in accordance with Section 033000.

E. Install engraved plastic nameplates in accordance with Section 260553 – Electrical Equipment Identification.

F. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2. MANUFACTURER'S FIELD SERVICES

A. Engage the services of a qualified factory-authorized service representative to inspect field-assembled components and equipment installation, including commissioning, start-up demonstration and training, and to assist in Field Quality Control inspection and testing.

1. Check out transfer switch connections and operations, and place in service.
2. Adjust control and sensing devices to achieve specified sequence of operation.

B. Following completion of switch installation and after making proper adjustments and settings, site tests shall be performed to demonstrate that the switch function as specified.

3.3. FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of ANS/NETA ATS section 7.22.3.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4. DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Furnish four (4) hours of instruction for four (4) persons, to be conducted at project site with manufacturer’s field service representative. Instruction shall include handouts to all trainees describing the procedures for the proper operation, adjustment and maintenance of the automatic transfer switch. Use approved O&M manuals.

C. Demonstrate operation of transfer switch in normal and emergency modes.

D. Simulate power outage by interrupting the normal source, and demonstrate that system operates to provide emergency power. Coordinate testing and training to coincide with the engine-generator unit testing and training.

END OF SECTION 262826

SECTION 264313 – SURGE PROTECTIVE DEVICES - SPD

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and local control equipment.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic currentvoltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a nationally recognized testing agency (NRTL), and marked for intended location and application.

B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. Comply with NEMA LS 1.

D. Comply with UL 1449.

E. Comply with NFPA 70.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 TYPE 2 PANELBOARD SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ABB USA.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

4. Intermatic, Inc.
5. Leviton Mfg. Company Inc.
6. Siemens Energy & Automation, Inc.
7. Square D; a brand of Schneider Electric.

B. Surge Protection Devices:

1. UL 1449 non-modular surge protective device.
2. LED indicator lights for power and protection status.
3. Fuses, rated at 200-kA interrupting capacity.
4. Fabrication using bolted compression lugs for internal wiring.
5. Integral disconnect switch.
6. Redundant suppression circuits.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.

C. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:

1. Line to Neutral: 70,000 A.
2. Line to Ground: 70,000 A.
3. Neutral to Ground: 50,000 A.

E. Protection modes and UL 1449 SVR for 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120 V.
2. Line to Ground: 400 V for 208Y/120 V.
3. Neutral to Ground: 400 V for 208Y/120 V.

F. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 480 V, 3-phase, 3-wire circuits shall be as follows:

1. Line to Line: 2000 V for 480 V.
2. Line to Ground: 1500 V for 480 V.

2.3 TYPE 3 CONTROL PANEL SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Hubbell SpikeShield.

2. Leviton Mfg. Company Inc.
3. Square D; a brand of Schneider Electric.

B. Surge Protection Devices:

1. UL 1449 non-modular 15A 120V surge protective device.
2. LED indicator lights for power and protection status.
3. Withstand rating: 2000V per UL498.
4. Maximum Continuous Operating Voltage: 150V rms.

C. Minimum single impulse current ratings, per mode:

1. Line to Neutral: 18,000 A.
2. Line to Ground: 9,000 A.
3. Neutral to Ground: 9,000 A.

D. Protection modes and UL 1449 SVR for 120V, single phase, 2-wire circuits shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, type suitable for application.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install Surge Preventative Devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide a 30A circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:
1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing SPD but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

C. SPD will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not energize or connect panelboards to their sources until SPD are installed and connected.

C. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

D. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265000 - LIGHTING

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Interior and exterior luminaries and accessories.

B. Exit signs.

1.2. DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. Lumen: Measured output of lamp and luminaire, or both.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3. REFERENCES

A. ANSI C78.379 - Electric Lamps - Classification of the Beam Patterns of Reflector Lamps.

B. ANSI C82.1 - Line Frequency Fluorescent Lamp Ballast.

C. IEC 801-2 Electrostatic Discharge Testing Standard.

D. IEC/EN 60669-2-1 switches for household and similar fixed electrical installations - electronic switches.

E. IESNA LM-79 – Electrical and Photometric Measurements of Solid State Lighting Products.

F. IESNA LM-80 – Measuring Lumen Maintenance of LED Light Sources.

G. ISO 9001 – Quality Management Systems.

H. NEMA SSL-1 – Electronic Drivers for LED Devices, Arrays, or Systems.

I. NFPA 70 – National Electrical Code.

J. NFPA 101 – Life Safety Code.

K. UL 8750 – Light Emitting Diode (LED) Light Sources for Use in Lighting Products

1.4. SUBMITTALS FOR REVIEW

A. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

B. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast, or LED Driver, including BF.
   4. Energy-efficiency data.
   5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
   7. Materials, dimensions, and finishes of poles.
   8. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

1.5. SUBMITTALS FOR INFORMATION

A. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LED-fixture-mounted, emergency battery pack: Furnish at least one.
   2. LED Driver: Furnish at least two of each type. Spare luminaires may be provided to satisfy this requirement.

1.6. QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7. COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction including piping, HVAC equipment, fire-suppression system, and partition assemblies.

1.8. REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended location and application.

C. Comply with IEEE C2.

PART 2 PRODUCTS

2.1. GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Exterior luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Where indicated, comply with IESNA RP-8 for parameters of lateral light distribution patterns for exterior luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

J. Diffusers:
   1. Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and diffusers.
   2. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
      b. UV stabilized.

K. Factory-Applied Labels: Comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.2. LUMINAIRES

A. Furnish products as specified in schedule. All exterior light fixture assemblies shall be rated for 175 mph wind loads.
   1. GENERAL: Lighting fixtures as hereinafter specified are identified by type as noted on drawings. Fixture specifications are based on construction and performance. Manufacturer's catalogue numbers are of general nature and indicate level of quality required, but do not necessarily reflect complete options as specified. Approval must be based on description and specification of fixture as well as catalogue number indicated. See specifications for fixture, lens, lumen and driver requirements.

B. Substitutions: Submit performance calculations for proposed substitutions.

C. Install drivers and specified accessories at factory.

2.3. LED Light Fixtures

A. General:
   1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
   2. LED light fixtures shall be a factory assembled luminaire including all required driver and light engine modules integral to and within a single housing. Lead lengths between driver and light engine shall not exceed 3 feet. Remote luminaire/driver installations are not acceptable.
   3. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) compliant.

B. LED Driver Modules
   1. Description: Universal voltage switching-mode LED driver module with a rated lifetime of not less than 50,000 hours when operated at an ambient temperature of less than 60-degrees C.
   2. LED drivers shall include native 0-10V dimming capabilities without additional control devices or field-installed circuitry. Integral short-circuit, open-circuit and overload fault protection to prevent driver failure.
   3. LED drivers shall be capable of producing adequate output current to produce the specified light levels. Compatibility of driver and LED light engine must be tested and ensured by driver manufacturer.

4. Minimum efficiency: 85% at full load.
5. Minimum Operating Ambient Temperature: -20° C (-4° F).
6. Input Voltage: 120V to 277V (±10%) AC at 60Hz. Drivers that require DC input shall include an integral converter that accepts standard line voltage AC.
7. Power Factor: ≥ 0.95.
8. Total Harmonic Distortion: ≤ 20% and meet ANSI C82.11 maximum allowable THD requirements
9. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
10. Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the driver is under fully-loaded conditions and case temperature is 62 degrees C.
11. Maximum inrush current of 2 amperes for 120-Volt and 277-Volt drivers.
12. Withstand up to a 4,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
13. Inaudible in a 27 dBA ambient.

C. LED Light Engine Modules:
1. Minimum CRI: 80.
2. Color Temperature: 4000K, unless otherwise noted.
3. Minimum Rated Life: 50,000 hours as per LM79.

2.4. LED INDUSTRIAL STRIP LUMINAIRES

A. INDUSTRIAL STRIP WITH REFLECTOR – L3
1. Type: Industrial Strip, with reflector;
2. Mounting: Surface, or Chain-hung Mounted;
3. Housing: metal parts, die-formed code-gauged steel, or extruded aluminum;
4. Lens: None;
5. LED Driver: Multi-voltage, solid state electronic;
6. Lamp: LED;
7. Finish: Metal Parts: White Polyester enamel;
8. Manufacturer: See Table L3.
9.

TABLE L3 - INDUSTRIAL STRIP FIXTURES WITH REFLECTOR

Manufacturer	1x4		
NOTE: *- complete fixture catalog number not shown			
COLUMBIA	LCL4-35MLEU		
LITHONIA	CLXRN48 L48 5000LM SEF MVOLT GZ10 50K		
METALUX (COOPER)	4SLSTP4040DD-UNV		

OR APPROVED EQUAL

2.5. POLE AND ARM MOUNTED LED LUMINAIRES

A. POLE MOUNTED LUMINAIRE – L5
1. Type: LED Arm-Mounted Cutoff, 4000K.
2. Housing: Aluminum rectilinear or cobra head housing, continuously welded; conduit entry, ¾" NPT conduit; corrosion-resistant industrial dark bronze polyester paint; Tenon mounting slip fitter with 9" arm for mounting on pole, one or two fixtures as shown;
3. Arm: 1¼" Aluminum Schedule 40 pipe, 42" offset from pole, 18" rise.
4. Driver: Multi-voltage HPF LED Driver, single in-line fuse;
5. Reflector: One-piece heavy gauge aluminum anodized reflector; IES Type "IV" or "V" distribu-tion;
6. Lens: Clear tempered glass lens, hinged and gasketed;
7. Lamp: LED;
8. Lamp Socket: None;
9. Manufacturer and Catalog #: See Table L5, or approved equal.
10.

Table L5 – Arm Mounted Pole Luminaires

	Catalog Series, or approved equal		
Manufacturer	Fixture	Mounting-Slipfitter	Photo-electric
LUXMARK	LDRL		*-PER
HUBBEL	PCPAS/PCPAL		*-PC
LITHONIA	ESX1 LED P4 40K R3 HVOLT UPA BLS DDBXD M2	T35-*	*-PE7
Note: **complete fixture catalog number not shown.			

2.6. EXIT SIGNS WITH EGRESS LIGHTING – L6

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    c. Battery: Sealed, maintenance-free, nickel-cadmium type.
    d. Charger: Fully automatic, solid-state type with sealed transfer relay.
    e. Operation: Relay automatically energizes lamp from battery when circuit voltage

drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger. Operate LED egress illumination lamp(s) continuously at an output of 1000 lumens.

f. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

g. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.7. WALL MOUNTED LUMINAIRE – L7

A. WALL MOUNTED LUMINAIRE

1. Type: LED, 3000K.
2. Housing: Aluminum housing, corrosion-resistant industrial dark bronze polyester paint; surface mount to wall over recessed box.
3. Driver: Multi-voltage HPF LED Driver;
4. Reflector: One-piece heavy gauge aluminum anodized reflector;
5. Lens: Clear tempered polycarbinate lens, gasketed;
6. Lamp: LED;
7. Lamp Socket: None;
8. Manufacturer and Catalog #: Lithonia, TWS LED P1 50K 120 PE or approved equal.

2.8. PHOTOCELL SWITCH

A. UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 120 volts ac, 60 Hz with single pole double-throw (SPDT) contacts for mechanically held contactors rated 1000 watts designed to fail to the ON position. Switch shall turn on at or below 32 lux (3 footcandles) and off at 43 to 107 lux (4 to 10 footcandles). A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Provide switch:

B. In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.

2.9. LIGHTING FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.10. LIGHTING POLES AND BASES

A. POLES
1. Type: Pre-cast concrete.
2. Fabrication: Octagonal, steel formed, mild steel reinforced, minimum 28-day compressive strength of 6,500 PSI. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire.
3. Length: 36 feet
4. Embedment depth: 6 feet
5. Design criteria:
    a. Wind velocity: 185 mph
    b. Exposure category: C
    c. Importance factor: 1.00
    d. Wind directionality factor: 0.95 (for octagonal pole)
    e. Gust effect factor: 0.85
    f. Force coefficient: 1.4 (for octagonal pole)
    g. Stand ultimate strength: 270 ksi (ASTM A416)
6. Standards:
    h. IBC
    i. ASCE
    j. ASTM
    k. AASHTO
    l. ACI

B. BASES
1. Type: Cast-in-place
2. Fabrication: Pour neat against soil, ASTM A615 Grade 60 reinforcement, minimum 28-day compressive strength of 3,000 PSI.
3. Depth: 9 feet, Diameter: 4 feet
4. Embedment depth: 6 feet
5. Design criteria:
    a. IBC
    b. ASCE
    c. ASTM
    d. AASHTO
    e. ACI

PART 3 EXECUTION

3.1. INSTALLATION

A. Install luminaries and pole plumb and adjust to align with building, site and property lines and with each other unless otherwise indicated. Secure to prevent movement.

B. Install concrete bases for lighting poles as recommended by pole manufacturer. Install poles plumb.

C. Install luminaries at height as scheduled.

D. Install accessories furnished with each luminaire.

E. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

F. Bond products and metal accessories to branch circuit equipment grounding conductor.

G. Provide specified photometric package and lumen output in each luminaire.

H. Coordinate installation of video surveillance cameras, wireless SCADA routers and signal conduits on poles identified in the project documents.

I. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2. IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3. FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

C. Verify operation of lighting controls, including operation of photoelectric controls.

D. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

3.4. ADJUSTING

A. Adjust Work under provisions of Division 1.

B. Aim and adjust luminaires as indicated on Drawings as directed.

C. Replace luminaires that have failed LED modules at Substantial Completion.

3.5. CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.6. DEMONSTRATION

A. Provide systems demonstration under provisions of Division 1.

B. Provide minimum of two hours demonstration of luminaire operation.

3.7. FIXTURE SCHEDULE

A. Fixture schedule is located on the drawings.

3.8. DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate luminaire operation for minimum of two hours.

3.9. PROTECTION OF FINISHED WORK

A. Relamp luminaires that have failed lamps at Substantial Completion.

END OF SECTION 265000

SECTION 310513 - SOILS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Subsoil materials.
2. Topsoil materials.

B. Related Sections:

1. Section 310516 - Aggregates for Earthwork.
2. Section 312317 - Trenching.
3. Section 312323 - Fill.
4. Section 313700 - Riprap.
5. Section 329119 - Landscape Grading.
6. Section 329219 - Seeding and Soil Supplements.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2216 – Standard Test Methods for Laboratory Determination (Moisture) Content of Soil and Rock by Mass.
5. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
6. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
7. ASTM D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Test Reports: Submit reports of all tests specified to be performed.

C. Materials Source: Submit name of imported materials source.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each subsoil or topsoil material from single source throughout the Work.

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1:

1. On-site excavated and re-used material.
2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
3. Maximum Plasticity Index of 12 and Liquid Limit of 35.
4. A maximum of 25% fines passing the No. 200 mesh sieve.
5. Conforming to ASTM D2487 Group Symbol GM or GC.

2.2 TOPSOIL MATERIALS

A. Topsoil Type S2:

1. Excavated and reused material or imported borrow.
2. Reasonably free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, toxic substances and foreign matter.
3. Imported borrow
    a. Soil conforming to ASTM D2487 Group Symbol OH.
    b. Soluble Salts: 600 ppm maximum
    c. Phosphorus (P): 10-40 ppm
    d. Potassium (K): 121-175 ppm
    e. Acidity range (pH) of 6.0 to 7.0.
    f. Containing minimum of 8 percent and maximum of 25 percent organic matter.

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing and Inspection Services Testing and analysis of soil material.

B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D1557.

C. Testing and Analysis of Topsoil Material: Analyze to ascertain percentage of phosphorus, potassium, soluble salt content, organic matter content, and pH value. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.

D. When tests indicate materials do not meet specified requirements, change or amend material and retest.

E. Furnish materials of each type from same source throughout the Work.

F. Testing frequency shall be one test for every 5,000 cubic yards of each type of imported soil.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.

B. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Contracting Officer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Stockpile topsoil 8 feet high maximum.

E. Prevent intermixing of soil types or contamination.

F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 310513

SECTION 310516 - AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coarse aggregate materials.
2. Fine aggregate materials.

B. Related Sections:

1. Section 310513 - Soils for Earthwork: Fill and grading materials.
2. Section 312316.13 - Trenching.
3. Section 312323 - Fill.
4. Section 313700 - Riprap.
5. Section 329119 - Landscape Grading.
6. Section 331116 - Site Water Utility Distribution Piping.
7. Section 312500 – Erosion and Sedimentation Controls: Slope protection and erosion control.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

E. Copies of test results from qualified testing laboratory and interpretation for compliance of these specifications to be submitted no less than 45 days prior to delivery for each imported material or anticipated use for excavated material.

1. Certified gradation analysis and test results conforming to the specified gradation, properties and characteristics.

2. Classification according to ASTM D2487 of each on-site and imported soil material proposed for fill and backfill.

3. Laboratory compaction curves according to ASTM D1557 for each on-site and imported soil material proposed for fill and backfill.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1 (3/4-inch Minus Granular Backfill): Crushed rock or gravel, and sand with the gradation requirements below. The material shall have a minimum R-value of 78.

1. Percent Passing per Sieve Size:
   a. 3/4 inch: 95-100.
   b. No. 4: 30 to 50.
   c. No. 200: 0 to 12.

B. Coarse Aggregate Type A2 (Crushed Aggregate Base) Crushed aggregate base material shall consist entirely of crushed corraline limestone that it can be compacted readily by watering and rolling to form a firm, stable base. The material shall meet the following requirements:

1. Gradation: Percent Passing per Sieve Size 1½-inch Max.:
   a. 2-inch: 100
   b. 1-1/2 inch: -
   c. 1-inch: 80-100
   d. 3/4 inch: 64-94
   e. 3/8 inch: 40-69
   f. No. 4: 31-54
   g. No. 30: -
   h. No. 40: -
   i. No. 200: 4-7

2. California Bearing Value (CBR): ≥ 100
3. Los Angeles Abrasion: ≤ 50
4. Liquid Limit: ≤ 25
5. Plasticity Index: ≤ 6
6. Sand Equivalent Value: ≥ 22

C. Coarse Aggregate Type A3 (Coarse Drainrock) Crushed granite rock or gravel with the following size gradation for Size Number 4 in accordance with ASTM C33

1. Percent Passing per Sieve Size:
   a. 2-inch: 100
   b. 1-1/2 inch: 90-100
   c. 1-inch: 20-55
   d. 3/4 inch: 0-15
   e. 3/8 inch: 0-5

D. Coarse Aggregate Type A4 (Graded Drainrock) Drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded with the following size gradation for Size Number 57 in accordance to ASTM C33

1. Percent Passing per Sieve Size:
   a. 1-1/2 inch: 100
   b. 1-inch: 95-100
   c. 1/2 inch: 25-60
   d. No. 4: 0-10
   e. No. 8: 0-5

E. Aggregate Type A5 (Pea Gravel): Clean and graded, washed gravel with the following size gradation for Size Number 8 in accordance with ASTM C33. The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

1. Percent Passing per Sieve Size:
   a. ½-inch: 100
   b. 3/8-inch: 85-100
   c. No. 4: 10-30
   d. No. 8: 0-10
   e. No. 16: 0-5

2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate Type A6 (Sand): Non-plastic, clean, natural sand or a combination of natural and manufactured granular material, free from loam, clay, mica, organic material or other substances not suitable for the purpose intended. Manufactured sand shall be the product obtained by crushing stone or gravel specially processed to assure suitable particle shape and gradation. Stone dust will not be permitted.

1. Percent Passing per Sieve Size:

a. 3/8-inch: 100
b. No. 4: 95-100
c. No. 30: 25-60
d. No. 50: 5-30
e. No. 200: 0-6

2. Liquid Limit: ≤ 25
3. Plasticity Index: ≤ 6

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing and inspection services.

B. Coarse Aggregate Material - Testing and Analysis: Perform according to ASTM D698. ASTM D1557. AASHTO T180. ASTM D4318. ASTM C136.

C. Fine Aggregate Material - Testing and Analysis: Perform according to ASTM D698. ASTM D1557. AASHTO T180. ASTM D4318. ASTM C136.

D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate aggregate materials from on-site locations indicated as specified in Section 312316.00 and 312316.26.

B. Stockpile excavated material meeting requirements for coarse aggregate materials and fine aggregate materials.

C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for coarse aggregate materials and fine aggregate materials from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 310516

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing surface debris.
2. Removing designated paving, curbs and other structures.
3. Removing designated trees, shrubs, and other plant life.
4. Removing abandoned utilities.
5. Excavating topsoil.

B. Related Sections:

1. Section 312318 - Rock Removal.
2. Section 312500 – Erosion and Sedimentation Controls.

1.2 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

1.3 QUALITY ASSURANCE

A. Conform to Guam EPA standards and permit requirements for environmental requirements, disposal of debris, burning debris on site, and use of herbicides.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Herbicide: Approved by Guam EPA

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify existing plant life designated to remain is tagged or identified.

C. Identify waste area and salvage area for placing removed materials.

3.2 PREPARATION

A. Call Local Utility Line companies at GTA 644-4482 and at GWA 647-7831 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.

B. The information and data indicated in the Contract Documents with respect to existing underground Utilities at or contiguous to the Site are based on information and data furnished to GWA or the Engineer by GWA of such underground Utilities or by others. GWA and the Engineer will not be responsible for the accuracy or completeness of any such information or data, and the Contractor shall have full responsibility for reviewing and checking all such information and data, for locating all underground utilities indicated in the Contract Documents, for coordination of the Work with GWA of such underground utilities during construction the safety and protection thereof, and for repairing any damage thereto resulting from the Work; the cost of all of which are deemed to have been included in the contract price.

C. If an underground utility is uncovered or revealed at or contiguous to the Site which was not indicated in the Contract Documents and which the Contractor could not reasonably have been expected to be aware of, the Contractor shall identify GWA of such underground utility and give written notice thereof to that owner and shall notify the Contracting Officer.

D. Protect trees, plant growth, and features designated to remain, as final landscaping.

E. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING

A. Clear areas required for access to site and execution of Work to minimum depth of 12 inches.

B. Remove trees and shrubs within marked areas indicated. Remove stumps, main root ball, root system to depth of 48 inches and surface rock.

C. Clear undergrowth and deadwood, without disturbing subsoil.

D. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Remove paving, curbs and other structures as indicated on Drawings. Neatly saw cut edges at right angle to surface.

C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

E. Do not burn or bury materials on site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, relandscaped, or marked areas without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to height not exceeding 8 feet and protect from erosion. Stockpile material on impervious material and cover over with same material, until disposal.

D. Remove excess topsoil not intended for reuse, from site.

END OF SECTION 311000

SECTION 312316 - EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating for building foundations.
2. Excavating for paving, roads, and parking areas.
3. Excavating for slabs-on-grade.
4. Excavating for site structures.
5. Excavating for landscaping.

B. Related Sections:

1. Section 310513 - Soils for Earthwork: Stockpiling excavated materials.
2. Section 310516 - Aggregates for Earthwork: Stockpiling excavated materials.
3. Section 311000 – Site Clearing: Topsoil and subsoil removal from site surface.
4. Section 312317 - Trenching: Excavating for utility trenches.
5. Section 312318 - Rock Removal: Removal of rock during excavating.
6. Section 312323 - Fill.
7. Section 331116 - Site Water Utility Distribution Piping.

1.2 REFERENCES

A. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
3. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. Local utility standards when working within 24 inches of utility lines.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Guam EPA's Permit Requirements and the Geotechnical Report.

B. Maintain one copy of documents on site.

1.5 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in the Territory of Guam.

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Call Local Utility Line companies at GTA 644-4482 and at GWA 647-7831 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum.

C. Protect utilities indicated to remain from damage.

D. Protect plant life, lawns, and other features remaining as portion of final landscaping.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

F. Comply with all Guam EPA Permit Requirements.

3.2 EXCAVATION

A. Underpin adjacent structures which may be damaged by excavation work.

B. Excavate subsoil to accommodate building foundations, slabs-on-grade paving and site structures, construction operations.

C. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 312323.

D. Slope banks with machine to angle of repose or less until shored.

E. Do not interfere with 45 degree bearing splay of foundations.

F. Grade top perimeter of excavation to prevent surface water from draining into excavation.

G. Trim excavation. Remove loose matter.

H. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. Remove larger material as specified in Section 312323.

I. Notify Engineer of unexpected subsurface conditions.

J. Correct areas over excavated with structural fill Type A2 specified in Section 312323.

K. Stockpile subsoil in area designated on site to depth not exceeding 8 feet and protect from erosion.

L. Repair or replace items indicated to remain damaged by excavation.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements and 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Request inspection of excavation and controlled fill operations by Contracting Officer at each lift.

C. Request visual inspection of bearing surfaces by Engineer before installing subsequent work.

3.4 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION 312316

SECTION 312316.13 - TRENCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating trenches for utilities from 5 feet outside building to utility service.
2. Compacted fill from top of utility bedding to subgrade elevations.
3. Backfilling and compaction.

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete: Concrete materials.
2. Section 310513 - Soils for Earthwork: Soils for fill.
3. Section 310516 - Aggregates for Earthwork: Aggregates for fill.
4. Section 312316 - Excavation: General building excavation.
5. Section 312323 - Fill: General backfilling.
6. Section 313700 - Riprap.
7. Section 329119 - Landscape Grading: Filling of topsoil over backfilled trenches to finish grade elevation.
8. Section 331116 - Site Water Utility Distribution Piping: Water piping and bedding from building to utility service.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

C. Samples: Submit, in air-tight containers, 10 lb. sample of each type of fill to testing laboratory.

D. Materials Source: Submit name of imported fill materials suppliers.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with OSHA standard and Guam Environmental Protection Agency’s Permit Requirements.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in the Territory of Guam.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 COORDINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Pipe Bedding: Type A6 as specified in Section 310516.

B. Subsoil Fill: Type S1 as specified in Section 310513.

C. Structural Fill: Type A2 as specified in Section 310516.

D. Granular Fill: Type A1 as specified in Section 310516.

E. Concrete: Lean concrete.

PART 3 - EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.

1. Engineer and Owner reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Maintain grade alignment of pipe using string line parallel with grade line and vertically above centerline of pipe.

1. Establish string line on level batter boards at intervals of not more than 25 feet.
2. Install batter boards spanning trench, rigidly anchored to posts driven into ground on both sides of trench.
3. Set three adjacent batter boards before laying pipe to verify grades and line.
4. Determine elevation and position of string line from elevation and position of offset points or stakes located along pipe route.
5. Do not locate pipe using side lines for line or grade

3.2 PREPARATION

A. Call Local Utility Line companies at GTA 644-4482 and at GWA 647-7831 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work. Contractor to secure appropriate permit from Department of Public Works.

3.3 TRENCHING

A. Excavate subsoil required for utilities to utility service.

B. Remove lumped subsoil, boulders, and rock up of 1/6 cubic yard, measured by volume. Remove larger material as specified in Section 312316.26.

C. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

D. Do not advance open trench more than 200 feet ahead of installed pipe.

E. Cut trenches to width indicated on Drawings. Remove water or materials that interfere with Work.

F. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

G. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

H. Do not interfere with 45 degree bearing splay of foundations.

I. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.

J. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Engineer until suitable material is encountered. notify Engineer, and request instructions.

K. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type Granular Fill and compact to density equal to or greater than requirements for subsequent backfill material.

L. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

M. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.

N. Remove excess subsoil not intended for reuse, from site.

3.4 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

A. Backfill trenches to contours and elevations, or to match existing grade with fill materials. When backfilling within the public right-of-way, follow DPW standards.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, or spongy subgrade surfaces.

C. Place material in continuous layers as follows:

1. Pipe Bedding: Maximum 8 inches compacted depth.
2. Subsoil Fill: Maximum 12 inches compacted depth.
3. Structural Fill: Maximum 8 inches compacted depth.
4. Granular Fill: Maximum 8 inches compacted depth.

D. Employ placement method that does not disturb or damage foundation perimeter drainage, utilities in trench.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Do not leave more than 50 feet of trench open at end of working day.

G. Protect open trench to prevent danger to the public.

3.6 TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1/2 inch from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1/2 inch from required elevations.

3.7 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements : Field inspecting, testing, adjusting, and balancing.

B. Perform laboratory material tests in accordance with ASTM D1557.

C. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
2. Moisture Tests: ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

E. Frequency of Tests: Per Section 331116 – Site Water Utility Distribution Piping.

3.8 PROTECTION OF FINISHED WORK

A. Section 017000 - Execution and Closeout Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.9 SCHEDULE

A. Storm and Waterline Piping:

1. Cover pipe and bedding with Fill Type Granular Fill: To subgrade elevation.
2. Compact uniformly to minimum 95 percent of maximum density.

B. Duct Bank:

1. Cover duct and bedding with Fill Type Granular Fill: To subgrade elevation.
2. Compact uniformly to minimum 95 percent of maximum density.

END OF SECTION 312316.13

SECTION 312316.26 - ROCK REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing identified and discovered rock during excavation.
2. Expansive tools to assist rock removal.

B. Related Sections:

1. Section 312316 - Excavation: Building excavation.
2. Section 312317 - Trenching: Trenching and backfilling for utilities.
3. Section 312323 - Fill: Backfill materials.
4. Section 313700 - Riprap.

1.2 DEFINITIONS

A. Site Rock: Solid mineral material with volume in excess of 1/3 cu yd or solid material that cannot be removed with 3/4 cu yd capacity excavator.

B. Trench Rock: Solid mineral material with volume in excess of 1/6 cu yd or solid material that cannot be removed with 3/4 cu yd capacity excavator.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements:Coordination and project conditions.

B. Verify site conditions and note subsurface irregularities affecting Work of this section.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

3.3 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method.

1. Drill holes and use wedges to fracture rock.

B. Cut away rock at bottom of excavation to form level bearing.

C. Remove shaled layers to provide sound and unshattered base for foundations.

D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

E. Remove excavated materials from site.

F. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 312323.

3.4 FIELD QUALITY CONTROL

A. Request visual inspection of foundation bearing surfaces by Geotechnical Engineer before installing subsequent work.

END OF SECTION 312316.26

SECTION 312323 - FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete: Concrete materials.
2. Section 310513 - Soils for Earthwork: Soils for fill.
3. Section 310516 - Aggregates for Earthwork: Aggregates for fill.
4. Section 312316 - Excavation.
5. Section 312317 - Trenching: Backfilling of utility trenches.
6. Section 313700 - Riprap.
7. Section 329119 - Landscape Grading: Filling of topsoil to finish grade elevation.
8. Section 331116 - Site Water Utility Distribution Piping.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for geotextile fabric indicating fabric and construction.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Guam Department of Public Work's standard.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S1 as specified in Section 310513.

B. Structural Fill: Type A2 as specified in Section 310516.

C. Granular Fill: Type A1 as specified in Section 310516.

D. Drainrock Fill: Type A4 as specified in Section 310516.

E. Concrete: Flowable fill concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

C. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 6 inches.

D. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 BACKFILLING

A. Backfill areas to contours and elevations, or match existing grade, as specified.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 8 inches compacted depth.
2. Structural Fill: Maximum 6 inches compacted depth.
3. Granular Fill: Maximum 6 inches compacted depth.

D. Employ placement method that does not disturb or damage other work.

E. Maintain optimum moisture content of backfill materials to attain required compaction density.

F. Backfill against supported foundation and retaining walls. Do not backfill against unsupported foundation and retaining walls.

G. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.

H. Slope grade away from building minimum 2 percent slope for minimum distance of 10 ft, unless noted otherwise.

I. Make gradual grade changes. Blend slope into level areas.

J. Remove surplus backfill materials from site.

K. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

B. Top Surface of Backfilling Within Building or Structure Areas: Plus or minus 1/2 inch from required elevations.

C. Top Surface of Backfilling Under Paved Areas: Plus or minus 1/2 inch from required elevations.

D. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform laboratory material tests in accordance with ASTM D1557.

C. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
2. Moisture Tests: ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

E. Frequency of Tests: One test for each 1,000 square feet of each lift of fill material.

F. Proof roll compacted fill surfaces under slabs-on-grade, and paving.

3.6 PROTECTION OF FINISHED WORK

A. Section 017000 - Execution and Closeout Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic.

3.7 SCHEDULE

A. Interior Slab-On-Grade, Vault Floor Slab:

1. Fill Type Structural Fill, thickness per drawings, compacted to 95 percent.

B. Fill Under Grass Areas:

1. Fill Type Subsoil Fill, to 6 inches below finish grade, compact uniformly to 90 percent of maximum density.

C. Fill Under Asphalt and Concrete Paving:

1. Compact subsoil to 95 percent of its maximum dry density.
2. Fill Type Granular Fill, to bottom of pavement layer, compact uniformly to 98 percent of maximum density, or per Department of Public Works if within the right-of-way.

D. Fill to Correct Over-excavation:

1. Fill Type Structural Fill, flush to required elevation, compact uniformly to 95 percent of maximum density.

END OF SECTION 312323

SECTION 312323.33 - FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flowable fill for:
   a. Structure backfill.
   b. Utility backfill.

B. Related Requirements:

1. Section 312316 - Excavation: General building excavation.
2. Section 312317 - Trenching: Soil and aggregate backfill for utility trenches.
3. Section 312323 - Fill: Soil and aggregate backfill for structures.
4. Section 329119 - Landscape Grading: Filling of topsoil over backfilled trenches to finish grade elevation.
5. Section 331116 - Site Water Utility Distribution Piping: Water piping and bedding from building to utility service.

1.2 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

B. Excavatable Flowable Fill: Lean cement concrete fill used where future excavation may be required, such as fill for utility trenches, bridge abutments, and culverts.

C. Non-excavatable Flowable Fill: Lean cement concrete fill used where future excavation is not anticipated, such as fill below structure foundations and filling abandoned utilities.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
3. ASTM C150 - Standard Specification for Portland Cement.
4. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
5. ASTM C403/C403M - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
6. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
7. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

8. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
9. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
10. ASTM D5971 - Standard Test Method for Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM).
11. ASTM D6023 - Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM).
12. ASTM D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Field Quality-Control Submittals:

1. Mix Design:
   a. Furnish flowable fill mix design for each specified strength.
   b. Identify design mix ingredients, proportions, properties, admixtures, and tests.
2. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements.

D. Delivery Tickets:

1. Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.

1.5 QUALITY ASSURANCE

A. Perform Work according to Guam Department of Public Work’s standards.

B. All testing will be performed by a testing laboratory selected by the Contractor and approved by the Construction Manager, except as otherwise indicated.

1.6 QUALIFICATIONS

A. Supplier:

1. Company specializing in supplying products specified in this Section with minimum three years documented experience.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 015000 - Temporary Facilities and Controls specifies ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not install flowable fill during inclement weather.

PART 2 - PRODUCTS

2.1 FLOWABLE FILL

A. Flowable Fill: Excavatable type. Non-excavatable type to follow Section 033000 - Cast-in-Place Concrete.

2.2 MATERIALS

A. Portland Cement: ASTM C150 Type II

B. Pozzolan: ASTM C618, Type F or C. Pozzolan content, by weight, in excavatable type shall not be greater than cement content.

C. Aggregates: ASTM C33.

D. Water: Clean and not detrimental to concrete.

2.3 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical Admixture: ASTM C494/C494M.

1. Type A - Water Reducing.

C. Fly Ash: ASTM C618 Class C or F obtained from residue of electric generating plant using ground or powdered coal.

2.4 MIXES

A. Mix and deliver flowable fill according to ASTM C94/C94M, Option A.

B. Flowable Fill Design Mix Requirements:

1. 28-Day Compressive Strength:
   a. Excavatable: Maximum 500 psi.
   b. Minimum 1,000 psi. Follow requirements of Section 033300 - Cast-in-Place Concrete.
2. Flow Test:
   a. Excavatable and Non-Excavatable: 8 to 12-inches.

C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.

D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.5 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.

B. Test and analyze properties of flowable fill design mix and certify results for the following:

1. Design mix proportions by weight of each material.
2. Aggregate: ASTM C33 for material properties and gradation.
3. Properties of plastic flowable fill design mix including:
    a. Temperature.
    b. Air entrainment.
    c. Wet unit mass.
    d. Yield.
    e. Cement factor.
    f. Flow Consistency.
4. Properties of hardened flowable fill design mix including:
    a. Compressive strength at 1 day, 7 days, and 28 days. Report compressive strength of each specimen and average specimen compressive strength.
    b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.

C. Prepare delivery tickets containing the following information:

1. Project designation.
2. Date.
3. Time.
4. Class and quantity of flowable fill.
5. Actual batch proportions.
6. Free moisture content of aggregate.
7. Quantity of water withheld.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting Work.

B. Verify excavation specified in Section 312316 Excavation and Section 312316.13 Trenching is complete.

C. Verify utility installation is complete and tested before placing flowable fill.

D. Verify excavation is dry and dewatering system is operating.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.

C. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.

D. Protect utilities and foundation drains to prevent intrusion of flowable fill.

3.3 INSTALLATION - FILL, BEDDING, AND BACKFILL

A. Place flowable fill by chute, pumping or other methods approved by the Engineer.

1. When required, place flowable fill under water using tremie procedure.
2. Do not place flowable fill through flowing water.

B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.

C. Place flowable fill evenly on both sides of utilities to maintain alignment.

D. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Perform inspection and testing according to ASTM C94/C94M.

1. Take samples for tests for every 150 cu yd of flowable fill, or fraction thereof, installed each day.
2. Sample, prepare and test four compressive strength test cylinders according to ASTM D4832. Test one specimen at 3 days, one at 7 days, and two at 28 days.
3. Measure temperature at point of delivery when samples are prepared.
4. Sample and flow test according to ASTM D6103

C. Defective Flowable Fill: Fill failing to meet the following test requirements or fill delivered without the following documentation.

1. Test Requirements:
   a. Minimum temperature at point of delivery.
   b. Compressive strength requirements for each type of fill.
   c. Flow test results at point of delivery.
2. Documentation: Duplicate delivery tickets.

3.5 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Remove spilled and excess flowable fill from Project Site.

C. Restore facilities and Site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION 312323.33

SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diversion Channels.
2. Sedimentation Ponds.
3. Erosion Control Blankets.

B. Related Sections:

1. Section 031000 - Concrete Forming and Accessories.
2. Section 032000 - Concrete Reinforcing.
3. Section 033000 - Cast-In-Place Concrete.
4. Section 040514 - Masonry Mortaring and Grouting.
5. Section 310513 - Soils for Earthwork.
6. Section 310516 - Aggregates for Earthwork.
7. Section 311000 - Site Clearing.
8. Section 312316 - Excavation.
9. Section 312323 - Fill.
10. Section 329119 - Landscape Grading.
11. Section 329219 - Seeding.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T88 - Standard Specification for Particle Size Analysis of Soils.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.

C. ASTM International:

1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).

4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D. Precast/Prestressed Concrete Institute:

1. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Product Data: Submit data on geotextile and erosion control blanket.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with requirements of Section 311000, Section 312323, Section 329119, and Section 329219.

B. Perform Work according to Guam EPA standards.

C. Maintain one copy of each document on site.

1.6 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

PART 2 - PRODUCTS

2.1 GEOTEXTILE MATERIALS

A. Geotextile Fabric: Furnish according to Guam EPA standards.

1. Must maintain 125 gpm per sq. ft. flow rate. Note: a 4" washed, rounded limestone aggregate layer may be substituted for geotextiles meant to separate layers.
2. Size: 0.08" thick equivalent opening size of #80 sieve.
3. In accordance with ASTM D751 (puncture strength – 125lb); ASTM D1117 (Mullen Burst Strength – 400 psi); ASTM D1682 (Tensile Strength – 300lb.)

B. Silt Fence Material: Furnish according to the plans.

2.2 EROSION CONTROL BLANKETS (ECB)

A. Manufacturers:

1. Contech Engineered Solutions/Landlok
2. Nilex
3. ACF Environmental
4. Carthage Mills
5. Or approved equal

B. Materials

1. Extended-term ECB with functional longetivity of 2 years.
2. 100% coconut fiber and two polypropylene nets securely sewn together with UV stabilized thread.
3. Light penetration – minimum 16% per ASTM D6567.
4. Tensile strength – minimum 100 lb/ft per ASTM D6818.
5. Unvegetated shear stress – minimum 2 lb/ft^2 per ASTM D6460.

2.3 POSTS FOR SILT FENCE

A. Fence Posts (for fabricated units): The length shall be a minimum of 36 inches long. Wood posts will be of sound quality hardwood with a minimum cross sectional area of 3.0 square inches. Steel posts will be standard T and U section weighing not less than 1.00 pound per linear foot.

2.4 WIRE FENCE FOR SILT FENCE

A. Wire Fence (for fabricated units): Wire fencing shall be a minimum 14 gage with a maximum 6 in. mesh opening, or as approved.

2.5 CONCRETE MATERIALS AND REINFORCEMENT

A. Cement: As specified in Section 033000.

B. Fine and Coarse Aggregates: as specified in Section 033000.

C. Water: Clean and not detrimental to concrete.

D. Admixtures:

1. Air Entrainment: manufactured by.
2. Chemical: As specified in Section 033000.
3. Fly Ash or Calcined Pozzolan: As specified in Section 033000.
4. Plasticizing: As specified in Section 033000.

E. Aggregate, Sand, Water, Admixtures - Precast: Determined by precast fabricator, as appropriate to design requirements and PCI MNL-116S.

F. Reinforcement Steel: As specified in Section 032000.

G. Welded Steel Wire Fabric: As specified in Section 032000.

2.6 AGGREGATE, AND SOIL MATERIALS

A. Coarse Aggregate: Type A1, as specified in Section 310516.

B. Soil Backfill: Soil Type S1, as specified in Section 310513. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

2.7 PLANTING MATERIALS

A. Seeding and Soil Supplements: As specified in Section 329219.

B. Mulch: As specified in Section 329219.

2.8 ACCESSORIES

A. Joint Sealers: As specified in Section 033000.

B. Joint Filler: As specified in Section 033000.

C. Grout: As specified in Section 040514.

2.9 MIXES

A. Concrete: As specified in Section 033000.

2.10 SOURCE QUALITY CONTROL (AND TESTS)

A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.

B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.

C. Test samples in accordance with ACI 301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify compacted subgrade, granular base or stabilized soil is acceptable and ready to support devices and imposed loads.

C. Verify gradients and elevations of base or foundation for other work are correct.

3.2 DIVERSION CHANNELS

A. Windrow excavated material on low side of channel.

B. Compact to 95 percent maximum density.

C. On entire channel area, apply soil supplements and sow seed as specified in Section 329219.

D. Mulch seeded areas with hay as specified in Section 329219.

3.3 SEDIMENTATION POND

A. Install Work according to the CNMI and Guam Stormwater Management Manual standards

3.4 EROSION CONTROL BLANKETS

A. Install on all slopes 3:1 or steeper and 6 feet or greater in length along the slope.

B. Install per manufacturer’s instructions.

C. Grade and compact area prior to installation. Remove large rocks, soil clods, vegetation and other sharp objects.

D. Amend soil, add fertilizer, and seed per Section 329219.

E. Dig anchor trench at top of slope. Extend end of blanket 6-12 inches beyond trench toward slope. Use staples or stakes to fasten blanket into trench at 12 inches on center. Backfill with soil and compact. Cover backfill with blanket roll and fasten on downhill side of trench at 12 inches on center.

F. Continue to unroll blanket down slope, ensuring direct contact with ground. Overlap edges a minimum of 3 to 6 inches.

G. Fasten with stakes or staples per manufacturer’s specifications. Do not stretch the blanket.

3.5 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2: 1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.

1. During non-germinating periods, apply mulch at recommended rates.
2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one year in accordance with Section 329219 at 50 percent of permanent application rate with no topsoil.
3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 329219 permanent seeding specifications.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.6 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements and 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

C. Field test concrete in accordance with Section 033000.

D. Compaction Testing: As specified in Section 312323.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.7 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

C. Do not damage structure or device during cleaning operations.

D. Do not permit sediment to erode into construction or site areas or natural waterways.

E. Clean channels when depth of sediment reaches approximately one half channel depth.

3.8 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Do not permit construction traffic over paving for 7 days minimum after finishing until 75 percent design strength of concrete has been achieved.

D. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION 312500

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.
5. Asphalt paving overlay for existing paving.
6. Surface slurry.

B. Related Requirement:

1. Section 099000 - Painting and Coating: Pavement markings.
2. Section 310516 – Aggregates for Earthwork: Base course
3. Section 312323 - Fill: Compacted subbase for paving.
4. Section 321723 - Pavement Markings: Painted pavement markings, lines, and legends.

C. The work under this section shall consist of furnishing all materials, mixing at the plant, hauling, placing and compacting a mixture of aggregate materials, mineral admixture, additives, and an asphalt binder to form a pavement course, or other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

D. It is the intent of this specification that the Contractor acquire and make all arrangements for a source, or sources, of material; that it furnish Certificates of Compliance as hereinafter specified; that it furnish a mix design using Marshall mix design methodology that will meet the design criteria specified hereinafter; and that it provide all the equipment, materials, and labor necessary to furnish and place the asphalt concrete in accordance with the requirements specified herein.

E. The mix design shall follow the methods as described in the most current edition of Design Methods for Asphalt Concrete and Other Hot-Mix Types MS-2 published by the Asphalt Institute.

1.2 REFERENCE STANDARDS

A. Federal Highway Administration

1. FP-03 – The Standard Specifications of the Construction of Roads and Bridges on Federal Highway Projects.

B. American Association of State Highway and Transportation Officials:

1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

C. Asphalt Institute:

1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
2. AI MS-19 - Basic Asphalt Emulsion Manual.
3. AI SP-2 - Superpave Mix Design.

D. ASTM International:

1. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
2. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
3. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
4. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
5. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
6. ASTM D977 - Standard Specification for Emulsified Asphalt.
7. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
8. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
9. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
10. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
11. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
12. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
13. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
14. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
15. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
16. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
17. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

18. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
19. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
20. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
21. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Conform to Public Work's standard**.**

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 5 years experience.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Aggregate: the more stringent of FP-03 Subsection 703.07 or Tables 321216-1 & 2

B. Asphalt binder: Tables 321216-1 & 2

C. Additives: As accepted by the Engineer

D. High-tensile strength synthetic fibers*: As accepted by the Engineer

E. Anti-strip additive use Type 3 (lime). Anti-strip additive shall be used on all bridge decks and where HMA is placed over concrete.

2.2 ASPHALT CONCRETE MIX DESIGN CRITERIA

A. The Contractor shall do all things necessary to furnish, develop, and supply asphalt concrete pavements to comply with the design and acceptance requirements for the HMA design as specified herein. Variation to the requirements shall not be considered except as may be hereinafter specified in Subsection 3.14, Alternate Mix Design Criteria.

Table 321216-1
HMA Base Course Requirements:

Criteria (AASHTO T 245)	Requirements
Voids in Mineral Aggregate (VMA)	13% minimum
Air Voids	3.0% to 5.0%
Air Voids Design Target Value	4%
Stability, pounds minimum	2700
Flow, 0.01 inches	8-14
Compaction, number of blows each end of test specimen	75
Dust –asphalt ratio	0.8-1.2
Asphalt Cement Binder	AR16000 or PG 70-10. AR8000 with additive may be used with approval of the Engineer
Immersion Compression (AASHTO T165 and T167) (1) Compressive strength, psi (dry) (2) Retained strength, minimum	 300 70%
Gradation (AASHTO T 27 & T 11)	FP-03 Table 703-4, Gradation Designation B
Los Angeles abrasion, AASHTO T 96	35% maximum
Sodium sulfate soundness loss of course and fine aggregate (5 cycles), AASHTO T 104	12% maximum
Fractured faces, ASTM D 5821	95% minimum, one face 90% minimum, two faces
Fine aggregate angularity, AASHTO T 304, method A	42 minimum
Flat and elongated particles, 3 to 1 ratio, ASTM D 4791	10% maximum 3:1 Ratio
Sand equivalent value, AASHTO T 176, alternate method No. 2, reference method	45 minimum

(a) For base course (binder) mixes, the VMA shall be calculated and reported to the nearest tenth of a percent. This value will be rounded to the nearest whole number for Job Mix Formula (JMF) acceptance and JMF verification testing. VMA calculated to xx.5% shall be rounded up to the nearest whole percent.

(b) Up to 15 percent recycled asphalt pavement material by mass may only be used in the HMA Base Course Mix.

(c) Furnish hard, durable particles or fragments of crushed stone, crushed slag, or crushed gravel.

Table 321216-2
HMA Friction Course Requirements:

Criteria (AASHTO T 245)	Requirements
Voids in Mineral Aggregate (VMA)	15% minimum
Air Voids	3.0% to 5.0%
Air Voids Design Target Value	4%
Stability, pounds minimum	2,000
Flow, 0.01 inches	8-14
Compaction, number of blows each end of test specimen	75
Dust-asphalt ratio	0.8-1.2
Asphalt Cement Binder	AR16000, or PG 70-10. AR8000 with additive – use will be limited and only with the approval of the Engineer
Immersion Compression (AASHTO T165 and T167) (1) Compressive Strength, psi (dry) (2) Retained strength, minimum	 300 70%
Gradation (AASHTO T 27 & T11)	FP-03 Table 703-4, Gradation Designation D
Fine Aggregate Angularity (AASHTO T 304)	43 minimum
Los Angeles abrasion, AASHTO T 96	30% maximum

(a) Voids in Mineral Aggregate (VMA) shall be calculated to the nearest tenth of a percent. VMA calculated to xx.5% shall be rounded up to the nearest whole percent for Job Mix Formula (JMF) acceptance and JMF verification. VMA shall be determined in accordance with Asphalt Institute Manual Series No. 2 (MS-2).

(b) The percent asphalt shall target a value of 4% air voids, to the nearest whole percent, for the preparation of the Job Mix Formula (JMF).

(c) The percent of air voids shall be based on AASHTO T166, T209, and T269. Maximum specific gravity (density) shall be based on AASHTO T 209.

(d) Dust-asphalt ratio is defined as the percent of material including non-liquid anti-strip and mineral filler passing the No. 200 sieve divided by the percent of the effective asphalt (calculated by mass of mix).

(e) The aggregate for the asphalt concrete wearing surface (friction course) shall be basalt or approved equivalent. Limestone, relatively pure carbonate aggregates or any aggregates known to polish shall not be used in the mix. The Los Angeles abrasion value for these aggregates shall not exceed 30%.

(f) An anti-strip additive is required for asphalt concrete wearing surface (friction course) when placed on bridge decks and concrete pavement.

(g) AR8000 asphalt cement binder may be used, with an additive, upon approval of the Engineer. The additive may be a Warm Mix or Polymer that shall modify the properties of AR8000 to meet or exceed AASHTO M 320, Standard Specifications for Performance-Graded Asphalt Binder for PG 70-10. The equivalent PG Grade and True Performance Grade of the AR8000 with the additive shall be submitted with the LJMF (Laboratory Job Mix Formula).

(h) No recycled asphalt pavement material is allowed in the friction course hot mix asphalt.

2.3 COMPOSITION OF LABORATORY JOB MIX FORMULA (LJMF)

A. The Contractor shall furnish mixes of aggregate, asphalt cement binder and additives that meet the applicable material requirements, appropriate design requirements specified in Tables 321216-1 and 321216-2, and are capable of being placed and compacted as specified.

1. Submission of LJMF. Utilizing mineral aggregate which has been crushed, processed, separated, and stockpiled for this project, a LJMF shall be formulated and submitted by the Contractor on Form FHWA 1622 (Marshall) and FHWA 0.45 power gradation charts for review at least 28 days before production begins. The LJMF shall include the location of all commercial mixing plants to be used. A separate LJMF for each plant is required. The LJMF shall be prepared under the direct supervision of, and shall bear the seal of, a registered professional engineer authorized to practice on Guam. The LJMF shall also include a signed statement prepared by the testing laboratory that certifies the proposed job-mix formula meets the requirements of the contract and can be compacted in the field during production to meet contract requirements.

   Testing laboratories used by the Contractor for Quality Control testing shall be properly accredited.

   Acceptable laboratory accreditations are:

   - American Association of State Highway and Transportation officials (AASHTO)
   - American Association for Laboratory Accreditation (A2LA)
   - International Accreditation Services, Inc. (IAS)
   - National Voluntary Laboratory Accreditation Program (NVLAP)
   - U.S. Army Corps of Engineer Materials testing Center (MTC)

   The Contractor shall supply split samples of aggregate, admixture and binder with the LJMF in the event the Engineer decides to perform verification testing. These samples shall be taken by the Contractor's personnel as split samples from the same material used for development of the LJMF. The samples shall be collected and split under the observation of the Engineer or the Engineer's representative.

   For each LJMF the Contractor shall submit the following:

   a. Aggregate and mineral filler.
      1) Target values;
         a) Target value for percent passing each sieve size for the aggregate blend; and
         b) Target values for the percent passing each sieve size for each stockpile.
      2) Stockpile blend ratios;
      3) Target values for individual hot bins of batch plants;
      4) Hot bin blend ratios;
      5) Target asphalt content;

6) Maximum density value according to AASHTO T 209;
7) Source and percentage of each aggregate stockpile to be used;
8) Average gradation of each aggregate stockpile;
9) Representative samples from each aggregate stockpile. Use split samples of material taken in accordance with 2.3(A.1) above;
10) 200 pounds of aggregates proportioned by stockpile according to the stockpile's proportion in the mix;
11) 20 pounds of bag house fines if proposed for the mix;
12) 20 pounds of mineral filler if proposed for mix; and
13) Results of aggregate quality tests for Contractor selected sources. Include the sand equivalent, fractured faces, Los Angeles abrasion, sodium sulfate soundness, coarse durability, and fine durability results from tests performed within 1 month of aggregate use.

b. Asphalt binder.
1) Target asphalt binder content;
2) Three 1-gallon samples of the asphalt binder to be used in the mix. Do not include anti-strip additives in these samples;
3) Recent test results from the manufacturer for the asphalt binder including a temperature-viscosity curve;
4) Material safety data sheets; and
5) Mixing temperature range and minimum compaction temperature for the grade of asphalt to be used in the mix.

c. Anti-strip additives. If part of the job-mix formula:
1) 1 pint of liquid anti-strip additive or 10 pounds of cement, fly ash, or lime anti-strip additive;
2) Name of product;
3) Manufacturer;
4) Material safety data sheet; and
5) Dosage rate.

d. High tensile strength reinforcing (micro) fibers.
The fiber reinforcement shall conform to the following
1) Approximate fiber length: ¾" (19mm);
2) Synthetic aramid fiber blend.
3) A high fiber tensile strength > 390,000 p.s.i.
4) Synthetic aramid fiber blend shall be tested using the Indirect Tensile (IDT) strength test protocol from AASHTO T322 or ASTM D6931 from a minimum of three (3) separate laboratory trials. Test results shall be conducted at a temperature between 50 degrees F and 70 degrees F and compared with a control that does not contain the aramid fiber blend. The aramid fiber blend shall be identical to control mix except for the inclusion of fibers added at the same dosage as proposed on the project. Indirect tensile test results from fiber specimens shall show an average tensile strength increase of 20 percent over control specimen.
5) Synthetic aramid fiber blend shall be tested using the Aramid Dispersion State Ratio (ADSR) Tests from a minimum of two (2) separate laboratory trials. Perform ADSR test based on ASTM D2172. The average extracted aramid fiber quantity must be greater than or equal to 0.007 percent by total sample weight with no individual result less than 0.005 percent of the total sample weight. All tested fiber mixes must achieve a minimum ADSR of 85%.
6) Fiber dosage rate and tolerance per manufacturer's requirements.

7) Fiber addition during asphalt production that ensure efficient and thorough distribution, mixing and melting of fibers through asphalt mix.
8) No change to the HMA mix design other than the addition of fibers.

e. Recycled asphalt pavement material. If part of the job-mix formula:
1) Source and percentage of recycled asphalt pavement material;
2) Average gradation of the recycled asphalt pavement material;
3) Percent asphalt binder in the recycled asphalt pavement;
4) Target value for the asphalt binder content (that considers the percent asphalt binder in the recycled asphalt pavement) and the percent new (virgin) asphalt binder to be added to the mix;
5) 200-pound representative sample of recycled asphalt pavement material. For existing pavements, mill where designated by the Project Engineer to the pavement removal depth. Sample the removed material and replace it with an approved asphalt concrete mix. Do not use the replacement material in the recycled mix; and
6) One gallon of recycling agent, if part of the job-mix formula.

2. Verification. The Engineer will review and may perform design verification testing for the Contractor's proposed mix design. If verification testing is performed by the Engineer the information supplied in the Contractor's LJMF must agree with the verification test results within the following tolerances:
a. Aggregate gradations. Representative aggregate samples from each stockpile, when combined according to the Contractor's recommendation for stockpile percentages, shall be within the gradation tolerances depicted in FP-03 Table 703-4, with the base point for each sieve defined by the target values of the LJMF.
b. Voids in Mineral Aggregate (VMA). See Table 321216-1 HMA Base Course Requirements.
c. Immersion Compression. The Contractor's dry strength result is verified if the Engineer's result is above the minimum contract requirement, or the average of the Contractor's and the Engineer's result is above the minimum contract requirement and the two values differ by no more than 50 pounds per square inch. The Contractor's percent of retained strength is verified if the Engineer's result is above the minimum contract specification.
d. Marshall Air Voids, stability, and flow. The Contractor's results are considered verified if they meet the contract requirements shown in Table 321216-1 for HMA Base Course Requirements or Table 321216-2 for HMA Friction Course Requirements.

3. Changes and Resubmissions. If a job-mix formula is rejected, material source is changed, or if the recycled asphalt pavement source, use or percentage used is changed, a new job-mix formula shall be submitted for acceptance. Up to 21 days may be required to evaluate a change. Approved changes in target values will not be applied retroactively for payment.

The Engineer will, at their discretion, deduct all job-mix formula evaluation costs from amounts due to the Contractor resulting from any of the following:
a. Contractor-requested changes to the approved job-mix formula;
b. Contractor requests for additional job-mix formula evaluations; and
c. Additional testing necessary due to the failure of a submitted job-mix formula.

4. Acceptance. Do not begin mix production until the job-mix formula is accepted by the Engineer.

2.4 MIXING PLANT

A. Use mixing plants conforming to AASHTO M 156 supplemented as follows:

1. All plants.
    a. Automated controls. Control the proportioning, mixing, and discharging of the mix automatically.
    b. Dust collector. AASHTO M 156, Requirements for All Plants, Emission Controls is amended as follows:
        1) Equip the plant with a dust collector. Dispose of the collected material. In the case of baghouse dust collectors, dispose of the collected material or return the collected material to the mix uniformly. Use of baghouse fines in asphalt concrete mixes requires approval from the Engineer, unless included as part of the approved job-mix formula.
    c. Recycled asphalt pavement. When recycled asphalt pavement material is incorporated into the mixture, modify plants according to the plant manufacturer's recommendations to process reclaimed material.
    d. High tensile strength reinforcing (micro) fibers. Deliver fiber-reinforcement in sealed, undamaged containers with labels intact and legible, indicating material name and lot number. Deliver fiber-reinforcement to location where it will be added to each batch or loaded into the mixer. Store materials covered and off the ground. Keep sand and dust out of boxes and do not allow boxes to become wet. Add aramid and polyolefin reinforcing fiber blends at a dosage rate proposed by the manufacturer that achieves the IDT and ADSR results required. Have a fiber manufacturer's representative on site during mixing and production. This requirement can be waived if fiber manufacturer and asphalt producer can supply evidence of manufacturer's brand of fiber being successfully produced a minimum of two times at the asphalt plant to be used for the project. Add fiber through specialized equipment that can accurately proportion and/or meter, by weight (mass), the proper amount per batch for batch plants, or continuously and in a steady uniform manner for drum plants.
2. Drum dryer-mixer plants.
    a. Bins. Provide a separate bin in the cold aggregate feeder for each individual aggregate stockpile in the mix. Use bins of sufficient size to keep the plant in continuous operation and of proper design to prevent overflow of material from one bin to another.

        Ensure that each bin compartment has the capacity and design to permit a uniform flow of aggregates. Mount the bin compartment over a feeder of uniform speed, which will deliver the specified proportions of the separate aggregates to the dryer at all times. If necessary, equip the bins with vibrators to ensure a uniform flow of the aggregates at all times.

        Provide each bin compartment with a gate that is adjustable in a vertical direction. Provide gates that can be held securely at any specified vertical opening. Equip the gates with a measuring device for measuring the vertical opening of the gates from a horizontal plane level with the bottom of the feeder.

        Each bin will have a 'no-flow' switch which will alert the plant operator that no material is flowing from the bin, if this bin is active for the mix being produced.

    b. Stockpiling procedures. Place each aggregate component in an individual stockpile, and separate each from the adjacent stockpiles, either by space or by a

system of bulkheads. Prevent the intermingling of different materials in stockpiles at all times. Identify each stockpile, including RAP, as shown on the mix design.

Form and maintain stockpiles in a manner that will prevent segregation. If a stockpile is determined to have excessive segregation, the Engineer will disapprove the material for use on the project until the appropriate actions have been taken to correct the problem.

c. Oversize Aggregate. Remove any oversized pieces of aggregate by use of a scalping screen. Do not return this oversized material to the stockpile for reuse unless it has been crushed and reprocessed into sizes that will pass the scalping screen.

d. Mineral Filler. If mineral filler is used in the mix, feed or weigh it in separately from the other aggregates.

e. High tensile strength reinforcing (micro) fibers. Inject fibers through the RAP collar by placing fibers on the RAP belt for by feeding them with a blower tube system. Rate the feeding of fibers with the rate the plant is producing asphalt mix. If there is any evidence of fiber balls at the discharge chute, increase the mixing time and/or temperature or change the angle of the fiber feeder line to increase dry mixing time. For manual feeding, place fibers on the RAP belt at intervals based on the plant production rate. If approved by the Engineer, fiber can be added manually by pre-weighed dissolvable bags for HMA mixes only. Have a manufacturer's representative approve all fiber addition systems. When using a blower tube system, add fibers continuously and in a steady uniform manner. Provide automated proportioning devices and control delivery within ±10% of the mass of the fibers required. Perform an equipment calibration to the satisfaction of the fiber manufacturer's representative to show that the fiber is being accurately metered and uniformly distributed into the mix.

3. Batch and continuous mix plants.

a. Hot aggregate bin. Provide a bin with 3 or more separate compartments for storage of the screened aggregate fractions to be combined for the mix. Make the partitions between the compartments tight and of sufficient height to prevent spillage of aggregate from one compartment into another. Heat and dry the aggregates before screening. Control the temperature of the aggregates so that the temperature of the completed mixture at the plant is within the range allowed.

b. Load cells. Calibrated load cells may be used in batch plants instead of scales.

c. Recycled asphalt pavement. Modify batch plants so the recycled asphalt pavement is introduced into the mix after bypassing the dryer. Design the cold feed bin, conveyor system, and special bin adjacent to the weigh hopper, if used, to avoid segregation and sticking of the recycled asphalt pavement material. Heat aggregate to a temperature that will transfer sufficient heat to the recycled asphalt pavement material to produce a mix of uniform temperature within the range specified in the approved job-mix formula.

d. High tensile strength reinforcing (micro) fibers. When a batch plant is used, add the fiber to the aggregate in the weigh hopper and increase both dry and wet mixing times. Ensure that the fiber is uniformly distributed before the injection of asphalt cement into the mixture.

2.5 PAVERS

A. Use pavers that are:
   1. Self-contained, power-propelled units with adjustable vibratory screeds with full-width screw augers;
   2. Heated for the full width of the screed;
   3. Capable of spreading and finishing courses of asphalt mix in widths at least 12 inches more than the width of one lane;
   4. Equipped with a receiving hopper having sufficient capacity to ensure a uniform spreading operation;
   5. Equipped with automatic feed controls, which are properly adjusted to maintain a uniform depth of material ahead of the screed;
   6. Operable at forward speeds consistent with satisfactory mix lay down;
   7. Capable of producing a finished surface of the required smoothness and texture without segregating, tearing, shoving, or gouging the mix; and
   8. Equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

C. Verify compacted granular subbase is dry and ready to support paving and imposed loads.

   1. Proof roll subbase with minimum two perpendicular passes to identify soft spots.
   2. Remove soft subbase and replace with compacted fill as specified in Section 312323.

D. Verify gradients and elevations of base are correct.

E. Verify manhole frames and valve covers are installed in correct position and elevation.

3.2 SURFACE PREPARATION

A. Clean the existing surface of all loose material, dirt, or other deleterious substances by approved methods. Apply an asphalt tack coat to contact surfaces of pavements, curbs, gutters, manholes, and other structures according to FP-03 Section 412.

3.3 WEATHER LIMITATIONS

A. Place hot mix asphalt pavement on a dry surface when the temperature of the road surface in the shade conforms to table below.

Table 321216-3
Asphalt Concrete Mix Placement Temperature

Compacted Lift Thickness	**< 2 Inches**	**2 – 3 Inches**	**> 3 Inches**
Road Surface Temperature °F	**Minimum Lay-Down Temperature[(1)] °F**		
50 – 59.9	295	280	270
60 – 69.9	285	275	265
70 – 79.9	280	270	265
80 – 89.9	270	265	260
≥ 90	265	260	255

B. Do not transport asphalt mix from the plant to the roadway unless all of the following weather conditions are suitable for the laying operations.

1. Temperature: Spread the HMA only when the air temperature in the shade and away from artificial heat is at least 60ºF for layers greater than 1 inch (100 lb/yd2) in thickness and at least 65ºF for layers 1 inch (100 lb/yd2) or less in thickness (this includes leveling courses). The minimum temperature requirement for leveling courses with a spread rate of 50 lb/yd2 or less is 70 ºF.

2. Wind: Do not spread the HMA when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc., are being deposited on the surface being paved to the extent that the bond between layers will be diminished.

3. Night Paving: Use Engineer approved night paving operations and traffic control plan.

4. Rain: Do not produce HMA when rain is falling at the plant or on site.

   Stop paving when rain starts and the ground or pavement becomes wet. Restart paving when the rain stops and the ground or pavement becomes dry.

3.4 ASPHALT PREPARATION

A. Uniformly heat the asphalt binder to provide a continuous supply of the heated asphalt binder from storage to the mixer. Do not heat asphalt binder above 350ºF unless the manufacture recommends a higher temperature due the modification of the asphalt binder.

B. If a liquid heat stable anti-strip additive is used, meter it into the asphalt binder transfer lines at a bulk terminal or mixing plant. Inject the additive for at least 80 percent of the transfer or mixing time to obtain uniformity.

3.5 AGGREGATE PREPARATION

A. If non-liquid anti-strip is used, adjust the aggregate moisture to at least 4 percent by mass of aggregate. Mix the anti-strip uniformly with the aggregate before introducing the aggregate into the dryer or dryer drum. Mix with the aggregate particles to produce a uniform mixture. Use calibrated weighing or metering devices to measure the amount of anti-strip and moisture added to the aggregate.

B. Treated aggregate may be held in stockpiles before mixing with asphalt, but the treated aggregate must be used during the same construction season in which it was produced.

C. For batch plants, heat, dry, and deliver aggregate for pugmill mixing at a temperature sufficient to produce a mix temperature within the approved range. Adjust flames used for drying and heating to prevent aggregate damage and contamination.

3.6 MIXING

A. Measure or meter the aggregate and asphalt into the mixer according to the approved job-mix formula. Mix until all the particles are completely and uniformly coated with asphalt according to AASHTO M 156. Maintain the discharge temperature within the approved range.

B. Control plant operations so the moisture content of the HMA at the plant is 0.5 percent or less according to AASHTO T 110.

C. The Contractor is responsible to produce a homogeneous mixture, with no segregated materials, that meets all specification requirements. Also apply these requirements to all mixes produced by the drum mixer process and all mixes processed through a hot storage or surge bin, both before and after storage.

D. Batch Mixing:

1. Aggregates: Once the dried aggregates and mineral filler (if required) are prepared in the manner previously described and combined in batches to meet the verified mix design by weighing each separate bin size, convey them to the empty mixer.
2. Asphalt Binder: Introduce the accurately measured hot asphalt binder into the mixer simultaneously with, or after, the hot aggregates. Continue mixing until the mixture is thoroughly uniform with all particles fully coated.
3. Mixing Time: The mixing time begins when the measuring devices for both the asphalt and the aggregates indicate that all the material is in the mixer, and continues until the material begins to leave the mixing unit. Since the mixing time varies in relation to the nature of the aggregates and the capacity of the mixer, mix sufficiently to produce a thoroughly and uniformly coated mixture according to AASHTO M 156.

E. Continuous Mixing: Introduce the dried aggregates and mineral filler (if required), prepared as specified and proportioned to meet the verified mix design, into the mixer in synchronization

with the accurate feeding of the hot asphalt cement. Mix sufficiently to produce a thoroughly and uniformly coated mixture.

F. Mix Temperature:
   1. Heat and combine the ingredients of the mix in such a manner as to produce a mixture with a temperature, when discharged from the pugmill or surge bin, which is within the master range as defined below.
   2. Determine the temperature of the completed mixture using a quick-reading thermometer through a hole in the side of the loaded truck immediately after loading. Locate 1/4 inch hole on both sides of the truck body within the middle third of the length of the body, and at a distance from 6 to 10 inches above the surface supporting the mixture. If a truck body already has a hole located in the general vicinity of the specified location, use this hole. At the Engineer's discretion, the Contractor may take the temperature of the load over the top of the truck in lieu of using the hole in the side of the truck.
   3. The normal frequency for taking asphalt mix temperatures will be for each day, for each design mix and every truck load. Take the temperature of the asphalt mix at the plant and at the destination, on arrival, and right before the mix is placed. Record the temperature on the front of the respective delivery ticket. The Engineer shall review the plant and destination temperature readings and may take additional temperature measurements at any time.
   4. The master range for all mix designs will be the target mix temperature from the mix design ±30ºF. There are two master ranges, one at the asphalt plant (mixing temperature from the mix design ±30ºF) and one at the roadway (compaction temperature from the mix design ±30ºF). Reject any load or portion of a load of asphalt mix at the plant or at the placement location with a temperature outside of the master ranges. The Engineer will be immediately notified of the rejection.

3.7 HAULING

A. Use vehicles with tight, clean, and smooth metal beds for hauling asphalt concrete mixes.

B. Thinly coat the beds with an approved material to prevent the mix from adhering to the beds. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mix. Drain the bed before loading.

C. Equip each truck with a canvas cover or other suitable material of sufficient size to protect the mix from the weather. When necessary to maintain temperature, use insulated truck beds and securely fastened covers. Provide access ports or holes for checking temperature of asphalt mix in the truck.

D. Deliver HMA using HMA trucks in sufficient quantities and at such intervals to allow continuous placement of the material. Do not allow trucks to leave the plant within 1 hour of sunset unless nighttime paving is approved by the Engineer. The Engineer can suspend construction operations if the Contractor fails to maintain a continuous paving operation. Before the truck leaves the plant, obtain a weigh ticket from a computerized truck scale. Before unloading, submit for each truckload a legible weigh ticket that includes the following:

   1. Name and location of the HMA plant;
   2. Project title and number;
   3. Load time and date;

4. Truck number;
5. Mix designation and number;
6. Plant lot number;
7. Tare, gross, and net weight; and
8. Daily Sub-Total.

E. The weight tickets shall have locations on the tickets to write the mix temperatures at the plant and at the destination, arrival time of the truck at destination, the unloading time of the truck, the locations of where the HMA was placed, signature of the scale operator, truck driver and inspector at site.

F. Each weight ticket will have at least 2 copies of which at least one copy will be kept by the inspector.

G. The weigh master and truck driver shall sign the weigh tickets.

H. In the event of breakdown of the weight ticket printer system, the Engineer can accept weigh tickets showing the information listed above written by hand for each truck, for a period not exceeding the necessary repair time but not to exceed a 24 hour period unless approved by the Engineer.

I. When using an automated batching plant, obtain weigh tickets from the printer used in conjunction with an automated batching and mixing system. The printed ticket shall show the individual weights of the various components of the HMA in a batch, the total weight of each batch, and the sum of all batch weights in the truckload. At the completion of each day's work, the HMA supplier's representative shall certify that the total net weight supplied to each contract was correct.

3.8 PRODUCTION START-UP PROCEDURES

A. Pre-paving Conference. At least 14 days before the start of paving operations, the Contractor shall arrange a pre-paving conference. Coordinate attendance with the Engineer and all applicable subcontractors. Submit and prepare to discuss the following:

1. Proposed schedule of paving operations;
2. List of all equipment (excavation, compaction, lay down, haul, pugmill, etc.), and personnel used in the production and construction of the work;
3. Proposed traffic control plan for paving operations including provisions for pavement drop-offs and moving operations;
4. Contractor quality control plan for paving and sampling and testing according to FP-03 Sections 153 and 154;
5. Procedures for constructing the control strip including placing, finishing, compacting, and smoothness procedures; and
6. Acceptance procedures according to FP-03 Subsections 106.05 and Subsection 3.13 below.

B. Control Strip

1. Provide 14 calendar days notice before beginning production of asphalt concrete mix.

2. On the first day of production, produce sufficient mix to construct a 1000-foot long control strip, a minimum of one-travel lane in width, and at the designated minimum lift thickness. Construct the control strip at an approved location.
3. Construct the control strip using mix production, lay-down, and compaction procedures intended for the entire mix. Cease production after construction of the control strip until the asphalt concrete mix and the control strip are evaluated and accepted. The Engineer shall provide an evaluation of the control strip to the Contractor within 5 business days after the control strip is completed.
4. Mixture
    a. During the production of HMA for the control strip the Contractor shall provide the Engineer with samples of asphalt cement and aggregates for the evaluation of the Production Job-mix Formula (PJMF). Aggregate samples shall be collected and split by the Contractor from the hot bins and cold feed bins as directed by the Engineer.
    b. The Engineer shall sample the HMA in at least five locations from the pavement of the control strip HMA samples for evaluation of the PJMF. The location of the samples shall be selected by the Engineer based on random numbers.
    c. It is recommended that the Contractor also obtain aggregate samples and samples from the control strip at the locations determined by the Engineer and prepare a companion Job Mix Formula with the HMA placed on the roadway from the control strip. This companion Job Mix Formula may be utilized by the Contractor to provide another LJMF, if necessary.
    d. The Engineer shall prepare a PJMF from the samples taken. The PJMF shall be evaluated against the LJMF. The PJMF and the HMA placed for the control strip will be acceptable if:
        1) The optimum binder content in the PJMF at 4% air voids is plus or minus 0.2% of the optimum binder content in the LJMF;
        2) The VMA in the PJMF is equal to or above the minimum VMA requirements;
        3) The gradation of the material placed for the control strip is within the LJMF tolerances;
        4) The AC content of the material placed for the control strip is within the specification limits;
        5) The air voids of the material placed is within the specification limits;
        6) Marshall Plug stability is above the specification limits; and
        7) Marshall Plug flow is within specification limits.
5. Compaction
    a. The Contractor shall take nuclear density readings behind each roller pass to determine the roller pattern necessary to achieve required density.
    b. At a minimum of five locations within the control strip, the Contractor shall take nuclear gauge readings in observance of the Engineer, and cut and test core samples according to Subsection 3.13. The test locations shall be selected by the Engineer based on random numbers. Density of the control strip is acceptable if all tests are within the specification range in Subsection 3.10.
6. Acceptance
    a. The LJMF and the control strip will be acceptable if the PJMF and densities meet the requirements of (1) and (2) above. If these requirements are not met the material placed for the control strip will be evaluated according to FP-03 Subsection 106.05. The control strip may remain in place at reduced payment in accordance with FP-03 Subsection 106.05 if the pay factor for asphalt content, gradation, and densities is 0.90 or greater. The pay factor shall be applied to the

Contractor's schedule of values for the pavement being evaluated. If the pay factor is less than 0.90 all material for the control strip shall be removed from the project at the Contractor's expense. Repeat the LJMF and control strip process until an acceptable control strip is produced and a pay factor of 1.0 is achieved. If an acceptable control strip is not achieved by the third attempt all of the material for all of the control strips shall be removed at the Contractor's expense and the control strip process repeated.

b. Once a control strip is acceptable the remaining HMA pavement will be evaluated in accordance with Subsection 3.13.

c. Previously performed PJMF for the same HMA material from the same source may be substituted for the PJMF listed above as approved by the Engineer.

3.9 PLACING AND FINISHING

A. The Engineer may direct the Contractor to prepare the surface of the existing HMA pavement by lightly milling or other approved methods so that the bond between the existing HMA surface and the Friction Course layer is improved.

B. Do not use HMA produced from different plants unless the HMA are produced according to the same job-mix formula, use material from the same sources, and are approved.

C. Place HMA at a temperature conforming to Table 321216-3. Measure temperature of the mix in the hauling vehicle just before dumping into spreader or measure it in the windrow immediately before pickup.

D. Place the HMA with a paver conforming to Subsection 2.5. Control horizontal alignment using a reference line. Automatically control the grade and slope from reference lines using a ski and slope control device, or dual skis. Use skis having a minimum length of 20 feet.

E. In areas where mechanical spreading and finishing is impractical, place and finish the HMA with Engineer approved alternate equipment. This alternate equipment shall produce a uniform surface closely matching the surface obtained when using a mechanical paver.

F. The Engineer will designate the job-mix formula to be used for wedge and leveling courses at each location. Place wedge and leveling courses in maximum 3-inch lifts. Complete the wedge and leveling before starting normal paving operations.

G. The Friction Course Mix shall have a thickness of 1-2 inches within a tolerance of (-0, +1/2"). The base course will be applied to the thickness of design within a tolerance of (-1/2", +1/2") and no one layer can be paved at more than a maximum thickness of 3-inches. When a base course thicker than 3-inches is required, multiple layers of approximate equal thicknesses will be applied.

H. If a core is found to be out of specification on thickness a new core will be taken 5 feet from the location of the out of specification core and if the thickness is found to be within specification the pavement is acceptable.

I. Apply an asphalt tack coat according to FP-03 Section 412 to the contact surface areas of asphalt pavement layers, leveling layers, and on any milled surfaces prior to placing the next layer of asphalt pavement.

J. Safety Edge Specification

1. Attach an approved device to the screed of the paver that confines the material at the end gate and extrudes the asphalt material in such a way that results in a compacted wedge shape pavement edge of approximately 30 degrees (not steeper than 35 degrees) relative to the pavement structure. Maintain contact between the device and the road shoulder surface, and allow for automatic transition to level for areas such as cross roads, driveways and obstructions. Use the device to constrain the asphalt head reducing the area by 10% to 15% increasing the density of the extruded profile. Do not use conventional single plate strike off.
2. Use the TransTech Shoulder Wedge Maker, or the Advant-Edge, or a similar approved-equal device that produces the same wedge consolidation results. Contact information for these wedge shape compaction devices is the following:
   a. TransTech Systems, Inc.
      1594 State Street
      Schenectady, NY 12304
      Ph. 1-800-724-6306
      Website:www.transtechsys.com
   b. Advant-Edge Paving Equipment LLC
      P.O. Box 9163
      Niskayuna, NY 12309-0163
      Ph. 518-280-6090
      Website: www.advantedgepaving.com

K. If electing to use a similar device, provide proof that the device has been used on previous projects with acceptable results or construct a test section prior to the beginning of work and demonstrate wedge compaction to the satisfaction of the Engineer. Short sections of handwork will be allowed when necessary for transitions and turnouts or otherwise authorized by the Engineer.

3.10 COMPACTING

A. Thoroughly and uniformly compact the asphalt surface by rolling. Do not cause cracking, shoving or undue displacement. Continue rolling until all roller marks are eliminated, all cracks are sealed, and the required density is obtained. Do not roll the mix after the surface cools below 175 °F.

B. Monitor the compaction process with nuclear density gauges. Calibrate the gauge according to the ASTM D 2950 calibration section within 6 months before use and check the standard and reference on each day of use according to the ASTM D 2950 standardization and reference check sections. Compact to a pavement specific gravity (density) that is no less than 92.0 percent and no more than 97.0 percent of the maximum specific gravity (density) determined according to AASHTO T 209 of the PJMF.

C. Along forms, curbs, headers, walls, and other places not accessible to the rollers, compact the mix with alternate equipment to obtain the required compaction.

D. Do not allow the rollers to deposit gasoline, oil, or grease onto the pavement. Remove and replace any areas damaged by such deposits as directed by the Engineer. While rolling is in progress, check the surface continuously, and correct all discrepancies to comply with the surface requirements. Remove and replace all drippings, fat or lean areas, and defective

construction of any description. Remedy depressions that develop before completing the rolling by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depression remain after obtaining the final compaction, remove the full depth of the mixture, and replace it with sufficient new mixture to form a true and even surface. Correct all high spots, high joints, and honeycombing as directed by the Engineer. Remove and replace any mixture remaining unbounded after rolling. Correct all defects prior to laying the subsequent course.

E. Keep sections of newly compacted asphalt concrete, which are to be covered by additional courses, clean until the successive course is laid. Do not dump embankment or base material directly on the pavement. Dress shoulders before placing the friction course on adjacent pavement.

F. Equip blade graders operating adjacent to the pavement during shoulder construction with a 2 inch by 8 inch or larger board, or other attachment providing essentially the same results, attached to their blades in such manner that it extends below the blade edge to protect the pavement surface from damage by the grader blade.

G. To prevent rutting or other distortion, protect sections of newly placed HMA base course and HMA friction course from traffic until the surface temperature has cooled below 160ºF for HMA base course and below 120ºF for HMA friction course.

H. The Contractor may use artificial methods to cool the pavement to expedite paving operations. In addition, the Engineer may direct the Contractor to use artificial cooling methods when maintenance of traffic requires opening the pavement to traffic at the earliest possible time.

3.11 JOINTS, TRIMMING EDGES AND CLEANUP

A. Complete pavement construction of adjacent traffic lanes to the same elevation within 24 hours. If drop-offs are left overnight, sign the drop-offs in excess of 1 inch with "Uneven Lanes" warning signs and provide a 1V:3H fillet for drop-offs in excess of 2 inches.

B. To both transverse and longitudinal joints, apply asphalt tack coat to the joint edge according to Section 412.

C. For all layers of pavement except leveling course, offset the longitudinal joint of one layer 6 to 12 inches laterally from the joint in the layer immediately below. The longitudinal joint in the top layer shall be at the centerline of two-lane roadways or at the lane lines of roadways with more than two lanes.

D. Plan offsets in advance so that longitudinal joints of the friction course are not in wheel path areas. The longitudinal joints for friction course layers shall be within 6 inches of the lane line, at the center of the lane or as approved by the Engineer. The Engineer may also waive this requirement where offsetting is not feasible due to the sequence of construction.

E. Place the asphalt concrete mix as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mix.

F. Dispose of material trimmed from the edges and any other discarded asphalt mix according to Subsection 211.02 (a) (2).

G. Butt joints shall be constructed according to the details shown on the plans. The surface removal shall be done according to Section 413. Construction of butt joints shall not begin prior to general operations on the project.

H. When butt joints are to be constructed under traffic, temporary ramps shall be constructed and maintained at both upstream and downstream ends of the surface removal areas immediately upon completion of the surface removal operation. The temporary ramps shall be constructed by providing hot asphalt concrete with a minimum taper rate of 1:40 (V: H). The HMA for the ramp shall meet the approval of the Engineer. Cold milled pavement tailings will not be acceptable. The temporary ramps shall be removed just prior to placing the HMA.

3.12 PAVEMENT SMOOTHNESS/ROUGHNESS

A. Use a 10-foot metal straight edge at right angles and parallel to the centerline to check for surface deviations. Defective areas are surface deviations in excess of 1/4 inch in 10 feet between any two contacts of the straightedge with surface. Measurements shall be made to the nearest 1/16 inch.

B. Correct defective areas. Obtain approval for the proposed method of correction. Re-check corrected areas according to the specified type of pavement smoothness/roughness. The smoothness/roughness value obtained will replace the original measured results.

3.13 ACCEPTANCE

A. See Table 321216-5 for sampling, testing and acceptance requirements.

B. Mineral filler and anti-strip additive will be evaluated under FP-03 Subsections 106.03 and 106.04. Chemical agents will be evaluated as required by the Engineer.

C. Asphalt binder will be evaluated under FP-03 Subsection 106.03(a), 106.04 and 702.09.

D. Construction of the HMA pavement courses not evaluated under FP-03 Subsection 106.05 shall be evaluated under FP-03 Subsections 106.02 and 106.04.

E. Testing for VMA, Air Voids, VFA, Marshall Stability and Flow will be completed and reported for each HMA sample taken. Gradation of cold feed bins, hot bins and mineral filler materials will be reported along with the percentages of each bin/material used.

F. When one days production is 100 tons or less one sample shall be taken each day and grouped with subsequent days production for evaluation.

G. Testing data used for acceptance shall be from an accredited laboratory conforming to FP-03 Section 154.

H. Asphalt content. The upper and lower specification limits are the accepted JMF target value for asphalt content +/- 0.4 percent.

I. Aggregate gradation. The upper and lower specification limits are the accepted JMF target values +/- the allowable deviations shown in FP-03 Table 703-4.

J. Density. The lower specification limit is 92.0 percent and the upper limit is 97.0 percent of the accepted JMF maximum specific gravity (density) determined according to AASHTO T 209. If a core is found to be out of specification, a new core will be taken 5 feet from the location of the out of specification core. If the density of the new core is found to be within specification, the new test result will replace the previous failed density test, and the pavement will be acceptable.

K. Pavement smoothness/roughness. The evaluation of pavement smoothness and roughness shall be made in accordance with Subsection 3.12 and FP-03 Subsection 106.04 after all defective areas are corrected.

L. Thickness.
1. For friction course pavement the thickness of the cores cannot be less than the design thickness of the friction layer and should be no more than 25% higher than design thickness. If a core is found to be out of specification a new core will be taken 5 feet from the location of the out of specification core and if the thickness is found to be within specification the pavement is acceptable. If the cores show that the pavement is thin, then pavement must be cored every 50 feet longitudinal from the original cores to establish the length of the thin pavement.
2. For binder pavement, no one core can be less than 15% of design thickness nor more than 25% higher of design thickness. If a core is found to be out of specification a new core will be taken 5 feet from the location of the out of specification core and if the thickness is found to be within specification the pavement is acceptable. If the cores show that the pavement is thin, then pavement must be cored every 50 feet longitudinal from the original cores to establish the length of the thin pavement.
3. Calculations will be completed of the actual tonnage placed and the theoretical tonnage which should have been placed.
4. Based on this information the Engineer will determine if:
    a. The pavement can be accepted at the contract units and/or unit rates;
    b. An additional thickness layer must be paved;
    c. The next lift of hot mix asphalt must be thickened; or
    d. The section determined to be outside the allowable thickness tolerance must be removed and replaced.

M. If the production tonnage meets the requirements of (a), (b) (c), and (e) above, it is accepted. If these requirements are not met, the material placed will be evaluated according to FP-03 Subsection 106.05.

N. If the evaluation, according to FP-03 Subsection 106.05, the pay factor for asphalt content, gradation, and densities is 0.80 or greater, the mix may remain in place at reduced payment in accordance with FP-03 Subsection 106.05. The pay factor shall be applied to the Contractor's schedule of values for the pavement being evaluated. If the pay factor is less than 0.80 all material in this evaluation shall be removed from the project and replaced at the Contractor's expense with HMA which meets these specifications.

3.14 ALTERNATIVE MIX DESIGN CRITERIA

A. The Contractor may propose an alternate mix design criteria such as Hveem or Superpave for the Engineer's consideration. This proposed JMF must meet or exceed the JMF requirements specified in Table 321216-1 and Table 321216-2. Changes to the pavement structural section will not be considered.

3.15 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from mechanical injury for twelve hours or until surface temperature is less than 140 degrees F.

Table 321216-4
Materials Quality Sampling and Testing Requirements
(Prior to Production)

Material or Product	Type of Acceptance (FP-03 Subsection)	Characteristic	Category	Test Method Specifications	Sampling Frequency	Point of Sampling	Split Sample	Reporting Time
Aggregate source quality	Measured and tested for conformance (106.04)	LA abrasion (coarse)	—	AASHTO T 96	1 per type & source of material	Source of Material or Stockpile	Yes	Before producing
		Sodium sulfate soundness loss (coarse & fine)	—	AASHTO T 104	"	"	"	"
		Sand equivalent	—	AASHTO T 176 Alternate method no. 2, reference method	"	"	"	"
Asphalt concrete (mix design)	Measured and tested for conformance (106.04)	Gradation	—	AASHTO T 27 & T 11	1 per submitted mix design	Stockpiles	Yes	28 days before producing
		Voids	—	AASHTO T 209	"	"	"	"
		Moisture Susceptibility	—	AASHTO T 165 & T 167	"	"	"	"
Aggregates (during aggregate production)	Measured and tested for conformance (106.04)	Gradation	—	AASHTO T 27 & T 11	1 per every hot mix sample	From each cold feed bin, hot bin and mineral filler	Yes	End of shift
		Sand equivalent	—	AASHTO T 176 alternate method no. 2 reference method	1 per type & source of material	"	"	"
		Fractured faces	—	ASTM 5821	"	"	"	"
		Sample for job-mix formula verification	—	Subsection 2.2	1 per aggregate sample Stockpile	"	"	28 days before approval of job-mix formula
Asphalt binder	Measured and tested for conformance (106.04)	Quality	—	FP-03 Subsection 702.01	1 per mix design and 1 per grade of asphalt binder	In line between tank & mixing plant	2 – 1 quart samples provided to the Government	Tested by the Government

Table 321216-5
Acceptance Sampling and Testing Requirements
(During Production)

Material or Product	Type of Acceptance (FP-03 Subsection)	Characteristic	Category	Test Method Specifications	Sampling Frequency	Point of Sampling	Split Sample	Reporting Time
Hot asphalt concrete pavement (control strip)	Statistical (106.05)	Gradation 1 inch 3/4 inch 1/2 inch 3/8 inch No .4 No. 8 No. 16 No. 30 No. 50 No. 100 No. 200 Asphalt Content	 I II II II I I II II II II I I	AASHTO T308, T 30 & T 110	3 minimum	Behind paver before compacting or from truck as determined by the Engineer. (2)	Yes	5 days
Hot asphalt concrete pavement (production paving)	Statistical (106.05)	Gradation	See control strip	AASHTO T30	3 minimum (3)	”	”	24 hours
		Asphalt content		AASHTO T308	“	“	“	“
		Compaction	I	AASHTO T166	“	Completed roadway after rolling	“	“
	PJMF	Gradation	—	AASHTO T 27 & T 11	1 per every hot mix sample	From each cold feed bin and hot bin -	—	“
Asphalt binder	Not Evaluated for Acceptance	Quality	—	FP-03 Subsection 702.01	1 per 130 tons of liquid	Line between storage tank and asphalt plant	2 – 1 quart samples	Tested by Government

(1) Cut core sample from the compacted pavement according to AASHTO T 230, method B. Fill and compact the sample holes with asphalt concrete mixture. Cores shall be 6 inches in diameter. Perform specific gravity and thickness test on cores and deliver to CO after testing is completed. Label cores and protect from damage due to handling or alteration due to temperature during storage or transfer.

(2) For HMA friction course, the point of sampling shall be from the hauling vehicle prior to discharge into the paver.

(3) For days where the production is less than 100 tons the sampling frequency shall be a minimum of 1 per day.

END OF SECTION 321216

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Traffic lines and markings.
2. Thermoplastic markings.

B. Related Requirements:

1. Section 32 12 16 - Asphalt Paving.

1.2 REFERENCE STANDARDS

A. Federal Specifications:

1. FP-03

B. American Association of State Highway and Transportation Officials:

1. AASHTO M247 - Standard Specification for Glass Beads Used in Traffic Paint.
2. AASHTO M249 - Standard Specification for White and Yellow Reflective Thermoplastic Striping.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer’s printed Product Data Sheet for each type of marking.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

D. Test and Evaluation Reports: Submit source and acceptance test results in accordance with AASHTO M247.

E. Manufacturer's Instructions: Submit instructions for application temperatures, eradication requirements, application rate, line thickness, type of glass beads, bead embedment and bead application rate, and any other data on proper installation.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Applicator: Company specializing in performing work of this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Invert containers several days prior to use when paint has been stored more than 2 months. Minimize exposure to air when transferring paint. Seal drums and tanks when not in use.

1.6 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.

B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by markings product manufacturer.

C. Do not apply exterior coatings during rain or when relative humidity is outside humidity ranges, or moisture content of surfaces exceed those required by marking product manufacturer.

PART 2 PRODUCTS

2.1 PAINTED PAVEMENT MARKINGS

A. Furnish materials in accordance with FP-03 for Type H thermoplastic pavement marking and AASHTO M249.

2.2 EQUIPMENT

A. Continuous Longitudinal Line Application Machine: Use application equipment with following capabilities.

1. Spray gun or extruder to apply lines of indicated width in solid or broken patterns or various combinations of those patterns.

B. Apply parking striping by approved mechanical equipment.

C. Machine Calibration:
1. Spray Guns: Calibrate to simultaneously apply thermoplastic at uniform rates as specified with an allowable tolerance of plus or minus 1 mil.

D. Other Equipment:

1. For application of stop lines, arrows and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for installation examination.

B. Do not apply markings to concrete surfaces until concrete has cured for 28 days.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Surface Preparation.

1. Clean and dry paved surface prior to painting.
2. Blow or sweep surface free of dirt, debris, oil, grease or gasoline.
3. Spot location of final pavement markings as specified and as indicated on Drawings by applying pavement spots 25 feet on center. The Contractor shall establish control points for marking and provide templates to control paint application by type and color at necessary intervals.
4. Notify Engineer after placing pavement spots and minimum 3 days prior to applying traffic lines.

3.3 APPLICATION

A. On areas to be marked on rigid pavements and old asphalt pavements, apply an epoxy resin primer/sealer according to the thermoplastic manufacturer's recommendations. Allow the primer/sealer to dry.

B. Apply thermoplastic when the pavement and air temperatures are above 50 ºF. Spray or extrude the thermoplastic at 430±5 ºF. For centerlines and lane lines, spray or extrude 90 mil minimum dry film thickness or at a rate of 17.8 square feet per gallon. For edge lines, spray or extrude 60 mil minimum dry film thickness or at a rate of 26.7 square feet per gallon.

C. The minimum bond strength of the thermoplastic shall be 175 pounds per square inch on rigid pavements.

D. Apply markings to indicated dimensions at indicated locations. Stripes shall be four (4) inches wide unless otherwise shown on the drawings. Broken line segments (dashed or skip traffic type) shall be as shown on the drawings or as directed by the Engineer.

E. Arrows, letters, stop lines and other pre-cut symbols shall be as shown on the drawings or as directed by the Engineer.

F. Prevent splattering and over spray when applying markings.

G. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.

H. Collect and legally dispose of residues from painting operations.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation from Dry Film Thickness: 5 mil.

C. Maintain cycle length for skip lines at tolerance of plus or minus 6 inches per 40 feet and line length of plus or minus 3 inches per 10 feet.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting, testing.

B. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

C. Repair lines and markings, which after application and curing do not meet following criteria:

1. Incorrect Location: Remove and replace incorrectly placed patterns.
2. Insufficient Thickness, Line Width, or Paint Coverage: Prepare defective material by acceptably grinding or blast cleaning to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface in accordance with this Section.
3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings in accordance with this Section and clean pavement surface one foot beyond affected area. Apply new markings on cleaned surface in accordance with this Section.

D. Replace pavement marking material under warranty using original or better type material. Continue warranty to end of original 1 year period even when replacement materials have been installed as specified.

E. When eradication of existing paint lines is necessary, eradicate by shot blast or water blast method. Do not gouge or groove pavement more than 1/16 inch during removal. Limit area of removal to area of marking plus 1 inch on all sides. Prevent damage to transverse and longitudinal joint sealers, and repair any damage according to requirements in Section 32 12 16.

F. Maintain daily log showing work completed, results of above inspections or tests, pavement and air temperatures, relative humidity, presence of any moisture on pavement, and any

material or equipment problems. Make legible entries in log in ink, sign and submit by end of each work day. Enter environmental data into log prior to starting work each day and at two additional times during day.

3.6 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect painted pavement markings from vehicular and pedestrian traffic until markings are fully bonded. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than 2 minutes cure time.

3.7 MAINTENANCE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

3.8 ATTACHMENTS

A. Pavement Markings:

Items	Location
12 inch White Thermoplastic	Stop Line
4 inch Yellow Thermoplastic, Type H	Parking Stalls

END OF SECTION

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts.
4. Manual gates and related hardware.

B. Related Sections:

1. Section 260526 – Grounding and Bonding for Electrical Systems.

1.2 REFERENCES

A. ASTM International:

1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM A817 - Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
6. A1011-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
7. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
8. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
9. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
10. ASTM F626 - Standard Specification for Fence Fittings.
11. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
12. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
13. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

B. Chain Link Fence Manufacturers Institute:

1. CLFMI - Product Manual.

1.3 SYSTEM DESCRIPTION

A. Fence Height: as indicated on Drawings.

B. Line Post Spacing: At intervals not exceeding 8 feet.

C. Fence Post and Rail Strength: Conform to ASTM F1043 Heavy Industrial fence quality.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

C. Product Data: Submit data on fabric, posts, accessories, fittings and hardware.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

C. Operation and Maintenance Data: Procedures for submittals.

1.6 QUALITY ASSURANCE

A. Supply material according to CLFMI - Product Manual.

B. Perform installation according to ASTM F567.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

C. Identify each package with manufacturer's name.

D. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Framing (Steel): ASTM F1083 Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 25 ksi; coating conforming to ASTM F1043 Type A on pipe exterior and interior.

B. Fabric Wire (Steel):ASTM A392 Class II zinc coated steel wire.

C. Barbed Wire: ASTM A121 Coating Type Z, galvanized steel; 12 gage thick wire, 3 strands, 4 points at 3 inch oc.

D. Concrete: Type specified in Section 033000.

2.2 COMPONENTS

A. Line Posts: 3 inch diameter.

B. Corner and Terminal Posts: 4 inch diameter.

C. Gate Posts: 4 inch diameter up to 6 foot leaf, 6.62 inch O.D. for leaf 6 foot to 9 foot, 8.62 inch O.D. for leaf larger than 9 foot.

D. Top and Brace Rail: 1.5/8 inch diameter, plain end, sleeve coupled.

E. Gate Frame: 1 5/8 inch diameter for welded or with fittings and truss rod fabrication.

F. Fabric: 2 inch diamond mesh interwoven wire, 9 gage thick, top salvage knuckle end closed, bottom selvage twisted tight.

G. Tension Wire: 6 gage thick steel, single strand, interlaced with the fabric or attached to the fabric along the extreme bottom of the fence.

H. Tension Band: 0.078 inch thick steel.

I. Tension Strap: 0.078 inch thick steel.

J. Tie Wire: Aluminum alloy steel wire.

2.3 ACCESSORIES

A. Caps: Cast steel galvanized or galvanized pressed steel; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.

C. Extension Arms: Cast steel galvanized or galvanized pressed steel, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.

D. Gate Hardware: Fork latch with gravity drop or Center gate stop and drop rod with Mechanical keepers; two 180 degree gate hinges for each leaf and hardware for padlock keyed to match GWA.

2.4 GATES

A. General:

1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
2. Factory assembled gates.
3. Design gates for operation by one person.

B. Swing Gates:

1. Fabricate gates to permit 180 degree swing.
2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

2.5 FINISHES

A. Components and Fabric: Galvanized to ASTM A123 for components; ASTM A153 for hardware; ASTM A392 for fabric; 2.0 oz/sq ft coating.

B. Hardware: Galvanized to ASTM A153, 2.0 oz/sq ft coating.

C. Accessories: Same finish as framing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install framework, fabric, accessories and gates according to ASTM F567.

B. Set intermediate, terminal, gate, and posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

C. Line Post Footing Depth Below Finish Grade: ASTM F567 3.0 feet.

D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567 3.5 feet.

E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

F. Install top rail through line post tops and splice with 6 inch long rail sleeves.

G. Install center and bottom brace rail on corner gate leaves.

H. Place fabric on outside of posts and rails.

I. Do not stretch fabric until concrete foundation has cured 28 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

K. Position bottom of fabric 2 inches above finished grade.

L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension wire stretched taut between terminal posts.

O. Install support arms sloped outward and attach barbed wire; tension and secure.

P. Support gates from gate posts. Do not attach hinged side of gate from building wall.

Q. Install gate with fabric and barbed wire overhang to match fence. Install three hinges on each gate leaf, latch, catches, drop bolt.

R. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

S. Connect to existing fence at existing terminal post, new terminal post or existing line post converted to terminal post by installation of brace rails and brace rods.

T. Install posts with 6 inches maximum clear opening from end posts to buildings, fences and other structures.

U. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.

V. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.

W. Extend concrete footings 1 inches above grade, and trowel, forming crown to shed water.

X. Allow footings to cure minimum 7 days before installing fabric and other materials attached to posts.

3.2 ERECTION TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

B. Maximum Variation From Plumb: 1/4 inch.

C. Maximum Offset From Indicated Position: 1 inch.

D. Minimum distance from property line: 6 inches.

END OF SECTION 323113

SECTION 329119 - LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation of subsoil.
2. Final grade topsoil for finish landscaping.

B. Related Sections:

1. Section 312316.13 - Trenching: Backfilling trenches.
2. Section 312323 - Fill: Backfilling at building areas.
3. Section 310513 - Soils for Earthwork.
4. Section 329219 - Seeding: Finish ground cover.

1.2 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures

B. Samples: Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

C. Test Reports: Indicate topsoil nutrient and pH levels with recommended soil supplements and application rates.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Furnish topsoil material from single source throughout the Work.

B. Perform Work in accordance with Guam EPA standard.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Topsoil: Fill Type S2 as specified in Section 310513.

B. Compost Material: For amending topsoil not meeting the requirements. Well decomposed organic material/green waste. Stable, weed free, dark brown in color, and parent material no

longer visible. It shall be derived from agriculture, food, yard trimmings, source-separated or mixed solid waste. Structure is mixture of fine and medium size particles and humus crumbs. 30-40% moisture. Free of non-organic debris (<1% by dry weight) and substances toxic to plants.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify building and trench backfilling have been inspected.

C. Verify substrate base has been contoured and compacted.

3.2 PREPARATION

A. Protect landscaping and other features remaining as final Work.

B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

3.3 SUBSTRATE PREPARATION

A. Eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove contaminated subsoil.

C. Scarify surface to depth of 4 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.4 PLACING TOPSOIL

A. Place topsoil in areas where seeding or planting is required to minimum thickness of 6 inches. Place topsoil during dry weather. Rake until smooth.

B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.

C. Remove roots, weeds, rocks, and foreign material while spreading.

D. Manually spread topsoil close to plant material to prevent damage.

E. Lightly compact placed topsoil.

F. Remove surplus subsoil and topsoil from site.

G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.5 TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

B. Top of Topsoil: Plus or minus 1 inch.

3.6 PROTECTION OF INSTALLED WORK

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Prohibit construction traffic over topsoil.

END OF SECTION 329119

SECTION 329219 - SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fertilizing.
2. Seeding.
3. Hydroseeding.
4. Mulching.
5. Maintenance.

B. Related Sections:

1. Section 312316.13 - Trenching: Rough grading over cut.
2. Section 310513 - Soils for Earthwork: Topsoil material.
3. Section 312500 Erosion and Sedimentation Controls: Erosion Control Blanket
4. Section 329119 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the Work of this section.

1.2 REFERENCES

A. ASTM International:

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.

B. Guam Landscaping Guidelines – August 2010

1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for seed mix, fertilizer, mulch, and other accessories.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.6 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Perform Work according to Guam EPA standards.

1.7 QUALIFICATIONS

A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.9 MAINTENANCE SERVICE

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Maintain seeded areas immediately after placement until grass is well established, 90% coverage, and exhibits vigorous growing condition for six months. Cut, fertilize, and water as required to meet coverage requirement.

PART 2 - PRODUCTS

2.1 SEED MIXTURE

A. Furnish materials according to Guam Landscaping Guidelines.

B. Seed Mixture:

Cynodon Dactylon, Common Bermuda Grass	
Minimum percent pure seed	95 percent
Minimum percent germination and hard seed	85 percent
Maximum percent week seed	0.5 percent

2.2 ACCESSORIES

A. Mulching Material: Wood cellulose fiber, shall be dyed green, free of growth or germination inhibiting ingredients and shall be manufactured so that when thoroughly mixed with seed, fertilizer and water, in the proportions specified, it will form homogeneous slurry that is capable of being sprayed.

B. Mulch Binder: Shall be applied to all slopes greater than 3:1 in steepness, or longer than 100 linear feet.

C. Fertilizer: Commercial grade; recommended for grass; of proportion necessary to eliminate deficiencies of topsoil, conforming to territorial and federal laws and suitable for application with equipment designed for that purpose. Fertilizer mix shall have the following proportions: Nitrogen 16 percent, phosphoric acid 20 percent, soluble potash 0 percent.

D. Lime: ASTM C602, Class T, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.

E. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.

F. Erosion Fabric: Erosion Control Blanket per Section 312500 Erosion and Sedimentation Controls.

G. Herbicide: Approved by the Guam EPA.

H. Stakes: Softwood lumber, chisel pointed.

I. String: Inorganic fiber.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify prepared soil base is ready to receive the Work of this section.

3.2 FERTILIZING

A. Apply lime at application rate recommended by soil analysis. Work lime into top 6 inches of soil.

B. Apply fertilizer at application rate recommended by soil analysis.

C. Apply after smooth raking of topsoil and prior to roller compaction.

D. Do not apply fertilizer at same time or with same machine used to apply seed.

E. Mix fertilizer thoroughly into upper 2 inches of topsoil.

F. Lightly water soil to aid dissipation of fertilizer. Irrigate top level of soil uniformly.

3.3 SEEDING

A. Apply seed at rate recommended by manufacturerevenly in two intersecting directions. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph.

D. Immediately following seeding, apply mulch to thickness of 1/8 inches. Maintain clear of shrubs and trees.

E. Apply water with fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.4 HYDROSEEDING

A. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at rate of 2,000 lbs per acre evenly in one pass.

B. After application, apply water with fine spray immediately after each area has been hydroseeded. Saturate to 4 inches of soil and maintain moisture levels two to four inches.

3.5 SEED PROTECTION

A. Identify seeded areas with stakes and string around area periphery.

B. Cover seeded slopes where grade is 3:1 or greater with erosion fabric per Section 312500 Erosion and Sedimentation Controls.

C. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

D. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.6 MAINTENANCE

A. Maintain planted areas in a satisfactory condition until meeting coverage requirements and final acceptance of the project.

B. Mow grass at regular intervals to maintain at maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at each mowing. Perform first mowing when seedlings are 40 percent higher than desired height.

C. Neatly trim edges and hand clip where necessary.

D. Immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps.

E. Water to prevent grass and soil from drying out.

F. Roll surface to remove minor depressions or irregularities.

G. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.

H. Immediately reseed areas showing bare spots.

I. Repair washouts or gullies.

J. Protect seeded areas with warning signs during maintenance period.

END OF SECTION 329219

SECTION 330513 - MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete manholes and structures with transition to cover frame, covers, anchorage, and accessories.
2. Modular precast concrete manholes and structures with tongue-and-groove joints and transition to cover frame, covers, anchorage, and accessories.
3. Bedding and cover materials.

B. Related Requirements:

1. Section 031000 - Concrete Forming and Accessories: Erection and bracing of forms.
2. Section 032000 - Concrete Reinforcing: Execution requirements for reinforcing steel as required by this Section.
3. Section 033000 - Cast-in-Place Concrete: Concrete type for manhole and structure foundation slab construction.
4. Section 040514 - Masonry Mortaring and Grouting: Mortar and grout.
5. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
6. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
7. Section 312316 - Excavation: Excavating for manholes, structures, and foundation slabs.
8. Section 312323 - Fill: Backfilling after manhole and structure installation.
9. Section 260533 - Raceways And Boxes For Electrical Systems: Execution requirements for ducts and manholes affected by this Section.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.

B. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C55 - Standard Specification for Concrete Building Brick.
6. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.

7. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
8. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
9. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
10. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
11. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
12. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
13. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
14. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

1.3 DESIGN REQUIREMENTS

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.

C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for frames and covers, component construction, features, configuration, and dimensions.

C. Shop Drawings:

1. Indicate structure locations, elevations, and sections.
2. Indicate sizes and elevations of piping, conduit, equipment or piping supports, access hatches, and penetrations.
3. Indicate design, construction and installation details, typical reinforcement and additional reinforcement at openings for each type, size, and configuration.

D. Submit concrete mix design for each different mix.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.

1.5 QUALITY ASSURANCE

A. Perform Work according to GWA standards.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Do not deliver products until concrete has cured 5 days or has attained minimum 75 percent of specified 28-day compressive strength.

D. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

E. Lift structures from designated lifting points.

F. Storage:

1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
2. Repair property damaged from materials storage.

G. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 - PRODUCTS

2.1 MANHOLES AND STRUCTURES

A. Furnish materials according to GWA standards.

B. Manhole Sections:

1. Description: Reinforced precast concrete conforming to ASTM C478 with gaskets conforming to ASTM C923.

2. Cast-in-place reinforced concrete base slab, 4,000 psi concrete.
3. Joints for Precast Manholes and Structures:
   a. Conforming to ASTM C913.
   b. Maximum Leakage: 0.025 gal. per hour per foot of joint at 3 feet of head.
4. Eccentric Cone Top Section with grade rings.
5. Sleeved to receive pipe sections.
6. Clear inside dimension as indicated on the drawings.

C. Design structures for minimum loads conforming to ASTM C857 and ASTM C890.

D. Roof Live Load: Comply with following loading conditions, including impact load:

1. Heavy Traffic:
   a. AASHTO HB-17, HS20-44.
   b. Maximum 16,000 lb. each wheel.
2. Light Traffic:
   a. AASHTO HB-17, HS10.
   b. Maximum 8,000 lb. each wheel.

E. Utility Structure Sections: Reinforced cast-in-place concrete as specified in Section 033000 - Cast-in-Place Concrete.

F. Precast Concrete Utility Structures:
1. Reinforced precast concrete.
2. Foundation Slab:
   a. Cast-in-place concrete of type as specified in Section 033000 - Cast-in-Place Concrete.
   b. Top Surface: Leveled.

G. Mortar and Grout:

1. As specified in Section 040514 - Masonry Mortaring and Grouting.
2. Type S.

H. Reinforcement:

1. Formed steel wire or rebar per design or plans.
2. Finish: Galvanized for wire.

I. Structure Construction:

1. Joints:
   a. Lipped male/female.
2. Sleeved to receive pipe sections.

J. Design Depth:

1. As indicated on Drawings.

K. Pipe Entry: Furnish openings as indicated on Drawings.

L. Structure Joint Gaskets:

1. Material: Ram-Nek Butyl Rubber Seal or approved equal.

M. Steps:

1. None. Ladder when shown on drawings.

2.2 PRECAST CONCRETE UTILITY STRUCTURE FABRICATION

A. Fabricate precast concrete utility structures conforming to ACI 318 and NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

B. Fabricate precast concrete utility structures and openings to size and configuration as indicated on Drawings.

C. Construct forms to provide uniform precast concrete units with consistent dimensions.

D. Clean forms after each use.

E. Reinforcing:

1. Install reinforcement by tying or welding to form rigid assemblies.
2. Position reinforcement to maintain minimum cover.
3. Secure reinforcement to prevent displacement while placing concrete.

F. Position and secure embedded items to prevent displacement while placing concrete.

G. Deposit concrete in forms and consolidate concrete without segregating aggregate.

H. Provide initial curing by retaining moisture using one of following methods:

1. Cover with polyethylene sheets.
2. Cover with burlap or other absorptive material and keep continually moist.
3. Apply curing compound according to manufacturer instructions.

I. Provide final curing according to manufacturer's standard.

J. Remove forms without damaging concrete.

2.3 FRAMES AND COVERS

A. Manufacturers (MH Frames and Covers):

1. Olympic Foundary
2. Barry Pattern and Foundry Co., Inc.
3. Campbell Foundry Co.
4. McKinley Iron Works.
5. Neenah Foundry Co.
6. EJ

7. Or approved equal.
8. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:

1. Construction: ASTM A48, Class 30B, cast iron.
2. Lid:
   a. Machined flat bearing surface.
   b. Removable.
   c. Locking type
3. Cover Design: Open checkerboard grille.
4. Live Load Rating: HS20
5. Cover: Molded with "WATER" or per GWA standards.
6. Nominal Lid Size: 30 inch opening or as shown on the drawings.

C. Access Hatches per Section 055000 – Metal Fabrications.

2.4 RISER RINGS

A. Riser Rings:

1. 4 Inches to 6 Inches Thick:
   a. Material: Precast concrete.
   b. Comply with ASTM C478.
2. Less than 4 Inches Thick:
   a. Material: Cast iron.
   b. Comply with AASHTO M306.

B. Accessories:

1. Joint Sealant: Comply with ASTM C990.
2. Bolts:
   a. Stainless Steel: Comply with ASTM F593.
   b. Galvanized: Comply with ASTM F1554.

2.5 MATERIALS

A. Cover and Bedding:

1. Bedding: Fill Type A2 as specified in Section 310516 - Aggregates for Earthwork.
2. Cover: Fill Type A2 as specified in Section 310516 - Aggregates for Earthwork.

2.6 ACCESSORIES

A. Foundation Slab:

1. Cast-in-place concrete as specified in Section 033000 - Cast-in-Place Concrete.
2. Top Surface: Level.

B. Strap Anchors:

1. Shape: Bent steel.
2. Size: As shown on the drawings.
3. Finish: Galvanized.

C. Concrete: 4,000 psi at 28 days as specified in Section 033000 - Cast-in-Place Concrete.

D. Grout: As specified in Section 040514 – Masonry Mortaring and Grouting.

E. Soil Backfill from Above Pipe to Finish Grade:

1. Soil Type S1, as specified in Section 310513 - Soils for Earthwork when not under pavement, otherwise use same material as cover.
2. Subsoil: No rocks over 6 inches in diameter or foreign matter.

2.7 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:

1. Perform following tests for each 150 cu. yd. of concrete placed with minimum one set of tests each week:

   Slump: Comply with ASTM C143.
   Compressive Strength: ASTM C31 and ASTM C39.
   Air Content: Comply with ASTM C231 or ASTM C173.
   Unit Weight: Comply with ASTM C138.

   Make test results available to Contracting Officer.

C. Inspection:

1. Visually inspect completed precast structures for defects.
2. Repair defects on surfaces exposed to view to achieve uniform appearance.
3. Repair honeycomb by removing loose material and applying grout to produce smooth surface flush with adjacent surface.
4. Repair major defects only if permitted by Engineer.

D. Owner Witnessing:

1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Notify Contracting Officer at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are properly sized and located.

C. Verify that built-in items are in proper location and are ready for roughing into Work.

D. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

C. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.

D. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate for manholes and structures as specified in Section 312316 - Excavation and in indicated locations and depths.
2. Provide clearance around sidewalls of manhole or structure for construction operations and granular backfill.
3. If groundwater is encountered, prevent accumulation of water in excavations; place manhole or structure in dry trench.
4. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation, as approved by Architect/Engineer.

B. Foundation Slab:

1. Place foundation slab and trowel top surface level.
2. Place manhole sections plumb and level, trim to correct elevations, and anchor to foundation slab.

C. Install manholes and structures supported at proper grade and alignment as indicated on Drawings.

D. Backfill excavations for manholes and structures as specified in Section 312323 - Fill.

E. Form and place manhole or structure cylinder plumb and level, to correct dimensions and elevations.

F. Cut and fit for pipe, conduit, or sleeves.

G. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.

H. Set cover frames and covers level to correct elevations without tipping.

I. Precast Concrete Manholes and Structures:

1. Lift precast components at lifting points designated by manufacturer.
2. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
3. Set precast structures, bearing firmly and fully on crushed stone bedding, compacted as specified in Section 312323 - Fill or on other support system as indicated on Drawings.
4. Assembly:
    a. Assemble multi-section manholes and structures by lowering each section into excavation.
    b. Install rubber gasket joints between precast sections according to manufacturer's recommendations.
    c. Lower, set level, and firmly position base section before placing additional sections.
5. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.
6. Maintain alignment between sections by using guide devices affixed to lower section.
7. Joint sealing materials may be installed on Site or at manufacturer's plant.
8. Verify that installed manholes and structures meet required alignment and grade.
9. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
10. Cut pipe flush with interior of structure.
11. Shape inverts through manhole and structures as indicated on Drawings.

J. Cast-in-Place Concrete Manholes and Structures:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.
2. Erect and brace forms against movement as specified in Section 031000 - Concrete Forming and Accessories.
3. Install reinforcing steel as indicated on Drawings and as specified in Section 032000 - Concrete Reinforcing.
4. Place and cure concrete as specified in Section 033000 - Cast-in-Place Concrete.

K. Frames and Covers:

1. Set frames using mortar and masonry.
2. Install radially laid concrete brick with 1/4 inch thick vertical joints at inside perimeter.
3. Lay concrete brick in full bed of mortar and completely fill joints.

4. If more than one course of concrete brick is required, stagger vertical joints.
5. Set frame and cover 2 inches above finished grade for manholes and structures with covers located within unpaved areas, to allow area to be graded away from cover beginning 1 inch below top surface of frame.

L. Access Hatches:

1. Install per manufacturer instructions and Section 055000 – Metal Fabrications.

M. Installation Standards: Install Work according to GWA standards.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Test cast-in-place concrete as specified in Section 033000 - Cast-in-Place Concrete.

C. Vertical Adjustment of Existing Manholes and Structures:

1. Where required, adjust top elevation of existing manholes and structures to finished grades as indicated on Drawings.
2. Frames, Grates, and Covers:
   a. Carefully remove frames, grates, and covers cleaned of mortar fragments.
   b. Reset to required elevation according to requirements specified for installation of castings.
3. Reinforcing Bars:
   a. Remove concrete without damaging existing vertical reinforcing bars if removal of existing concrete wall is required.
   b. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.
4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 033000 - Cast-in-Place Concrete.

END OF SECTION 330513

SECTION 331116 - SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings for Site water line, including domestic water line.
2. Valves: Gate, butterfly, ball, swing check, pressure reducing, pressure reducing and sustaining, and air release combination.
3. Couplings.
4. Dismantling Joints.
5. Valve Operators.
6. Underground pipe markers.
7. Valve boxes.
8. Bedding and cover materials.

B. Related Requirements:

1. Section 033000 - Cast-in-Place Concrete: Concrete for thrust restraints.
2. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
3. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
4. Section 312316 - Excavation: Product and execution requirements for excavation and backfill.
5. Section 312316.13 - Trenching: Execution requirements for trenching.
6. Section 312323 - Fill: Requirements for backfill to be placed by this Section.
7. Section 331300 - Disinfecting of Water Utility Distribution: Disinfection of Site service utility water piping.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
3. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

C. American Society of Sanitary Engineering:

1. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.

2. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.

D. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A182 – Forged or rolled alloy steel pipe flanges, forged fittings and valves and parts for high temperature service.
3. ASTM A312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
4. ASTM A403 – Wrought austenitic stainless steel piping fittings.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
6. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
7. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3).
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
9. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
11. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
13. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
14. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. American Water Works Association:

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
6. AWWA C153 – Ductile-Iron Compact Fittings, 3 In. through 24 In. and 54 In. through 64 In., for Water Service
7. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
8. AWWA C502 - Dry-Barrel Fire Hydrants.
9. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
10. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
11. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
12. AWWA C550 – Protective Interior Coatings for Valves and Hydrants
13. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
14. AWWA C606 - Grooved and Shouldered Joints.

15. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
16. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
17. AWWA C702 - Cold-Water Meters - Compound Type.
18. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
19. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
20. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

F. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

G. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves.

H. UL:

1. UL 246 - Hydrants for Fire-Protection Service.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on pipe materials, pipe fittings, valves, and accessories including all options, appurtenances and cavitation data.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work according to Guam Waterworks Authority standards.

B. For piping and fitting surfaces in contact with potable water, the coating material shall be listed by the NSF International as in compliance with NSF 372 and NSF 600 according to the requirements of NSF 61.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. Ductile Iron Pipe:

1. Comply with AWWA C151, C104 and C105.
2. Pressure Class 250 minimum.
3. Fittings:
   a. Material: Ductile iron.
   b. Thickness: Standard.
   c. Comply with AWWA C153 and C116.
4. Joints:
   a. Comply with AWWA C111.
   b. Provide rubber gasket with rods.
5. Jackets: AWWA C105, polyethylene jacket.

B. Copper Tubing:

1. Comply with ASTM B88.
2. Type K, annealed.
3. Fittings: ASME B16.18, cast copper or ASME B16.22, wrought copper.
4. Joints: Compression connection.

C. Stainless Steel Pipe:

1. Comply with ASTM A312.
2. Type: Seamless, 316, Schedule 40.
3. Fittings and Special Sections:
   a. Comply with ASTM A403 or A182.
   b. Type: Threaded or flanged.

D. Stainless Steel Tubing:

1. Comply with ASTM A213.
2. Type: Seamless, 316, annealed.
3. Fittings: ASME A479, stainless steel.
4. Joints: Compression connection.

E. PVC Pipe:

1. Comply with AWWA D1785, Schedule 80.
2. Fittings:
   a. Material: PVC
   b. Comply with ASTM D2466
3. Joints:
   a. Material: PVC
   b. Comply with ASTM D2855, solvent weld.

F. PVC Pipe:

1. Comply with AWWA C900, Class 235 (DR 18).
2. Fittings:
   a. Material: Ductile iron.
   b. Thickness: Standard.
   c. Comply with AWWA C153 and C116.
3. Joints:
   a. Comply with ASTM D3139.
   b. Provide compression gasket ring.

2.2 GATE VALVES 2-1/2 INCH AND SMALLER

A. Manufacturers:

1. Nibco
2. Apollo Valves
3. Powell Valves
4. Crane
5. Or approved equal
6. Substitutions: As specified in Section 016000 - Product Requirements.

B. Furnish materials in accordance with GWA's standards.

C. Description:

1. Comply with AWWA C500, NSF 61, NSF 372 and NSF 600.
2. Lead-free markings
3. Materials:
   a. Body: Bronze.
4. Seats: Solid wedge.
5. Stem:
   a. Type: Non-rising.
   b. Material: Bronze.
6. Operation:
   a. Hand wheel.
   b. Open counterclockwise unless otherwise indicated.
7. End Connections: Threaded or soldered bell.
8. Coatings:
   a. Comply with AWWA C550.
   b. Interior and exterior.
9. Pressure Rating:
   a. 200 psig.

D. Mark manufacturer's name and pressure rating on valve body.

2.3 GATE VALVES 3 INCH AND LARGER

A. Manufacturers:

1. Clow Valve

2. Kennedy Valve
3. American AVK
4. Or approved equal
5. Substitutions: As specified in Section 016000 - Product Requirements.

B. Furnish materials in accordance with GWA's standards.

C. Description:

1. Comply with AWWA C509, NSF 61, NSF 372 and NSF 600.
2. Materials:
   a. Body: Ductile iron.
3. Seats: Resilient.
4. Stem:
   a. Type: Non-rising.
   b. Material: Bronze.
5. Operation:
   a. Square operating nut or hand wheel as shown on the plans and depending on access.
   b. Open counterclockwise unless otherwise indicated.
6. End Connections: Flanged, mechanical joint, or bell as indicated.
7. Coatings:
   a. Comply with AWWA C550.
   b. Interior and exterior.
8. Pressure Rating:
   a. 12-inch Diameter and Smaller: 200 psig.
   b. 16-inch Diameter and Larger: 150 psig.

D. Mark manufacturer's name and pressure rating on valve body.

2.4 BUTTERFLY VALVES

A. Manufacturers:

1. Clow Valve
2. Kennedy Valve
3. Val-Matic
4. Henry Pratt
5. Or approved equal
6. Substitutions: As specified in Section 016000 - Product Requirements.

B. Furnish material in accordance with GWA's standards.

C. Description:

1. Comply with AWWA C504, MSS SP-67 and API 609, NSF 61, NSF 372 and NSF 600.
2. Materials:
   a. Body: Ductile iron.
   b. Disc: Ductile iron
   c. Extended neck

3. Seats: Resilient, EPDM or Buna N stem seals. Mate with 316 stainless steel body ring. Seal retaining hardware 316 stainless steel.
4. Stem:
   a. Type: Non-rising.
   b. Material: Stainless steel.
5. Operation:
   a. Square operating nut or hand wheel as shown on the plans.
   b. Open counterclockwise unless otherwise indicated.
   c. Operator for Sizes 2 inches to 6 inches: Standard lever handle with memory stop.
   d. Position indicator for valves inside vaults or above ground
6. End Connections: Flanged or mechanical joint as indicated.
7. Coatings:
   a. Comply with AWWA C550.
   b. Interior and exterior.
   c. molded-in or bonded-in EPDM or Buna N seat.
8. Pressure Rating:
   a. 12-inch Diameter and Smaller: 200 psig CWP.
   b. 16-inch Diameter and Larger: 150 psig CWP.
   c. 150 psi maximum pressure differential.
   d. Suitable for dead-end service in either direction at the full working pressure of the valve with the downstream flange removed for up to 96 hours.

D. Mark manufacturer's name and pressure rating on valve body.

2.5 BALL VALVES

A. Furnish materials in accordance with GWA's standards.

B. 2 Inch and Smaller: AWWA C800, NSF 61, NSF 372 and NSF 600. 316 stainless steel body, 316 stainless steel ball, full port, reinforced seats, blow-out proof stem, tee stem pre-drilled for control rod, AWWA standard corporation stop thread or iron pipe thread (IPT) inlet and outlet end, with control rod, valve box, and valve key.

C. Mark manufacturer's name and pressure rating on valve body.

2.6 SWING CHECK VALVES

A. Manufacturers:

1. Cla-Val
2. Val-Matic
3. Flowmatic Valves
4. APCO
5. Or approved equal
6. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:

1. 2 inches to 24 inches:

a. Comply with AWWA C508.
b. Ductile iron body, ASTM A536 Grade 65-45-12.
c. Angle seating at 45 degrees.
d. Buna-N seal. Seal design shall provide both a metal-to-metal and seal-to-metal seal
e. Body interior and exterior coated in accordance AWWA with , NSF 61, NSF 372 and NSF 600 certified fusion bonded epoxy.
f. Flanged ends.
g. Backflow actuator/jack.
h. Position indicator.

C. Mark manufacturer's name and pressure rating on valve body.

2.7 PRESSURE REDUCING VALVES

A. Manufacturers:

1. Cla-Val Model 90-01
2. Or approved equal
3. Substitutions: As specified in Section 016000 - Product Requirements.

B. General: The valve shall be hydraulically operated, diaphragm valve, globe pattern with the pilot control. The pilot control automatically throttles the valve to maintain an accurate and constant outlet pressure regardless of changing flow rate and/or inlet pressure.

1. 6 to 12 inches valve
   a. ASTM A536 ductile iron body and cover.
   b. ANSI B16.42 Class 150 flanges.
   c. Stainless Steel main valve trim and seat
   d. Buna-N Disc and Diaphragm, resilient, synthetic rubber
   e. 316SS Stem, Nut & Spring
   f. Valve position indicator with air release
   g. Features to control the speed of closing of the valve
   h. Pressure rating 250 psi
2. Pilot System
   a. Adjustment range: 20 to 105 psi or as specified on the drawings.
   b. 316 Stainless steel Pilot Control
   c. Pilot control tubing shall be installed on the ladder side of the valve by the manufacturer. This information shall be included on the order form.
   d. 303 SS Trim (316 SS if available by manufacturer)
   e. Identifying nameplate of stainless steel or brass with catalog number, function, size, material, pressure rating, and control adjustment range
   f. Normally open designed to permit flow upon pilot failure
   g. CV speed control
   h. Strainer
3. Control Tubing and Fittings
   a. 316 Stainless steel
4. Finish: fusion bonded epoxy coated (interior and exterior) IAW AWWA and , NSF 61, NSF 372 and NSF 600.

5. Commissioning: A manufacturer technician, a direct employee of the manufacturer, shall be available, on Guam, for start-up service, inspection, commissioning, and necessary adjustments per Section 019100 Commissioning.
6. Warranty: manufacturer warranty for a period of 3 years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.

2.8 AIR RELEASE COMBINATION VALVES

A. Manufacturers:

1. Cla-Val
2. Val-Matic
3. APCO
4. Or approved equal
5. Substitutions: As specified in Section 016000 - Product Requirements.

B. General: Multipurpose valve able to vent air upon pipeline fill and break vacuum upon drain to prevent pipeline collapse.

1. 1 inch to 2 inches:
   a. ASTM A126 Cast Iron body.
   b. 316 SS Float, plug, and all other internal metal parts
   c. Type 316 SS spring
   d. Buna-N rubber seal.
   e. Body interior and exterior coated in accordance AWWA with , NSF 61, NSF 372 and NSF 600 certified fusion bonded epoxy.

2.9 COUPLINGS

A. Manufacturers:

1. Romac Industries
2. Smith-Blair
3. Or approved equal
4. Substitutions: As specified in Section 016000 - Product Requirements.

B. General: Furnish couplings and coupling adapters where indicated to connect plain end pipe sections or join plan end pipe to flanged valves and fittings.

1. Body: Ductile iron ASTM A536, bolt circle, bolt size and spacing conform to ANSI Class 125 and 150 flange drilling.
2. Gasket: SBR per ASTM D2000 MBA 710, compounded for water service or Nitrile Buna N certified to NSF/ANSI 61 and 372. Flange o-ring gasket is NBR rubber.
3. Bolts and Nuts: Type 316 stainless steel.
4. Finish: Fusion bonded epoxy finish certified to NSF 61, NSF 372 and NSF 600

C. All couplings for PVC and ductile iron pipe and all fittings at tees and bends shall be restrained.

2.10 DISMANTLING JOINTS

A. Manufacturers:

1. Romac Industries DJ405
2. Or approved equal
3. Substitutions: As specified in Section 016000 - Product Requirements.

B. General: Furnish dismantling joints where indicated to connect flanged pipe spools or flanged valves and fittings to other flanged valves and fittings.

1. Body: Ductile iron ASTM A536, bolt circle, bolt size and spacing conform to ANSI Class 125 and 150 flange drilling.
2. Gasket: SBR per ASTM D2000 MBA 710, compounded for water service or Nitrile Buna N certified to NSF 61, NSF 372 and NSF 600. Flange o-ring gasket is NBR rubber.
3. Bolts and Nuts: Type 316 stainless steel.
4. Finish: Fusion bonded epoxy finish

2.11 FIRE HYDRANTS

A. Manufacturers:

1. Clow Valve
2. Mueller
3. Or approved equal
4. Substitutions: As specified in Section 016000 - Product Requirements.

B. Furnish materials in accordance with GWA's standards.

C. Fire Hydrants:

1. Comply with AWWA C503 and UL listed, certified to NSF 61, NSF 372 and NSF 600.
2. Type: Wet barrel.
3. Body: Ductile iron
4. Working pressure: 200 psi
5. Minimum Inside Diameter: 7 inches.
6. Inlet: 6-inch bell or mechanical joint connection with accessories, gland bolts, and gaskets.

D. Fire Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.

E. Hose and Streamer Connection:

1. Match sizes and type of thread with requirements of GWA.
2. Provide two hose nozzles and one pumper nozzle.
3. Independently valved ports.
4. Standard nut size of valve stem and protector cap shall be pentagonal shape of 1-1/8" measured form point to flat of the pentagon.
5. Protector caps of grey cast iron, securely chained to hydrant barrel.

F. Finish:

1. Primer and two coats of enamel.
2. Color according to GWA requirements.

2.12 VALVE OPERATORS

A. General

1. Valve operator types describe only general characteristics of operators.
2. Provide operators compatible with valve with which it will be used and of same manufacturer, or product that is recommended by valve manufacturer.
3. Size operator to operate valve for full range of pressures and velocities specified.
4. Valve operators shall open by turning counterclockwise.

B. Manual Operators

1. General
   a. Provide 2 inch AWWA operating nut where located below valve cover in vault, otherwise provide manual handwheel operators within vaults, unless otherwise shown or specified.
   b. Galvanize and paint ferrous handwheels same color as valve and associated pipeline.
   c. When maximum force required to operate valve under full operating head exceeds 40 pounds, provide gear reduction operators.
   d. Gear operators totally enclosed and lubricated.
   e. Quarter-turn valve operators: self-locking type to prevent disc or plug from creeping and provide with position indicators to show position of valve disc or plug.
   f. Worm and gear type operators: self-locking worm-gears, one-piece design, of gear bronze material, accurately machine cut. Worm hardened alloy steel, with thread ground and polished.
   g. Geared traveling nut type operators: threaded steel reach rods with internally threaded bronze or ductile iron nut.
   h. Provide safety isolation valves and lockout valves with handles, handwheels, or chain wheels painted “safety yellow.” Equip handles to take padlock and wheels, chain and padlock. Isolation valves are valves that shut off source of stored energy (such as compressed air or water pressure) and that, if opened, could endanger safety or life.
2. Exposed Operators
   a. Furnish with geared operators, extension stems, floor stands, and other elements to permit operation from normal operating level.
   b. Lever type operators: means of being fixed in any given position to prevent accidental movement; rugged, noncorrosive construction; fully compatible with valve.
3. Buried Operators
   a. Provide buried service operators on valves larger than 2½ inches with 2 inch AWWA operating nut.
   b. Provide buried operators on valves two inches and smaller with cross handle for operation.

c. All moving parts of valve and operators enclosed in housing to prevent contact with soil.
d. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at FULLY OPEN or FULLY CLOSED positions without damage to valve or operator and grease pack and gasket to withstand submersion in water to 10 psi.
e. Install valves with extension stems, as required, and valve boxes.

2.13 UNDERGROUND PIPE MARKERS

A. Detectable Ribbon Tape:

1. Bright colored, color coded, continuously printed.
2. Metallic foil laminated between two layers of impervious plastic film.
3. Minimum 6 inches wide by 5 mil thick.
4. Manufactured for direct burial service.

B. Trace Wire:

1. Bare Copper, 10 gage, solid conductor.

2.14 VALVE BOXES

A. Furnish materials in accordance with GWA's standards.

B. Description:

1. Valve boxes and covers, including position indicators and valve extensions.
2. Material: Cast iron.
3. Type: Extension, with slide adjustment.
4. Covers marked with a "W" or "Water".

2.15 MATERIALS

A. Bedding and Cover:

1. Bedding: Coarse aggregate type A5, pea gravel, as specified in section 310516 Aggregates for Earthwork.
2. Cover: Coarse aggregate base material type A2 as specified in section 310516 Aggregates for Earthwork.

2.16 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 033000 - Cast-in-Place Concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that building service connections and municipal utility water main sizes, locations, and elevations are as indicated on Drawings.

B. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

D. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

E. Examine threads on valve and mating pipe for form and cleanliness.

F. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

G. Do not attempt to repair defective valves; replace with new valves

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

D. Protect and support existing distribution piping and appurtenances as Work progresses.

3.3 INSTALLATION - PIPE

A. Refer to Section 312316 for trenching and Section 312333 backfill.

B. Wrap all steel pipe, coat all iron, and heat shrink wrap pipe joints after assembly where buried or concrete encased.

C. Perform Work according to Guam Waterworks Authority standards.

D. Maintain separation of water main from sewer piping according to GWA standards.

E. Route pipe in straight line; re-lay pipe that is out of alignment or grade.

F. High Points:

1. Install pipe with no high points unless directed on drawings.
2. If unforeseen field conditions arise that necessitate high points, install air release valves as directed by Engineer.

G. Bearing:

1. Install pipe to have bearing along entire length of pipe.
2. Excavate bell holes to permit proper joint installation.
3. Do not lay pipe in wet trench.

H. Prevent foreign material from entering pipe during placement.

I. Install pipe to allow for expansion and contraction without stressing pipe or joints.

J. Close pipe openings with watertight plugs during Work stoppages.

K. Install access fittings to permit disinfection of water system performed under Section 331300 - Disinfecting of Water Utility Distribution.

L. Cover:

1. Establish elevations of buried piping with not less than 3 feet of cover.
2. Measure depth of cover from final surface grade to top of pipe barrel.

M. Pipe Markers:

1. Install detectable ribbon tape and trace wire continuous buried 18 inches below finish grade, and over top of pipe, respectively.
2. Coordinate with trench Work as specified in Section 312316.13 - Trenching.

3.4 INSTALLATION - VALVES

A. Install valves as indicated, according to manufacturer’s written instructions.

B. Piping installation requirements are specified in other Division 33 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.

3.5 PIPE BEDDING, PIPE ZONE AND BACKFILL

A. Excavate pipe trench as specified in Section 31 23 16.13 - Trenching.

B. Place bedding material at trench bottom.

C. Level fill materials in continuous layers not exceeding 6 inches compacted depth.

D. Compact to 95 ASTM D1557 percent of maximum density.

E. Backfill around sides and to top of pipe with cover fill, tamp in place, and compact to 95 ASTM D1557 percent of maximum density.

3.6 PVC PIPE

A. All rigid PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Plastic pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and during operation.

B. Schedule 40 pipe shall not be threaded. Use Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.

C. Only strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to overtighten these fittings. Pipe shall not be laid when the temperature is above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.

D. Provide adequate ventilation when working with pipe joint solvent cement.

3.7 DUCTILE IRON PIPE

A. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.

B. Dressing Cut Ends

1. Dress cut ends of pipe in accordance with the type of joint to be made.
2. Dress cut ends of buried pipe joints to remove sharp edges or projections which may damage the rubber gasket.
3. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
4. Dress cut ends of pipe for flexible couplings, flanged coupling adapters, and grooved end pipe couplings as recommended by the coupling or adapter manufacturer.

C. Fabrication of Flanged Pipe

1. Fabricate flanged pipe in the shop, not in the field, and deliver to the jobsite with flanges in place and properly faced.

2. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.
3. Face flanges after fabrication in accordance with ANSI A21.15/AWWA C115.
4. Hydrostatically shop test a sufficient number of selected flange-to-pipe threaded joints to ensure joint integrity.

D. Jointing Pipe

1. Grooved End: Install in accordance with the manufacturer's printed instructions.
2. Flanged
   a. Prior to connecting flanged pipe, thoroughly clean the faces of the flanges of all oil, grease, and foreign material.
   b. Check the rubber gaskets for proper fit and thoroughly clean.
   c. Take care to assure proper seating of the flange gasket.
   d. Tighten bolts so that the pressure on the gasket is uniform. Use torque-limiting wrenches to ensure uniform bearing insofar as possible.
   e. If joints leak when the hydrostatic test is applied, remove and reset gaskets and retighten bolts.
3. Mechanical, Proprietary Restrained, and Push-On Joint
   a. Join pipe with mechanical, proprietary restrained, and push-on type joints in accordance with the manufacturer's recommendations.
   b. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation.
   c. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes will be permitted under any circumstances.

E. Encapsulate all buried ductile iron pipe and/or fittings in polyethylene jacket in accordance with AWWA C105.

3.8 THRUST RESTRAINT

A. Anchor all pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

B. Determine dimensions of thrust blocks based upon the pipeline maximum design pressure.

C. Pipe anchorage and expansion provisions are not completely detailed. The absence of these details on any Contract Document shall not relieve the Contractor of the responsibility for providing them where required, and at his sole expense.

D. Place thrust blocking between undisturbed ground and the fitting to be anchored. Place blocking so that pipe and fitting joints will be accessible for repairs. Place concrete in accordance with Section 033000.

E. As an alternative to thrust blocks, the contractor may use thrust restrained joint couplers such as MegaLug or equal.

3.9 ELECTROMAGNETIC FLOW METERS

A. Install flow meter in accordance with the manufactures recommendations.

B. Meter specified in Section 409001 Instrumentation and Control Components

3.10 DISINFECTION

A. Flush and disinfect system as specified in Section 331300 - Disinfecting of Water Utility Distribution.

3.11 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Install pipe within tolerance of 5/8 inch.

3.12 FIELD QUALITY CONTROL

A. Pressure test system according to AWWA C600 for ductile iron pipe and AWWA C605 for PVC and following:

1. Test Pressure: Not less than 200 psig for ductile iron, 150 psig for PVC or 50 psi in excess of maximum static pressure, whichever is greater. Not less than 50 psi in excess of maximum static pressure for piping other than ductile iron or PVC.
2. Conduct hydrostatic test for at least two hours.
3. Slowly fill with water section to be tested and expel air from piping by installing corporation cocks at high points.
4. Close air vents and corporation cocks after air is expelled and raise pressure to specified test pressure.
5. Observe joints, fittings, and valves under test. Remove and renew cracked pipes, joints, fittings, and valves showing visible leakage and retest.
6. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
7. Maintain pressure within plus or minus 5 psi of test pressure.
8. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
9. Compute maximum allowable leakage using following formula:
    a. $L = SD \times \sqrt{P}/C$.
        1) L = testing allowance, gph.
        2) S = length of pipe tested, feet.
        3) D = nominal diameter of pipe, inches.
        4) P = average test pressure during hydrostatic test, psig.
        5) C = 148,000.
    b. If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
10. If test of pipe indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
11. Correct visible leaks regardless of quantity of leakage.

B. Compaction Testing for Bedding: Comply with ASTM D1557.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

D. A direct factory representative shall be made available by the equipment supplier for start-up service, inspection and necessary adjustments of altitude and pressure reducing valves.

E. Frequency of Compaction Tests: One set of two (2) tests per 100 L.F. of trench per lift when under roadways pavement or structures and one set of one (1) tests per 100 L.F. of trench per lift in other areas, for each trench type.

END OF SECTION 331116

SECTION 331300 – DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Disinfection of potable water distribution and transmission system.
2. Testing and reporting of results.

B. Related Requirements:

1. Section 331116 - Site Water Utility Distribution Piping: Product and execution requirements for installation and testing of site domestic water distribution piping.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA B300 - Hypochlorites.
2. AWWA B302 - Ammonium Sulfate.
3. AWWA B303 - Sodium Chlorite.
4. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Certify that cleanliness of water distribution system meets or exceeds specified requirements.

E. Certify that water conforms or fails to conform to bacterial standards of GWA and Guam EPA.

F. Certify that water conforms to quality standards of GWA and Guam EPA.

G. Test and Evaluation Reports: Indicate testing results comparative to specified requirements.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Qualifications Statements:

1. Submit qualifications for water treatment firm and testing firm.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

C. Bacteriological Report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Submit bacteriologist's signature and authority associated with testing.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years' documented experience.

B. Testing Firm: Company specializing in testing potable water systems, certified on Guam.

C. Submit bacteriologist’s signature and authority associated with testing.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Ammonium Sulfate: Comply with AWWA B302.
3. Sodium Chlorite: Comply with AWWA B303.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that piping system has been cleaned, inspected, and pressure tested.

C. Perform scheduling and disinfecting activity with startup, water pressure testing, adjusting and balancing, and demonstration procedures, including coordination with related systems.

3.2 INSTALLATION

A. Provide and attach required equipment to perform Work of this Section.

B. Perform disinfection of water distribution system and installation of system and pressure testing as specified in Section 331116 - Site Water Utility Distribution Piping.

C. Inject treatment disinfectant into piping system.

D. Maintain disinfectant in system for 24 hours.

E. Flush, circulate, and clean until required cleanliness is achieved using domestic water.

F. Replace permanent system devices that were removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation according to AWWA C651.
2. Use of liquid chlorine is not permitted.
3. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
4. Disposal:
    a. Legally dispose of chlorinated water.
    b. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
5. After final flushing and before pipeline is connected to existing system or placed in service, employ an approved independent testing laboratory to sample, test, and certify that water quality meets quality standards of GWA and suitable for human consumption.

END OF SECTION 331300

SECTION 409000 – INDUSTRIAL INSTRUMENTATION AND PROCESS CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. WORK INCLUDED

1. This Section covers the Instrumentation and Controls (I&C) system, complete; except for field interconnection wire and conduit, which is specified under Sections 26 05 19 and 26 05 33. The work includes furnishing, installing, calibrating, adjusting, testing, documenting, and starting up the I&C system. The work also includes training of the Owner's personnel.
2. Instruments are listed herein for reference but shall be furnished and installed in this work.
3. Construct and install process controllers, DIN rails, terminals, power supplies, conductors, wireways, lights, switches, human-machine interfaces (HMI) and all associated equipment in Local Control Panels.
4. Install field raceway and wire or cable connecting instruments and control components to the Local Control Panels.
5. All items shown in the contract drawing shall be supplied and installed by the contractor except those items specifically labeled "NIC" (Not In Contract), "NIW" (Not In Work), "Other or Owner Furnished" (OF) or "Other or Owner installed" (OI) in the drawings.
6. Manufacture and test the control systems in accordance with all applicable sections of Division 26 and 40.
7. Systems Integration: **Programming and configuration of the RTU, PLC, HMI, routers, switches and firewalls shall be supplied by the Contractor.**
8. All in-line devices, except thermowells, must be removed when the piping is being flushed, cleaned, or pressure tested. All in-line devices shall be reinstalled after the flushing, cleaning, or pressure testing.
9. Nameplate/Label Style Details shall be as specified in Section 26 05 53, and as indicated on the drawings.

B. WORK SPECIFICALLY EXCLUDED

1. Installation of all in-line devices shall be responsibility of the Mechanical contractor, including, but not limited to:
   a. Control valves (including altitude and pressure reducing valves),
   c. Orifice plates,
   d. Magnetic flow meters,
   e. Safety relief valves
   f. Pressure Reducing Valves.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 26 05 00 – Common Work Requirements for Electrical Systems

B. Section 26 05 19 - Wire and Cable

C. Section 26 05 33 – Raceways and Boxes

D. Section 26 05 53 - Electrical Equipment Identification

E. Section 40 94 43 – Programmable Logic Process Controllers

1.3 REFERENCES

A. ASCE 7-16 – "Minimum Design Loads for Buildings and Other Structures"

B. ASME/ANSI B16 – "Standards for Pipes and Fittings"

C. ANSI/NSF 61 – "Drinking Water System Components"

D. IBC – "International Building Code" most recent applicable version.

E. ISA S5.4 – "Instrument Loop Diagrams"

F. NEMA ICS 1 – "Industrial Control and Systems: General Requirements"

G. NFPA 79 – "Electrical Standard for Industrial Machinery"

H. UL 508 – "Industrial Control Panels for General Use"

1.4 DEFINITIONS

A. The following abbreviations or acronyms are used in this work:

1. CF = Contractor Furnished
2. CI = Contractor Installed
3. CC = Contractor Connected
4. OF = Other (or Owner) Furnished (i.e., Not in this work)
5. OI = Other Installed (i.e., Not in this work)
6. OC = Other Connected (i.e., Not in this work)
7. O2 = Oxygen
8. CND = Conductivity
9. VX = Vortex Shedding (Flow sensor/transmitter)
10. HOA = Hand/Off/Auto
11. VFD = Variable Frequency Drive

B. Note that some instrumentation components labeled "OF" and "OI", such as valve limit switches, are furnished and installed by the mechanical contractor.

1.5 SUBMITTALS

A. Transmit submittals as required by each Section of Division 26, Electrical, and as per Division 01 Submittal Procedures.

B. Product Submittals

1. Product submittals shall be submitted within 45 days after the Notice to Proceed. In addition, no products shall be fabricated or shipped until the Engineer has reviewed the applicable submittals.
2. As-built copies of product submittals shall be included in the O&M manuals.
3. Before any material is fabricated or shipped, furnish to the Engineer full details, shop drawings, dimensions, catalog cuts, schematic (elementary) diagrams, wiring diagrams, and other descriptive matter as required to fully describe the equipment specified under this Section.
4. Provide a bill of materials, which is a listing that includes all of the panels, instruments, components, and devices provided under this Section. Components on and within panels shall be included on the Bill of Materials for the panel. All components shall be grouped by component type, with the identification code used in these Specifications. The list shall contain the following, as a minimum:
    a. Instrument, panel, rack or device, tag number
    b. Description
    c. Quantity supplied
    d. Reference to component datasheet and/or catalog cut
    e. Component type
5. Provide complete submittal information on control panels and other control enclosures.
    a. Provide panel construction drawings, including shop drawings and catalog material. Drawings shall include dimensions and shall show the location of all panel-mounted devices as well as doors, hinges, fasteners, louvers, and subpanels. Drawings shall include a panel legend and a Bill of Materials. The panel legend shall list and identify front-of-panel devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions. The Bill of Materials shall list all devices mounted within the panel that are not listed in the panel legend, and shall include the tag number, description, manufacturer, and model number for each.
    b. Panel Temperature Control: Provide calculations for panels, and determine heat dissipation, and panel operating temperature. Heat dissipation shall be minimum and stated in BTU per hour or watts. Operating temperature shall be calculated at 40 degrees C ambient temperatures and based on any heating and/or cooling provisions that may be required.
    c. If ventilation fans are used, submit audible sound level data for the fans.
    d. Panel Power: Provide calculations for panels to determine panel electrical power required. Power requirements shall state required voltages, currents, and phases. Size each bus, circuit breakers, and fuses.
    e. For each UPS and power supply, provide load calculations and duration calculations where applicable. See Component Specifications.
6. Drawings and data shall be complete and shall represent the equipment proposed for this project. Drawings and data shall be adequate to demonstrate that the equipment meets the requirements of the Contract Drawings and Specifications, and to be used by the Owner for operation, maintenance, and troubleshooting of the facility.
7. Provide electrical schematic diagrams and connection (wiring) diagrams that show locations and wiring for items specified in this Section and show interface wiring between items specified in this Section and other items on this project.
8. Provide complete drawings and descriptive data for control panels.

9. Electrical schematic diagrams shall show circuits and device elements in ladder-diagram form without regard to physical location. “Typical” schematic diagrams are not acceptable; provide individual diagrams for multiple pieces of equipment.
10. Connection (wiring) diagrams shall show the connections and physical relationship of electrical devices and apparatus in circuits or groups of circuits within each control panel or other identifiable unit of equipment.
11. Loop Diagrams: Provide an individual loop diagram for each analog, or discrete loop (control circuit) in the I&C system showing all terminal numbers, the location of the dc power supply, the location of any common dropping resistors, input/output module connections, and all other components. Switching contacts in analog loops and output contacts of analog devices shall be shown on the loop diagrams. Reference shall be made to the specific control diagrams where the functions of these contacts are shown. As a minimum, the loop diagrams shall meet the requirements of ISA S5.4. In addition, each loop diagram shall be divided into at least three areas for identification of element locations: panel face, back of panel, and field, respectively. Loop diagrams shall be on individual 11-inch by 17-inch drawings.

C. Programmed Systems Submittals: Additional submittal requirements for application program listings, hardware and software products, and related items are covered in Section 40 96 30.

D. Testing Submittals: Submittal requirements for testing, test plans, and test reports are covered under the Articles, TESTING.

1.6 QUALITY ASSURANCE

A. Meet applicable requirements of Section 26 05 00, including the following:

1. Field investigations.
2. O&M Manuals.
3. Warranty.

B. All equipment shall be designed, manufactured and tested according to the latest IEEE, ANSI, NEMA, and shall be tested, listed where applicable by a Nationally Recognized Testing Laboratory (NRTL). The equipment shall comply with the current OSHA state and local requirements.

1. Wherever the drawings or specifications call for material, workmanship, arrangement, or construction of quality that is superior to that required by any applicable Code or Standard, the drawings and specifications shall prevail
2. Otherwise, should there be a conflict between any Code or Standard and the drawings and specifications, the applicable Codes and Standards shall prevail.

C. Where technical specifications (Division 26 & 40) are more stringent than UL Standard 508, the technical specifications shall take precedence. The contractor shall include any design change costs of a standard other than UL 508 being used to list the panels.

D. The contractor shall familiarize himself with all furnished data before commencing the

installation work. The contractor shall notify the manager or plant engineer should there be inconsistencies between any of the documents. The Contract manager or plant engineer will then determine which portions of the specifications or drawings are applicable.

E. The Contractor shall be responsible for the correct installation and assembly of all items or equipment.

1. Manufacturer's instructions shall be carefully read and rigidly adhered to during installation, supplemented by details given herein by the specifications and drawings.
2. Any damage that results from failure to observe the manufacturer's instructions or failure to understand how a particular job is to be done will be the contractor's responsibility, and he shall make good any resulting loss or damage.

F. The work under this contract shall be carried out by certified and trained tradesmen with adequate supervision and equipment necessary to complete the work, in accordance with good trade practice, shown on the drawings and specifications. The Contractor may be required to produce evidence of such certification and training.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Provide operation and maintenance manuals within 20 days after the start of the Functional Acceptance Test (FAT). Include the following (both hardcopies and electronic copies on CD):

1. Corrected submittals as required herein.
2. Record (as built) wiring diagrams, control schematic (elementary) diagrams, interconnection diagrams, and equipment drawings.
3. Record (as-built) program listings, point listings, reference documentation, and operation and maintenance descriptions.
4. For all equipment suppliers, list of current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.
5. Record (as-built) Contract Drawings marked with red pencil to show revisions to the electrical work and the underground raceway and cable when different from the original Contract Drawings. Prepare by obtaining new, clean sets of Contract Drawings from the Engineer, and pay all costs for it.
6. Test results.

B. The O&M manuals shall include operating and maintenance information for all subsystems and components covered in this Section. The O&M information shall be in sufficient detail to allow the operation, removal, installation, adjustment, calibration, and maintenance of each component provided under this Section down to the printed circuit board level.

C. Each set of manuals shall be assembled in one or more three-ring binders, each with a title page, table of contents, and heavy section dividers with labeled index tabs. When more than one binder is required, the binders shall be labeled "Volume 1," "Volume 2," etc. The table of contents shall encompass the entire set of O&M manuals, shall list the contents of each volume, and shall appear in each binder.

D. Provide integrated O&M’s, regardless of source of supply.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Unless otherwise specified, the Contractor will be responsible for receiving, unloading, safekeeping, and storage of all materials and equipment supplied by the plant Owner or by the Contractor.

1. The Contractor will inspect the equipment and materials against the project's Instrument List, Specifications and purchase orders to ensure quantity, type, ranges, etc., are as specified.
2. By certification of the Supplier's packing list, the Contractor will be deemed to have acknowledged that all equipment and materials are complete and satisfactory.
3. The Contractor shall inspect and note apparent damage or defect at time of receipt and during storage, handling, or installation. Any discrepancies shall be reported immediately be reported to the Contract Manager and Plant Engineer.

B. The Contractor shall provide a separate adequate storage space, indoors, secure, protected from unauthorized tampering, free from fire hazard, clean and dry.

1. This facility shall be heated.
2. All instruments, wherever possible, shall be kept in their original shipping cartons until they are installed.
3. This separate storage space shall be maintained apart from areas where piping (conduit / raceway) items and equipment are stored.

C. The Contractor shall be responsible for issue of all stored instruments whether installed by Contractor or other disciplines, and maintenance of accurate records showing equipment and material received, stored, issued, and installed.

D. The Contractor shall be responsible for reasonable protection of all installed instruments from damage by inclement conditions or physical damage. The Contractor shall bear all costs of repair or replacement of such damaged instruments prior to acceptance by the Owner Contract manager.

1.9 FIELD INVESTIGATIONS AND PREPARATION OF DRAWINGS

A. This project includes field investigation and modifications to in-service water systems. Downtime at operating facilities will be required, with extensive planning requirements.

B. Prior to preparing any submittals associated with site installations and prior to performing any construction work at a site, perform a field investigation of that site and prepare related drawings as described below.

C. Using detailed information ascertained during the field investigation, prepare and submit the following drawings as specified in Section 26 05 00:

1. Elementary diagrams
2. Wiring diagrams
3. Layout submittals

D. Enclosures and Panels – Prior to submitting panel construction drawings for a new enclosure, the Contractor shall inspect the field conditions to determine all site-specific requirements, including the size, layout, and details of existing panels and enclosures as required to perform the work. The Contractor shall verify available space and review surrounding conditions for

suitability of installing new enclosures and verify that existing wiring to be reused is long enough to reach its intended new termination point without damage during construction. After thorough field inspection, the Contractor shall then submit panel drawings.

E. Instruments – Prior to submission of instrument information and loop diagrams, the Contractor shall inspect existing instruments and the installation locations for new instruments, verify the condition and determine the wiring requirements for each instrument, and determine the exact installation location and conduit routing for each new instrument. After thorough site inspection, the Contractor shall prepare and submit loop diagrams and electrical drawings related to instrument conduit and wire.

1.10 WARRANTY

A. The work and materials covered in this Section shall be guaranteed for a period of 1 year from the date of acceptance thereof against defective materials, design, and workmanship.

B. Warranty coverage shall include any and all costs for labor, travel, lodging, and parts.

PART 2 - PRODUCTS

2.1 GENERAL

A. Instrumentation and control components shall be either furnished as described in this specification, furnished by the control panel fabricator or furnished with other equipment packages.

B. Unless otherwise indicated, provide all first quality new materials, free from any defects, and suitable for the intended use and the space provided. Provide materials approved by UL wherever standards have been established by that organization.

C. Control panels are design-build by Contractor. Drawings are schematic designs to demonstrate Owner's intent and are not fully detailed. Panel size, number of terminals, spacing, wire duct sizes, etc. to be determined by Contractor. Submit shop drawings for approval before constructing panels.

2.2 ELECTRICAL DEVICES

A. Circuit breakers and other electrical devices and equipment not specified in this Section shall meet the requirements of Division 26.

2.3 SUPPLY VOLTAGE DISTORTION

A. Electrical (60 Hz) power for equipment furnished under this Section may contain up to 10% harmonic distortion in voltage. All systems and equipment covered in this Section shall operate properly under this condition of supply voltage distortion.

2.4 EQUIPMENT FINISH

A. Unless otherwise indicated, finish for stainless steel electrical equipment and enclosures shall be satin-polished. Unless otherwise indicated, finish for cold rolled steel electrical equipment

and enclosures shall be manufacturer's standard gray or ANSI 61 gray over a primer and rust inhibitor.

2.5 ENCLOSURES

A. Provide enclosures rated for the environment:

1. NEMA 12: Dry interior locations.
2. NEMA 4X: Pump rooms, interior locations with water piping, and exterior locations.
3. NEMA 6P (Submersible): For vault and sub-grade locations.

2.6 NAMEPLATES, NAME TAGS, AND SERVICE LEGENDS

A. All components provided under this Section, both field- and panel-mounted, shall be provided with permanently mounted nametags bearing the entire tag number of the component. Panel-mounted tags shall be phenolic; field-mounted tags shall be stamped stainless steel.

B. Nameplates are defined as inscribed, laminated phenolic plates mounted under or near a panel-mounted instrument. Service legends are defined as inscribed, laminated plastic integrally mounted on a panel-mounted instrument.

C. Service legends and nameplates shall be engraved, rigid, laminated phenolic type with adhesive back. Unless otherwise noted, color shall be black with white letters and letter height shall be 3/16 inch.

D. Components mounted inside panels shall have laminated phenolic nameplates with 3/16-inch-high characters. Unless otherwise noted, color shall be black with white letters.

E. Field-mounted tags shall be 16-gauge, stainless steel, with 3/16-inch-high characters. Each tag shall be affixed to the instrument with stainless steel wire.

F. Each panel shall be provided with a face-mounted laminated nameplate as specified above. Unless otherwise noted, color shall be black with 1/2-inch-high white letters.

2.7 SPARE PARTS, CONSUMABLE ITEMS, AND TOOLS

A. Fuses: Provide 20% of each size and type used rounded to the next whole number, but no less than five of each size and type.

B. Indicating Light Bulb: Provide 20% of each size and type used rounded to the next whole number, but no less than 10 of each type. This requirement applies to annunciator light bulbs as well, if any are supplied under this Section.

C. Corrosion-Inhibiting Vapor Capsules: 2-year supply.

2.8 PANELS

A. General:

1. Unless otherwise approved by the Engineer, all panels shall be constructed with external dimensions as shown on the Drawings. Instrument arrangement shall be as

shown, with minor modifications as may be required for the particular equipment furnished. Modifications shall be subject to the approval of the Engineer.

2. Freestanding panels shall be completely fabricated, and the instruments shall be installed, wired, at the Contractor's or panel builder's factory.

B. Environmental Requirements:

1. Panels shall be designed for continuous operation in the environments in which they are to be installed.

C. Temperature Control:

1. Unless noted otherwise, panel temperature control shall be based on maximum and minimum ambient temperatures of 104 degrees F and 32 degrees F, respectively.
2. Panels shall be sized and equipped to adequately dissipate heat generated by equipment mounted inside or in the panel face. Panel maximum internal temperatures shall not exceed 140 degrees F or the lowest upper limit of any panel-mounted equipment, whichever temperature is lower.
3. Panels shall be provided with louvers, forced ventilation, and sun shields as indicated. Louvers, where used, shall be provided with washable or replaceable filters and shall be located top and bottom on opposite sides of panels. Louvers shall include bug screens.
4. Forced-ventilation fans, where used, shall provide a positive internal pressure within the panel. Fan motors shall operate on 120-volt, 60-Hz power.
5. Temperature loss and/or temperature rise calculations shall be submitted to support panel temperature control requirements and methods.
    a. For panel temperature calculations where a UPS is included, run the calculations in two ways:
    (1) On commercial power, with UPS batteries fully discharged, and under peak charging conditions.
    (2) On UPS power.
    b. If UPS heat rejection is the same in both cases, then only one case need be addressed.
    c. Should UPS heat rejection data be unavailable, calculate estimated rejection based on charging and discharging efficiencies or other available information.
6. Provide sunshields for panels located outdoors.

D. Corrosion Control: All panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules.

E. Panel Construction:

1. Fabricate each panel from sheet 316 stainless sheet steel with a minimum 12-gauge thickness. Panel fronts shall be fabricated from a single piece of sheet steel. The panels shall be so constructed that no seams or bolt heads are visible when viewed from the front. Panel cutouts for instruments and other devices (e.g., lights and switches) shall be cut, punched, or drilled and smoothly finished with rounded edges.
2. Provide angle and/or plate stiffeners on the back of the panel face as required to prevent panel deflection under instrument loading or operation. Internally, the panels shall be supplied with a structural framework for instrument support purposes and

panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging and lifting of the panel during installation. Plugs shall be provided and shall unobtrusively fill the panel lifting ring holes when substituted for the lift rings after installation is complete. Where two or more panels are shown mounted immediately adjacent to one another, they shall be securely bolted together with their front faces parallel.

3. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with three-point latches, lockable with a padlock. Access doors shall be conveniently arranged and sized such that they extend no further than 24 inches beyond the panel when opened to the 90-degree position. All panel access doors shall be provided with full-length, continuous, piano-type steel hinges with stainless steel pins.

F. Panel, Electrical:

1. Power Distribution Within Panels:
   a. Each panel shall be provided with one 120-volt ac, 60-Hz feeder circuit as shown. On each panel, make provisions for feeder circuit conduit entry and provide a terminal board for termination of the wires.
   b. Branch circuit breakers shall meet the requirements of Section 26 24 16 – Panelboards and Circuit Breakers, unless stated otherwise herein. Control power circuit breakers shall be DIN rail mount, snap action, thermal magnetic circuit breakers. Breakers shall be rated for use with both AC and DC power circuits, and be capable of interrupting a minimum of 10,000 amps at 240V AC.
   c. Provide 120-volt plug-mold to plug in line cords for all panel components with line cords.
   d. Provide an indicating fuse for each DC supply line to each individual two-wire and four-wire transmitter. Provide additional fusing as called for in these Specifications and shown on the Drawings. Fuses shall be DIN rail mounted and located so that they can be easily seen and replaced.
   e. Power and control wiring shall be Type SIS or Type MTW.
2. Analog Signal Distribution Within Panels:
   a. The 4- to 20-mA signals may be distributed within panels as 1- to 5-volt signals. The tolerance of the signal conversion shall be less than 0.5%.
   b. For those cases where 4-20mA signals have multiple destinations, for example where a field device drives a panel indicator as well as an RTU input, provide signal isolators.
   c. All signal wiring shall be twisted, shielded pair cable. Cable shall be UL listed as Type PLTC/ITC for use in industrial instrumentation circuits, and shall be AWG 16, 19-strand copper, with PVC insulation rated 300 volts. The shield shall be aluminum polyester with copper drain wire. The outer jacket shall be PVC. The cable shall be rated 90 degrees C, minimum. Belden 9316, Type PLTC/ITC meets these requirements.
3. Terminal Strips:
   a. Provide terminal strips with a separate terminal for every wire entering or leaving the panel, including spare wires, plus 25% spare terminals, minimum.
   b. Provide DIN rail-mounted, modular feed-through type blocks. High-density (“double-deck”) terminals are not acceptable. Terminal strips shall be

Weidmuller SAK-6, Allen-Bradley 1492-J Series, or equal.

4. Plug-In Relays:

a. Plug-in relays shall be UL listed, enclosed, with silver or silver cadmium contacts rated 10 Amps at 120 Volts, 60 Hz AC, and 28 Volts DC. Enclosures shall be clear plastic. Relays shall have indicating lights or mechanical indicators. Relays shall operate reliably at 80% of rated coil voltage. Coil burdens shall be not greater than 1.5 Watt for DC coils or 2.6 voltamperes for 60-Hz AC coils. The relays shall be Potter and Brumfield KRPA Series, IDEC RR Series, Square D Type K, or approved equal.

b. Relays used for analog signal switching shall have gold plated silver or silver-palladium alloy contacts rated 1 Amp at 120 Volts, 60 Hz AC or 3 Amp at 30 Volts DC. The relays shall be Idec RY Series, or approved equal.

c. Time delay relays with ranges up to 180 seconds shall be enclosed and shall operate properly at any voltage within plus or minus 15% of the nominal voltage rating and shall have a time delay on energization or deenergization, as required for the application. Time delay shall be knob-adjustable over the range 2 to 180 seconds. They shall have double-pole, double-throw contacts rated 10 Amps at 120 Volts, 60 Hz AC. Relays shall have indicating lights or mechanical indicators. The relays shall be Potter and Brumfield CD Series, or equal.

d. When a “true off delay” relay is called out on the drawings, the relay shall be a time delay drop-out relay, which does not require power during the timing cycle. “True off delay” relays shall be Potter & Brumfield CK series, T&B/Agastat SCE series, or approved equal.

e. Time delay relays with required ranges greater than 180 seconds shall be adjusted by setting rotary switches (thumbwheel switches) or DIP switches, shall have a minimum range of 5 seconds to 999 minutes, and shall have time delay on energization or deenergization, as required. Accuracy of time setting shall be 1% or better. Contacts shall be double-pole, double-throw, rated 10 Amps minimum at 120 Volts, 60 Hz AC, and 24 Volts DC. The relay shall be of the enclosed, plug-in type, and shall operate properly at any voltage within plus 10% and minus 15% of nominal voltage rating. Relays shall have indicating lights or mechanical indicators. The relay shall be Square D Class 9050 Type JCK, Potter and Brumfield Series CNT, or approved equal.

f. Relays shall be plugged into DIN rail mounted sockets with saddle clamp terminals. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

5. Power Supplies:

a. Provide DC power supplies of the quantity and rating as required to power instruments requiring DC power, including two-wire transmitters and DC relays. Power supplies shall be mounted such that dissipated heat does not adversely affect other components.

b. The DC power supplies shall be sized to drive all loads, including all connected instrument loops at 30mA, plus 30% spare overhead, minimum. Provide calculations.

c. DC Power Supply: The DC power supplies shall operate on 120 volts, 60 Hz input and shall produce DC power of the appropriate voltage, with 0.5% regulation and no greater than 0.1% ripple under rated load.

d. The DC power supplies shall be self-contained units with output overvoltage and

overcurrent protective circuits.

6. Pushbuttons, Selector Switches, and Indicating Lights

   a. Pushbuttons, selector switches, and indicating lights shall be heavy duty oil tight, manufactured to the requirements of NEMA ICS. Provide suitable NEMA-rated enclosures or mount in panels as indicated.
   b. Unless noted otherwise, provide extra-large, integral, metal service legends (legend plates) indicating their specific functions and laminated phenolic nameplates indicating the equipment they control.
   c. Unless noted otherwise, pushbuttons shall be momentary contact and shall have the number and type of contacts as indicated or as required.
   d. Unless noted otherwise, selector switches shall be maintained contact, shall have the number of positions indicated, and shall have the number and type of contacts as indicated or as required.
   e. Indicating lights shall be LED-type indicators, unless noted otherwise. Indicating assemblies shall have push-to-test feature.
   f. Pushbuttons, selector switches, and indicating lights shall be Square D Type K Heavy Duty, Allen-Bradley Bulletin 800T, Eaton/Cutler-Hammer 1025OT Series, General Electric CR104P Heavy Duty, or approved equal.

7. Standard Colors and Inscriptions for Pushbuttons and Indicating Lights:

   a. Unless otherwise noted, the following color code and inscriptions shall be followed for all pushbuttons and indicating lights:

TAG FUNCTION	INSCRIPTION(S)	COLOR
OO	ON OFF	Red Green
OC	OPEN CLOSE	Red Green
OCA	OPEN CLOSE AUTO	Red Green White
OOA	ON OFF AUTO	Red Green White
MA	MANUAL AUTO	Yellow White
SS	START STOP	Red Green
RESET	RESET	Red
EMERGENCY STOP	EMERGENCY STOP	Red
ALARMS	--	Amber

   b. All unused or non-inscribed buttons shall be black.
   c. Lettering shall be black for white and yellow buttons. Lettering shall be white for black, red, and green buttons.

8. Internal Panel Lights:

   a. Panels shall be provided with a switched LED light strip. One light shall be

provided for each panel.

b. Light strips shall be LED type, 4,000K color temperature, medium diffuse lens, mounted inside and in the top of the back-of-panel area.

c. Coordinate all necessary connectors with the manufacturer.

9. Service Outlets:

a. Panels shall be provided with three-wire, 120-volt, 15-ampere duplex receptacle, as shown on control diagrams.

2.9 MAGNETIC FLOWMETER

A. Product Description: The Magnetic Flow Meter shall consist of a metering tube detector portion and a signal amplifier display unit connected using a manufacturer's cable.

1. The flowmeter shall be Endress Hauser Promag W 500 or W 800 as shown on the plans or approved equal.
2. Metering Tube (Detector): Consist of stainless steel tube lined with a non-conductive material connected to a remote signal amplifier. Contractor shall verify distance of cable needed per site.
3. For W500 and W800: Signal Amplifier and Display Unit: The amplifier receives, amplifies, and processes the detector's analog signal. Signal is converted to both analog and digital signals that are used to display rate of flow and totalization. Integrated LCD display indicates rate of flow, forward and reverse totalizers and diagnostic messages.
4. In general, there shall be no cable or wire splices between terminals of the equipment, unless approved by the Owner. The Contractor shall order the appropriate cable or wire lengths to eliminate cable or wire splicing. If splices are necessary in underground and in manholes for installation of cables, the Contractor shall submit, for Owner's review and approval, the request for cable splice locations supported by cable pull calculations or other splice requirements.
5. The system shall be listed by the NSF International as in compliance with NSF 372 and NSF 600 according to the requirements of NSF 61.
6. Flow meter system product submittal and order form shall be submitted to the Owner for review prior to placing the order.

B. Components

1. Metering Tube (Detector)
   a. The metering tube shall be constructed of 304L stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.
   b. The metering tube shall be sized per plans.
   c. The metering tube end connections shall be carbon steel flanged, according to ANSI B16, Class 150, and AWWA Class B standards.
   d. The insulating liner material of the metering tube shall be made of polyurethane and listed by the NSF International as in compliance with NSF 372 and NSF 600 according to the requirements of NSF 61.
   e. The metering tube shall include two self-cleaning measuring electrodes. The electrode material shall be corrosion resistant, bullet nose style, and constructed of 316L stainless steel.
   f. Sufficient special manufacturer cables shall be provided for interconnection

between the metering tube and the signal amplifier/display unit. Cables shall facilitate both signal and power for the flow element. Coordinate cable lengths prior to ordering. The meter and signal amplifier/display unit shall be interconnected by cables furnished, fitted, and potted on the meter by the Manufacturer. The sensor shall be IP68, NEMA 6P, factory-potted corrosion protection EN ISO12944. No splicing shall be allowed.

g. The metering tube shall include a third “empty pipe detection” electrode located in the upper portion of the inside diameter of the flow tube in order to detect an empty pipe condition when the flow tube is running partially empty. Empty pipe detection that is not activated until the pipe is 50% empty is not acceptable.

h. The meter shall be bi-directional and have a minimum of two totalizers to measure forward and reverse.

i. The metering tube junction box shall be constructed of powder-coated cast aluminum and shall meet NEMA 6P (IP68) ratings.

j. The metering tube shall be provided with a pair of corrosion resistant grounding rings. The grounding ring material shall be 316L stainless steel.

k. Suitable covers shall be provided for flow element ends to protect the tube liner during shipment.

l. Process fluid: Potable water

m. Process fluid temperature range: The fluid temperature range shall be 32°F to 178°F at maximum ambient temperature of 122°F for the hard rubber liner material.

2. Signal Amplifier and Display Unit (Transmitter)

a. The signal amplifier shall be microprocessor based and shall energize the detector coils with a digitally controlled pulsed DC signal.

b. The signal amplifier electrical power requirement shall be 100-240V AC / 24V/DC. The signal amplifier shall be suitable for use in an ambient temperature of -4°F to 140°F.

c. The signal amplifier shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of a power interruption.

d. If the signal amplifier is mounted in a control building or above ground panel enclosure, the signal amplifier shall be constructed of powder-coated cast aluminum, meeting NEMA 4X (IP67) ratings.

e. For W500: Outputs: The output shall be Modbus RS485 and 4-20mA.

C. Control and Programming

1. The signal amplifier shall be programmed via three function buttons. The programming functions shall be available in a user-friendly, menu driven software through the four-line LCD interface.

2. Programmable parameters of the amplifier include, but are not limited to: calibration factors; totalizer resets; unit of measure; analog and pulse output scaling; flow-alarm functions; language selection; low-flow cutoff; noise dampening factor; and excitation frequency selection.

3. The signal amplifier shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of power interruption.

4. The signal amplifier shall have a programming option allowing entry of a selected

alphanumeric password value for tamper protection.

D. System Performance

1. The metering system shall perform to an accuracy ± 0.5 percent of rate for velocities greater than 1.64 ft/s, ± 0.0032 ft/s for velocities less than 1.64 ft/s.
2. The metering system shall be capable of measuring the volumetric flow rate of liquids having an electrical conductivity as low as 5.0 micro mhos per centimeter.
3. The system shall be suitable for single direction or bi-directional use.
4. The system measuring repeatability shall be <0.10% of full scale.
5. Flowmeter accuracy shall be verified by calibration in a flow laboratory traceable to the NIST (National Institute of Standards and Technology). Calibration documents, including test reports, shall be submitted to the Owner for review and shall meet all applicable requirements called out under SUBMITTALS.

E. Indication

1. Nameplate detailing instrument number and description of process function mounted on display unit in accordance with Section 26 05 53.
2. All product data and operation manuals shall be provided on a CD.
3. The signal amplifier shall include a four-line, 20-character, backlit LCD interface to display the following values:

   a. Flow rate in selectable rate units
   b. Forward totalizer in selectable volume units
   c. Reverse totalizer in selectable volume units
   d. Net totalizer in selectable volume units
   e. Error on alarm messages
   f. Software revision level

F. W 800 Communication

1. Data shall be sent using SIM card per GWA requirements. Coordinate with GWA prior to submittal preparation.

2.10 LEVEL SENSOR

A. Product Description: The level sensor shall consist of a field mounted level sensing element and a signal amplifier display unit connected using a manufacturer's cable.

1. Sensing element: Consist of stainless steel unified ultrasonic transmitter and detector, suitable for installation in a wet or damp location, connected to a remote signal amplifier. The sensing element shall not require a contact with the process material and shall be suitable for detecting the level of fresh potable water. Contractor shall verify distance of cable needed per site.
2. Signal Amplifier and Display Unit: The amplifier receives, amplifies, and processes the sensing element's signal. Signal is converted to a 4- to 20-mA analog signals that are used to display the level in engineering units. An integrated LCD display indicates total level and diagnostic messages.

B. In general, there shall be no cable or wire splices between terminals of the equipment, unless

approved by the Owner. The Contractor shall order the appropriate cable or wire lengths to eliminate cable or wire splicing. If splices are necessary in underground and in manholes for installation of cables, the Contractor shall submit, for Owner's review and approval, the request for cable splice locations supported by cable pull calculations or other splice requirements.

C. Level sensing element shall be powered via the manufacturer's connecting cable and shall not require additional power inputs.

D. The Signal Amplifier shall have an optional HART protocol output in addition to the 4- to 20-mA signal output.

E. The level sensor shall be a Siemens Hyrdoranger XPS-15, or approved equal.

2.11 LEVEL SWITCH, FLOAT-TYPE, SUSPENDED

A. Units shall be direct-acting float type with a snap-action switch within the float. Floats shall be polypropylene and shall be flexibly supported by means of a PVC-jacketed three-conductor cable.

B. Each unit shall be provided with a clamp to secure the cable to its support and a weight to hold the switch in a suspended position.

C. The switches shall be SPDT and shall be rated for 15 Amps at 120 Volts 60Hz AC.

D. Units shall be MJK Model 7030, Flygt Model ENM-10, Charles F. Warrick Company, B/W Controls, Inc., or approved equal.

2.12 PRESSURE TRANSMITTER, ELECTRONIC

A. The unit shall be Danfoss MBS 3000 or approved equal.

B. The unit shall be a pressure sensing instrument producing a 4- to 20-mA DC signal proportional to sensed pressure. Wetted parts shall be 316 stainless steel. Process temperature range shall be -40°C to 85°C. The unit shall include a mechanical pulse-snubber to reduce the effects of severe medium influences like cavitation, liquid hammer or pressure peaks and shall be capable of withstanding six times the full scale pressure without damage.

C. The transmitter shall be of the 2-wire type and shall transmit a 4- to 20-mA DC signal into a load impedance in the range of 0 to 590 ohms when fed by a 24 Volt DC supply. The unit shall have a sensing range as noted on the drawings. The unit shall be designed such that the unit range noted lies between 60% and 80% of the unit's maximum range. Accuracy shall be plus or minus 0.5% of span. The enclosure shall be of 316 stainless steel construction and be NEMA 4X (IP67) rated and suitable for Class I, Div 2 installations.

D. Process connection shall be 1/2-inch FNPT and constructed of 316 stainless steel.

E. Nameplate detailing instrument number and description of process function and ranges mounted on transmitter in accordance with Section 26 05 53.

2.13 PRESSURE SWITCH

A. Unit shall be a Bourdon tube actuated, single-adjustment pressure switch with snap action, SPDT contacts rated 15 Amps, continuous, at 120/240 Volts 60Hz AC. The adjustable setpoint range shall be such that the noted setpoint falls between 30% and 70% on the adjustable range.

B. The switch shall have a calibrated dial, an externally adjusted setpoint pointer, and visible on/off indication. Unless otherwise noted, the unit shall be automatic reset type with a fixed deadband.

C. The switch enclosure shall have a NEMA 4X rating installations above ground and NEMA 6P rating for installations in vaults or underground.

D. Switches shall have 1/2-inch FNPT bottom process connection.

E. Wetted parts shall be 316 stainless steel, unless otherwise noted.

F. Unit shall be Mercoid Type DSW, Endress Hauser, Siemens or approved equal.

2.14 PRESSURE GAUGE

A. Pressure gauges for measurement of process variables shall be of the direct-reading, capsule, or bellows type for ranges below 10 psig and shall be Bourdon-tube-actuated for pressures 10 psig and above.

B. Range shall be as noted on drawings. (Confirm ranges with GWA prior to ordering).

C. Gauge wetted parts shall be suitable for the service intended. As a minimum, bellows gauges shall have 316SS bellows and socket, and Bourdon tube gauges shall have 316SS tube and socket, unless otherwise noted.

D. When so noted, provide pulsation dampener and/or compound scale.

E. Unless noted otherwise, pressure gauges shall meet the following requirements:

1. Plus or minus 0.5% accuracy, for ranges 10 psi and above (3% those meant for temporary installation)
2. Plus or minus 2-1/2% accuracy, for ranges below 10 psi
3. Stem mounting, 1/2 inch for permanent installation and 1/4 inch for temporary
4. 4-1/2-inch diameter dial for permanent installation, or 1-1/2-inch diameter dial for temporary
5. Solid front with pressure relief back

F. Bellows-type gauges shall be Ashcroft General Service Series 1180, U.S. Gauge/Ametek 1919, Robertshaw Acragage, or equal. Bourdon-tube-type gauges for permanent installation, such as pump stations, shall be Ashcroft Duragauge Model 1279/1379, U.S. Gauge/Ametek 1980, or approved equal. Bourdon-tube-type gauges for temporary installation, such as sampling or pressure reducing stations, shall be Ashcroft Model 1005S, with 1-1/2” dial, or approved equal.

G. Provide 10 pressure gauges for temporary installation to GWA in addition to locations shown on the plans or described in the specifications.

2.15 SIGNAL CONVERTER, CURRENT-TO-CURRENT, DUAL OUTPUT SPLITTER

A. The unit shall receive a 4- to 20-mA,24V DC input signal and shall produce two isolated 4- to 20-20mA, 24V DC outputs linearly proportional to the input.

B. Accuracy shall be minimum plus or minus 0.25% of span. Output shall be capable of driving a 0-600 ohm load without load adjustments.

C. Input, outputs, and power input shall be transformer isolated with no DC connections between them.

D. Unit shall operate on 24 Volt DC power, unless otherwise noted.

E. The unit shall be Acromag 633T, API APD 4930, or approved equal.

2.16 INTRUSION DETECTION SWITCHES

A. Switches shall be two-piece magnetic reed proximity type. One piece shall contain the switch and the other the magnet. Normal position with the magnet in close proximity to the switch shall cause the switch contact to be closed. When the magnet is moved away, the switch contact shall open.

B. Switch contact rating shall be 200 mA minimum at 48V DC.

C. Switch shall be Microswitch 40FR3-3 switch and Microswitch 41 FR2 magnet actuator, Sentrol 1045 Series, or approved equal.

2.17 PROXIMITY OR LIMIT SWITCHES

A. Switch shall be of the induction type, able to be securely fastened to movable indicating members.

B. Switch shall be ifm effector, Turck, Allen Bradley, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Make circuit connections as per the drawings.

B. Conductor labels shall be as per specification Section 26 05 53.

C. Field mounted instruments shall be identified (labeled) as per specification Section 26 05 53.

D. Install wiring and components to provide a complete operating system for motor control, or instrumentation, as indicated by schematic and loop diagrams.

E. Termination of power, and instrument and control wiring is included in this contract.

F. Work shall be performed in a competent manner by craftsmen skilled in the particular trade.

Work shall be performed in accordance with the Drawings, Specifications, manufacturers' recommendations, and the best practice of the trade. Completed work shall present a neat and finished appearance.

G. Coordinate the work covered in this Section with the Owner and the work of other trades to avoid conflicts, errors, delays, and unnecessary interference during construction.

3.2 INSTRUMENTATION AND CONTROL CIRCUITS

A. Fabricate and install raceway from field instruments to control panels as per Section 26 05 33.

B. Install and connect wire or cable as required per Section 26 05 19.

3.3 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss, damage, and the effects of weather. Prior to installation, store items to be installed in indoor locations. Items subject to corrosion under damp conditions and items containing insulation, such as control panels and instruments, shall be stored in indoor, heated, dry locations.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Keep openings in boxes or equipment closed during construction.

3.4 CONTROL SYSTEM INSTALLATION

A. Controls shall be designed, assembled, and tested (see Factory Testing below) by one control system manufacturer at the factory.

3.5 MATERIAL AND EQUIPMENT INSTALLATION

A. Follow the manufacturer's installation recommendations, unless otherwise indicated. Follow the Engineer's decision, at no additional cost to the Owner, wherever any conflict arises between the manufacturer's instructions, State or other codes and regulations, and these Contract Documents. Keep a copy of the manufacturer's installation instructions available on the jobsite for review at all times.

B. Secure control panels and other freestanding equipment rigidly to floors or mounting pads with anchor bolts, expansion shields, or other approved means per the manufacturer’s recommendations.

3.6 SEISMIC REQUIREMENTS

A. Provide anchorage as shown on the Drawings, and/or as recommended by the manufacturer.

B. Enclosures, and their contents therein, shall be manufactured, fabricated, assembled, and where applicable tested to meet the following seismic requirements:

1. Most recent adopted IBC requirements.
2. ASCE 7-16, Site Class D (unless soil properties are known and indicate otherwise), Risk Category IV, and Seismic Importance Factor 1.5.

C. With product submittals, provide written confirmation from the manufacturer or fabricator that each assembly meet the requirements above.

D. This Article covers the following items:

1. Boxes/enclosures greater than 12 inches in any dimension (other than buried boxes, handholes, and pullboxes).
2. Panelboards/Switchboards.
3. Control panels.
4. Other items of weight 40 pounds or greater.

3.7 DEMOLITION

A. This project may include demolition described in the Drawings and Specifications. Required demolition of I&C equipment, wire and conduit, and other equipment is covered under this Section. Demolition work includes disconnecting, removing, capping, patching, painting, and cleanup.

B. Where existing materials and equipment are removed or relocated, remove all materials no longer used, such as studs, straps, conduits, and wires. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least 3/4 inch below the final finished surface.

C. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface in a neat and competent manner. Follow any specific instructions in other sections of these Specifications. Utilize skilled craftsmen of the trades involved.

3.8 CUTTING AND PATCHING

A. Do not cut or notch any structural member or building surface without specific approval of the Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of materials and equipment. Following such work, restore surfaces neatly to new condition using skilled craftsmen of the trades involved, at no additional cost to the Owner.

3.9 CLEANING AND TOUCHUP PAINTING

B. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from the premises and from the interior and exterior of all devices and equipment. Refinish damaged surfaces to new condition using skilled craftsmen of the trades involved, at no additional cost to the Owner.

3.10 MECHNICAL SYSTEMS

C. The Drawings relating to mechanical systems covered in this Section are diagrammatic in nature and are not intended to specifically define element locations or piping and tubing run lengths. All materials and installations shall be based on field measurements and shall conform to the requirements specified hereinafter and as noted on the Drawings.

1. Use stainless steel tubing and fittings for pressure instrument connections.

2. Installation:

   a. Installation shall conform to the applicable requirements for mechanical systems in other parts of these Contract Documents.

   b. Tubing shall be supported at 4-foot intervals, maximum.

   c. Straighten all coiled tubing by unrolling on flat surface; do not pull to straighten. Cut tubing square with sharp tubing cutter or properly guided hacksaw. Deburr all cuts and remove chips. Do not gouge or scratch surface of tubing.

   d. All fittings shall be made up and installed in accordance with the manufacturer's recommendations. Verify proper makeup of all tube fittings with manufacturer's inspection gauge.

   e. All tubing runs shall allow clear access to hatches, valves, equipment, and shall allow easy removal of components or equipment. Components in tubing runs shall not be supported by the tubing but shall be separately supported.

   f. Supply expansion loops and use adapters at pipe, valve, or component connections to obtain proper orientation of fitting.

3. Cleaning: All tubing shall be blown clean of all interior moisture and debris prior to closing system.

4. Perform leak tests as described in the Article, OPERATIONAL READINESS TEST.

3.11 TESTING, GENERAL

D. Testing, test plans, and test reports shall be provided by the Contractor as specified herein. The Contractor shall perform tests as required to demonstrate that the equipment and systems covered in this Section operate safely and meet the requirements of these Specifications. The Contractor shall provide labor, instruments, and other material to complete the tests.

E. Test plans and test reports shall be submitted as formal submittals and shall meet all applicable requirements of the Article, SUBMITTALS.

F. Tests and test plans shall be in the cause-and-effect format. The person conducting the test shall initiate an action (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

G. The Contractor shall coordinate and integrate the documentation and efforts of suppliers and subcontractors to achieve unified tests and test plans.

3.12 TESTING

H. Perform all testing in accordance with Section 40 96 37. Tests shall include:
   1. Factory and Field testing
   2. Operational Readiness Testing
   3. Functional Acceptance Testing
   4. 14-day Operational Tests

3.13 FIELD SUPPORT

I. Provide the services of experienced, factory-trained service engineers or technicians to assist with installation, checkout, startup, testing, and support of each installation.

3.14 FINAL ADJUSTMENTS

J. Upon completion of the Functional Acceptance Tests (FATs) final adjustments shall be made to the equipment as necessary.

3.15 TRAINING

K. Provide the services of an experience, factory-trained service engineer or technician to train the Owner's personnel in operation, maintenance, and troubleshooting of the systems and equipment specified in this Section.

END OF SECTION 409000

SECTION 409443 - PROGRAMMABLE LOGIC PROCESS CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Programmable controllers, remote terminal units, programming software, programming, and accessories.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 26 05 26 – Basic Electrical Materials, Methods and Grounding

C. Section 26 05 53 – Electrical Equipment Identification

D. Section 26 43 13 – Surge Protection Devices

E. Section 409000 – Industrial Instrumentation & Process Controls

1.3 REFERENCES

A. International Electrotechnical Commission

1. IEC 61131-3 Programmable Controllers- Part 3: Programming Languages

B. International Society for Automation (ISA):

1. S5.1 - Instrumentation Symbols and Identification.
2. S5.4 - Standard Instrument Loop Diagrams.
3. S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
4. S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments.
5. ISA-5.06.01 - Functional Requirements Documentation for Control Software Applications

C. National Electrical Manufacturers Association:

1. NEMA IA 2.2 - Programmable Controllers-Equipment Requirements and Tests.
2. NEMA IA 2.3 - Programmable Controllers - Programming Languages.
3. NEMA IA 2.8 - PART 8: Guidelines for the Application and Implementation of Programming Languages
4. NEMA ICS 3 - Industrial Control and Systems: Factory Built Assemblies.

D. Underwriters Laboratories:

1. UL 1449 – Standard for Surge Protective Devices

1.4 ABBREVIATIONS

A. HMI – Human Machine Interface

B. OIT – Operator Interface Terminal

C. RTU – Remote Terminal Unit

D. SCADA – Supervisory Control and Data Acquisition

1.5 SYSTEM DESCRIPTION

A. Configuration:

1. Non-proprietary networked programmable controllers shall be incorporated into fully assembled control panels for controlling, communicating with and monitoring of controls, control systems, instrumentation and SCADA system with all required components and programming for a fully functional system.
2. Programmable controller shall use a combination of discrete, analog, PID functions, programmable logic and programmable algorithms to control, annunciate and interface with connected systems.
3. Programmable controller shall be part of a completely assembled control panel with all components required for operation, including all associated components shown and where specified in other sections. Control panels shall be assembled by a UL508A certified contractor and contain labeling indicating UL508A compliance with a unique UL serial number.

B. Special Requirements:

1. Programmable Logic Controller shall be constructed of non-proprietary components and shall use an open-source code programming protocol for programming and unit configuration.
2. All Programmable Logic Controllers shall be from a single manufacturer.

1.6 SUBMITTALS

A. Programming Approach: Indicate listing of I/O Points, device specific communications translation protocols (e.g. HART), HMI to RTU programming approach and SCADA I/O interface description, complete with tag designations for new and existing system.

B. Programming narrative: Include a narrative that describes device and I/O functionality. Narrative shall include connected devices, derived values and runtime scenarios to demonstrate function.

C. Shop Drawings: Provide shop drawings indicating the arrangement and layout of panel, component spacing and enclosure size. Indicate electrical characteristics and connection

requirements, including layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.

1. Control System Block Diagram
   The drawing must include media, protocol, and network level information. The protocol must be identified for each media line. The network level must also be indicated by using the following abbreviations written parallel to the media line on the drawing. Possible network levels are:
   a. HMI
   b. RTU/Controller
   c. I/O
   The Control System Block Diagram drawing must also include protocol converters (i.e., Fiber-to-Ethernet) which are external to network devices.
2. Controller Layout Detail
   The Controller Layout Detail must indicate the physical location of every device. It also includes the power supply part number, the processor part number, and the I/O module name and part number.
3. Controller Wiring Detail
   The Controller Wiring Detail shall be according to ISA-5.1. Drawings shall include the I/O module part number and name, the I/O tag name, and point number. The controller wiring detail drawings shall be functionally equivalent to the ISA Standard S5.4, Instrument Loop Diagrams. They shall show all conductors and terminations fully labeled. In addition, the drawings shall identify field equipment brand and model as shown in the O&M manual for the equipment. All field instruments shall be labeled with the tag name, as well as brand and model. Tag names as used on the drawings shall exactly match the tag names indicated on the ISA Standard Form S20 furnished for the instrument.

D. Product Data: Submit catalog data for each component specified showing electrical characteristics and connection requirements.

E. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

F. Testing Documentation Submittals:

1. Thirty (30) days prior to testing, submit Site Acceptance Test (SAT) plan. Prepare and submit for review a SAT plan that includes contact information, planned dates, step-by-step functional testing procedures and special considerations. The plan shall comprehensively identify all systems being tested and list each testing procedure in detail with the expected outcome.
   a. Format of plan shall be tabulated and at a minimum include the following information:
      1) Title, including commissioning description and date.
      2) Test number in ascending order.
      3) Completion check off box.
      4) Description of test.
      5) Completion notes indicating what is being checked and expected result.
      6) Space for field notes.
      7) Space for signature indicating testing has been completed.

2. Test Reports: Upon completion of commissioning tests, prepare and submit for review a complete test report indicating results of system commissioning, deficiencies, corrective measures and recommendations.

G. Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of controller cabinets and input and output devices connected to system. Include interconnection wiring and cabling information, and terminal block layouts in controller cabinets. Include copy of as-built drawings.

B. Operation and Maintenance Data: Submit bound copies of operating and programming instructions, and include card replacement, adjustments, and preventative maintenance procedures and materials. Provide Compact Disk (CD) containing all programmable logic code to GWA upon project closeout with full copies of programs required to both upload and download Code to controller and related components.

1.8 PROGRAM ORGANIZATION

A. Program organization provides general guidelines to be used for developing controller software that will establish a common approach to software. A typical program consists of the following general hierarchy:

1. Task - Program Routine
   There can only be a single scheduled task or routine in many controller types with various subroutines for subtasks within the main program structure. The program structure is generally managed by the software provided by the manufacturer for each type of control processors. The main program shall be named MainTask. Each task consists of multiple programs which are scheduled to run one after another within the MainTask. There are 5 sections or components/subroutines in the main program to manage main aspects of a controller program and are listed in this section.
2. Each of the component programs will consist of one or more routines. There will always be a main routine for each program. Its name is <program>_Main and its primary purpose is to call the other routines within the program. <program> as above is the one-word name of the program as denoted below. All routines within the program are names <program>_<function> where <program> is the one-word name of this program and <function> is a one-word function name for the routine. This scheme will insure all routines have a unique name and can be readily placed within the overall task structure by name alone.
3. Standard Program Sections
   a. System
      The first program called on every scan. It is responsible for initializing values, performing housekeeping, global definitions, functions that are a required on a global level for the entire controller. There is at minimum the routine SYSTEM_Main that calls the other routines in the program.
   b. IO_Mapping
      This program is responsible for moving data from physical modules into the internal controller tags where it can be acted on by the program logic. Changes in

the I/O configuration will require corresponding changes be done within this routine.

c. Control Modules
The processing of field equipment is simplified by using object oriented programming techniques. This program is where object oriented programming code would be developed.

d. Process Modules
Application logic unique to this program is organized here. This will be a collection of routines organized by a PROCESS_Main routine that orchestrates the interaction of objects managed by the previous program.

4. Optional Programs
The following programs may or may not exist with a controller task depending on process requirements.

a. Message
This program manages all inter-processor messaging between the main processor and other processors within the system. Most water remote sites will have one processor and not require this section but treatment plant and larger sites may have multiple processors that require this function.

b. Security
This program is only present if there is a need to interface controller points to a security system.

c. Protocol interface
If there is a need to interface to Modbus communications or similar protocol due to interfacing with packaged systems, management of the interface used is placed here.

d. Alarming
Alarm detection shall take place in controller logic and not rely on HMI software. Alarm conditions are determined by the controller and shall result in controller bits being set. OIT / HMI software can make use of these bits to extend the alarm conditions to graphical displays, annunciators, and alarm call-out systems. If required, the alarm bits can be mapped to digital output signal lines to trigger alarm autodialers or similar external alarms that utilize such signals.

B. Program Annotation and Comments

1. The controller programming environment has provisions for copious descriptions and comments to be added throughout. It is important that these facilities are not overlooked and all programs delivered to or developed by GWA must have an adequate level of commentary in the source code.
2. Descriptions
   a. Programming components need to have descriptions applied which serve to clarify their purpose. Descriptions are free-form text fields of limited size that identify the purpose and functionality of the software components.
   b. Most controllers allow descriptions to be attached to tasks, programs, routines and tags, including the constituent fields within ladder logic. It is important that useful descriptions be applied that offer succinct identification of all tags created or functions developed. This greatly improves the ability to maintain and enhance programming, especially when done many years after the original programming. Tag descriptions added to software definitions will often be duplicated to the other instances a particular device or function is used.

c. Task, program and routine descriptions must, at a minimum, describe the purpose of the code.

3. Code Comments
   a. All code must contain comments describing in plain language what functionality is being performed in the code. Not every rung needs to be commented when the function is intuitive unless additional description will add value. Providing a synopsis block of comments preceding a section of code is often the most useful. Individual rung comments are useful for particularly difficult code, or where the actual functionality is not obvious. Sheets of function blocks can make use of text boxes to contain comments.
   b. External conditions that affect code sections must have comments explaining those conditions and the effects they drive.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Supplier: Authorized distributor of specified manufacturer with minimum five years experience.

C. Service and Maintenance Provider: Authorized and trained service engineer or technician by manufacturer of specified product with minimum five years documented experience.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Conform to specified service conditions during and after installation of programmable controllers. Maintain area free of dirt and dust during and after installation of products.

1.11 MAINTENANCE SERVICE

A. Division 01 - Execution and Closeout Requirements: Maintenance service.

B. Furnish service and maintenance of programmable controllers for (3) three years from project close out.

1.12 MAINTENANCE MATERIALS

A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish (1) one spare RTU module for each unique module type installed.

PART 2 - PRODUCTS

2.1 REMOTE TERMINAL UNIT

A. Manufacturers:

1. Rockwell Automation Micro870, models as noted on drawings
2. Substitutions: Not Permitted.

B. Product Description: Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points, and communications capability. Provide on-board I/O expansion board, as required to provide required I/O.

C. Service Conditions: Conform to NEMA ICS 3 and the following:

1. Temperature: 0°F to 150°F
2. Altitude: 500’ above sea level.

D. Protocol: DNP3, with SAv5 encryption.

E. Programming Language: Programming language shall be IEC 61131 compliant. The standard languages used shall be Ladder Diagrams and Function Block. Ladder Diagram programming must be used for Boolean logic or sequential control operations, while Function Block shall be used for all analog control. These two types of programming may be mixed within a given program if desired. Programming shall be done using manufacturer’s software. Where function blocks are used, they shall be drawn from the standard function blocks supplied with the software provided by the manufacturer. Deviation from these requirements will only be allowed with written permission from GWA.

F. Programming Software: Connected Components Workbench

G. Micro870 Controller

1. Digital inputs: 14x, dry contact inputs, 12/24 VDC
2. Digital outputs: 10x, 12/24 VDC

H. 2085-IF8(K) Analog Input Expansion Module

1. Analog Inputs: 8x, 4-20mA or 0-10V user configurable terminals

I. Serial Ports:

1. Capable of full-duplex, half-duplex and radio modem operation
2. Embedded ports: RS232/RS-485 non-isolated serial, USB 2.0 non-isolated (reserved for programming)

J. Networking Connections: Ethernet, RJ45, 10/100BaseT.

K. Input Voltage: 10-30 VDC.

2.2 SCADA WIRELESS RADIO

A. Manufacturers:

1. Hitachi Tropos 2420 w/ AN074580 Antenna as required.
2. Hitachi Tropos 6420 w/ integral antenna as required.
3. Substitutions: Not Permitted.

B. Product Description: Wireless router and bridge for field automation applications, supporting Modbus and DNP3.

C. Protocols: Modbus, DNP3, and IEC 61850.

D. Hardwire Networking Connections: Ethernet, RJ45, 10/100BaseT, per IEEE 802.3u.

E. Wireless Networking Connections: IEEE 802.11b/g/n

F. Input Voltage: 12-48 VDC.

2.3 COAXIAL CABLE SURGE ARRESTER

A. Surge arrester shall be in-line replaceable gas-filled surge voltage arrester in a CN-UB-280 dc adapter housing, fitting with Type N connectors that shall be permanently mounted in the cabinet. Surge suppressors shall be installed on transmitter antenna coaxial cable.

2.4 HUMAN-MACHINE INTERFACE

A. Manufacturers:

1. Rockwell Automation PanelView 800
2. Substitutions: Not Permitted.

B. Product Description: Size: 10 inch, 800 x 600 pixels display with analog touch input screen

C. Serial Ports: Separate RS-232 and RS-422/485 connectors

D. Mounting: Control panel door

E. Ethernet Ports: 1x 10/100 BASE-T

F. Voltage: 18-32 VDC (24 VDC Nominal)

2.5 NETWORK FIREWALLS

A. Manufacturers:

1. Phoenix FL MGUARD RS2005 TX VPN
2. Substitutes: Not Permitted

B. Product Description: NERC CIP compliant firewall

C. Ports: 2x RJ45, 1x USB

D. Mounting: DIN rail

E. Voltage: 24VDC

2.6 CONTROL PANELS

A. As specified in Section 40 90 00 Industrial Instrumentation and Process Controls.

B. Door shall swing open 90 degrees without interference to provide access to rear panel.

C. Provide adequate space for conduit entry, termination of control cable, device wiring and raceway.

D. Each component shall be identified with readily visible engraved identification tags.

E. Panel shall have a metal protective pouch to hold wiring diagrams and process system information.

F. Enclosure:

1. Provide suitable grounding stud on door and body.
2. Provide oil-resistant door gasket attached with oil resistant adhesive.
3. Provide integral door stop.
4. Where provided with louvered openings, provide louver filter assembly.
5. Covers/Doors:
    a. Provide continuous hinge door.
    b. Provide multi point quarter turn three point latch and semi flush key cylinder.
    c. Door hardware shall be stainless steel and shall maintain NEMA rating of enclosure.
6. Provide interior metal panel for mounting components, finished with white enamel.
7. Manufacturer:
    a. Hoffman
    b. Hammond
    c. B-Line
    d. Or equal

G. Terminal Blocks

1. Fused and Non-Fused Modular Terminal Blocks: Terminal blocks shall use screw type modular connector assemblies and shall have no exposed conductive terminals. Mount using din rail assembly secured to enclosure back panel.
2. Material: Self extinguishing, UL94-V2 listed.
3. Fused Type Terminal Blocks:
    a. Minimum 15-Amp rated.
    b. Feed through type with side terminating terminals.
    c. No loose parts which may fall off when replacing fuse.

d. Latch in open position.
e. Externally accessible testing terminals

4. Non-Fused Type Terminal Blocks:
   a. Minimum 10-Amp rated.
   b. Feed through type with side terminating terminals.
   c. Externally accessible testing terminals
5. Labeling: Provide printed plastic terminal strip markers indicating circuit identification to match drawing designation. Markers shall be readily visible and mounted on terminal block. Identification tag designations for each terminal block shall match those shown on the wiring diagrams.
6. Terminal Block Color Code:
   a. Data/Communications – Blue
   b. AC Power – Orange
   c. DC Power - Tan, Brown, Grey or Black
   d. Ground – Green
   e. Intrinsic Barrier – Red
   f. Discrete, Analog, and systems not listed elsewhere – Tan, Brown, Grey or Black
7. Manufacturer:
   a. Wago
   b. Phoenix
   c. Weidmuller
   d. Or equal

H. Plastic Raceway
1. Product Description: Non-metallic plastic channel with hinged or snap-on cover, suitable for control wiring, branch circuit wiring, data and other low voltage wiring.
   a. The raceway and all system components must be UL listed and exhibit non-flammable self-extinguishing characteristics.
   b. Both raceway and cover shall be manufactured from rigid molded polyvinyl-chloride compound.
   c. Raceway splices shall incorporate overlapping joints so that enclosed cables are completely protected.
   d. Raceway shall be securely fastened to the back panel.
   e. Color: White or gray
2. Wireway Size: Size wireway so that fill ratio does not exceed 20% of the interior cross section area of the wireway. As a minimum, provide 2 inch x 3 inch wireway.

I. Control Relays
1. Intrinsically Safe Control Relay
   a. Product Description: Din rail mounted, sealed, isolated relay for use in class I and class II listed areas.
   b. Contacts: Form A or B (normally open / normally closed or both) as required.
   c. Contact Ratings: Minimum 8 amperes continuous.
   d. Coil Voltage: 24VDC
   e. Listing: UL
   f. Manufacturer: Rockwell, Model 897H-S120, or equal
2. Solid State Relay
   a. Product Description: Panel Mount, Solid-state electronic relay with optically isolated output (Non-Intrinsically Safe Control Relay)
   b. Contacts: Form A (normally open).
   c. Contact Ratings: 10 through 90 amperes continuous, as required.

d. Enclosure: Hermetically sealed, suitable for Class 1, Division 1 and 2 installations.
e. Coil Voltage: As required.
f. Manufacturer: IDEC, RSSAN Series or equal

3. Time Delay Relay (On-Time Delay and Off-Time Delay)
   a. Product Description: Din rail mount solid-state time delay relay with base and retainer. Time delay after energization or after de- energization, as required.
   b. Provide with surge suppressor diode.
   c. Contacts: Form A or B (normally open / normally closed or both) as required.
   d. Contact Ratings: Minimum 10 amperes continuous.
   e. Coil Voltage: As required.
   f. Manufacturer: IDEC, RTE Series or equal
4. General Purpose Plug-in Relay
   a. Product Description: Din rail mount miniature, sealed relay with base and retainer and Light Emitting Diode (LED) indicator.
   b. Provide with surge suppression diode.
   c. Contacts: Form A or B (normally open / normally closed or both) as required.
   d. Contact Ratings: Minimum 10 amperes continuous.
   e. Coil Voltage: As required.
   f. Socket: To match relay and meet conditions of installation.
   g. Manufacturer: IDEC, RJ Blade Series or equal
5. Under Voltage Relay
   a. Product Description: Din rail mount, AC/DC sealed under voltage relay. Relay provides actuation based on under voltage condition.
   b. Interface: Front face dial based adjustment with LED status indication.
   c. Contacts: Form A or B (normally open / normally closed or both) as required.
   d. Contact Ratings: Minimum 10 amperes continuous.
   e. Socket: To match relay and meet conditions of installation.
   f. Accessories: Provide with hold-down retainer.
   g. Manufacturer: Macromatic, VA Series or equal

J. Analog Signal Isolators
1. Provide analog signal isolators for analog signals that are sent from one control panel to another.

K. Communication Protocol Converters
1. The communications system shall utilize communication protocol conversion devices where required to transform and transmit device level communication protocols to a common system level protocol.
2. Unless specified elsewhere, the common system protocol shall be DNP3 encapsulated within the TCP/IP Ethernet protocol (IEEE 802.3).
3. Each native device I/O bit shall be accessible over the network using this common system protocol. Media converters shall be manufacturer listed for use in industrial environments. Media converters shall be din rail mounted within a listed and suitable enclosure.

L. Blocking Diodes
1. Description: Used in DC power distribution circuits to segregate power sources where two DC power sources are used for redundancy. Provides a means of preventing DC power from the primary source to back feed the secondary power source. Provides automatic switching between DC power sources.
2. Power Ratings: 24VDC, Minimum 40 amperes continuous.

3. Mounting: DIN rail mounted
4. Manufacturer: Phoenix Contact, Quint Diode/40 Series or equal

M. Power and Distribution
1. Circuit Breakers: Panel mount NEMA AB 1, bolt-on type thermal magnetic and instantaneous magnetic trip circuit breaker. Circuit breaker thermal elements shall be of the bimetallic type and shall be capable of withstanding sustained overload and short-circuit currents without injury and without affecting the calibration of the bimetallic element. The thermal element shall have inverse time characteristics. The instantaneous elements shall trip the circuit breaker at the minimum standard trip setting.
   a. Provide common trip handle for multiple pole circuit breakers.
   b. Minimum integrated short circuit rating:
      1) Circuit Breakers rated 240-Volts - 10,000 amperes RMS symmetrical.
      2) Circuit Breaker rating shall match or exceed the serving panels interrupting rating.
      3) Series rated breakers shall not be acceptable.
2. Incoming Power and Power Distribution Blocks:
   a. Material: High impact thermoplastic with tin plated copper lugs, size and ampacity per requirements.
   b. Manufacturer listed finger safe cover.
   c. Panel mounted.
   d. Manufacturer: Square D, Class 9080, or equal.
3. Incoming Power Ground Bus:
   a. Provide ground bus for power connection to enclosure back panel.
   b. Bond back panel to enclosure using panel manufacturer provided back panel bonding washer.
   c. Provide connection to door mounted ground studs.
   d. Manufacturer: GE, TGK24CP, or equal.

N. Electrical Transient Protection
1. Description: All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting cabling from lightning discharges and nearby electrical systems.
   a. Panel mount Surge Protection Device (SPD).
   b. UL 1449 Listed.
   c. LED Status indicator.
   d. 100,000 amps per phase surge capacity
   e. Voltage rating to match panel supply voltage
   f. Manufacturer: Schneider, XW Series, or equal
2. Provide each SPD with panel mounted circuit breaker rated per manufacturer requirements.
3. As specified in Section 26 43 13 Surge Protection Devices.

O. Control Power Transformer
1. Description: Panel mounted industrial control transformer:
   a. Epoxy encapsulated copper windings.
   b. 55°C rise, 105°C insulation.
   c. NEMA ST-1 compliant.
   d. Integral fusing with finger safe covers.
   e. Voltage: Primary: As indicated on drawings, Secondary: 120 Volts AC

f. Rating: As required for system, plus 25 percent spare capacity

2. Use Limitations: Control Power transformers shall be permitted for use in transforming power for use as control panel general control and distribution power for use by relays, indicating lamps, panel mount receptacles and power supply input source. Where providing system control power for use by system controls and active system components, refer to Power Supply section within this specification for requirements.
3. Fusing: Control transformers shall be equipped with primary and secondary fusing and sized for all connected equipment and components, plus 25% spare capacity.
4. Each control transformer shall be provided with manufacturer listed "finger safe" terminals.
5. Provide fused disconnecting means for each connected control power distribution leg.
6. Maintain a minimum 12 inch separation from radios, RTU's and other active components located within the control panel.
7. Manufacturer: Sola, SBE Series or equal

P. Power Supply

1. Description: Panel mounted linear power supply with battery backup:
   a. Regulation: .05 percent output variation at rated voltage with 10% input variation
   b. Ripple; 3.0mV max peak to peak
   c. Transient Response Time: 50 msec
   d. Stability .5 percent
   e. Operating Temperature Range: 0°C to 50°C
   f. Voltage: Primary: 120 Volts AC, 60-Hz, Secondary: 24 Volts DC
   g. Rating: As required for system, plus 25 percent spare capacity
   h. Battery: auto-switching 24 Volts DC backup power source, rated to provide a minimum of one hour of unpowered stand-alone operation
2. Use Limitations: Power supplies shall be used for powering RTU's, wireless transmitters, and other active low voltage control panel devices.
3. Provide fused disconnecting means for each connected control power distribution leg.
4. Maintain a minimum 2-inch separation from adjacent devices located within the control panel.
5. Manufacturer: Phoenix UPS power supply as indicated on drawing's Bill of Materials. Substitutions not permitted.

Q. Mounting Hardware

1. Description: General mounting hardware requirements associated with mounting equipment and components.
   a. Control Panel mounted hardware: Grade 5 (minimum), zinc plated bolts, screws washers and lock washers.
   b. Follow manufacturer's requirements for mounting hardware size and mounting requirements.

2.7 SOURCE QUALITY CONTROL

A. Test programmable controller in accordance with NEMA IA 2.2.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install hardware per manufacturer's recommendations.

B. Ground and bond controllers in accordance with Section 26 05 26.

C. Connect and configure input and output devices.

D. Verify intended system function and commissioning.

3.2 CONTROL PANEL WIRING METHODS

A. Maintain Separation of Systems Within Enclosure:
   1. Communications circuits – Maintain minimum 1" physical separation.
   2. Less than 50V line-to-ground - Maintain minimum 1/4" physical separation (discrete I/O, analog, digital, etc).
   3. 50V line-to-ground through 120V line to ground - Maintain minimum 1" physical separation (discrete I/O, power distribution, etc).
   4. Greater than 120V line-to-ground - Maintain minimum 3" physical separation (power distribution, etc).
   5. Provide group marker for each terminal block system grouping.

B. Use a color code scheme to differentiate connected systems within panel. As a minimum use the following color scheme;
   1. Three phase power: Per voltage and phase
   2. 120 Volt power: Black and White
   3. Discrete 120 Volts: Red
   4. Discrete 24 Volts: Purple
   5. Analog 4-20mA: Yellow and Orange
   6. Ground: Green

C. Route and secure control panel conductors in a craftsman like manner using smooth bends. Do not bend conductors at sharp angles.

D. Arrange wiring neatly, cut to proper length, and remove excess wire.

E. Secure conductors to avoid incidental contact and to prevent contact with sharp surfaces where conductor damage may occur.

F. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.

G. Secure cable to enclosure where routed outside of wireways using nylon tie wraps. Secure nylon tie wraps using supports secured to enclosure and back panel with epoxy-based adhesive.

H. Provide hinged wiring loop where transitioning from fixed face to hinged component. Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve using nylon sock material. Spiral wrap shall not be acceptable.

I. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.

J. Splice and tap wires only at device terminals or terminal blocks.

K. Arrange wiring to allow ease of access for testing, removal, and maintenance of circuits and components.

L. All RTU and instrumentation interface points shall be terminated on terminal blocks or fused terminal blocks as specified.

M. Using appropriate lugs to terminate wires and cables. Wires terminating directly under screw terminals is not acceptable.

N. Provide interposing relays for all input and output circuits connected to RTU's, control devices where driving loads or interfacing with external devices.

O. Power feeds, external power supply outputs, and other power distribution wiring to external equipment shall be terminated on a fused terminal. All fuses shall be provided for all fuse terminals.

P. Terminal ground bus: Provide ground bus terminal blocks, with each connector bonded to enclosure through terminal strip din rail for control power grounding connections.

3.3 SEQUENCE OF OPERATIONS

A. Program the RTU to perform the control sequences and monitoring functions as described in the Sequence of Operations.

3.4 HMI AND REPORT DEVELOPMENT

A. Coordinate with GWA for specific HMI design requirements prior to commencing work. Any rework required as a result of not coordinating with GWA prior to commencing work shall be provided by the Contractor at no additional cost to GWA.
   1. GWA will provide concept level HMI design criteria to the contractor to be used as a basis of development for the HMI layout and graphics. All necessary software programming to meet the HMI design intent and as directed by GWA to develop the HMI screens shall be provided by the contractor.

B. Organize and attend preliminary coordination, sixty-five (65) percent, and one hundred (100) percent design meetings to review design criteria, initial HMI design, report design, GWA requirements for HMI, operational requirements and all general HMI screen design elements required.
   1. The preliminary coordination meeting shall occur prior to submittals being finalized and within sixty (60) days of the notice to proceed.
      a. Review concept level HMI navigation screens with GWA and provide copies of developed material for review.
   2. Intermediate sixty-five (65) percent design meeting shall occur after successful submission of submittals and within ninety (90) days of notice to proceed.

a. Review concept level HMI navigation screens with GWA and provide copies of developed material for review.

3. Final one hundred (100) percent design meeting shall occur within sixty (60) days of the intermediate sixty-five (65) percent design meeting.
   a. Review functional HMI navigation screens with GWA and provide copies of developed material for review.

C. Provide simulated HMI elements during the review meetings to demonstrate graphic functions, system response and system interactions.

3.5 FACTORY TEST

A. Prior to shipping control panel to site, provide a full-function factory test to verify intended operation and proper function of all connected devices. Where interfacing with other systems, simulate inputs and outputs as necessary to verify proper operation. Where the testing of a control panel has failed the test, the deficiencies shall be corrected prior to shipping the control panel to the site for installation.

3.6 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform operational testing on control systems to verify proper operation and field wiring connections.

3.7 DEMONSTRATION AND TRAINING

A. Furnish 8 hours of instruction each for four (4) Operators, to be conducted with manufacturer's representative. Coordinate with GWA for times and locations of training. Training times and locations shall be as directed by GWA.

END OF SECTION 409443

SECTION 409630 – PROCESS CONTROL PROGRAMMING AND PROCESS LOOP DEFINITION

PART 1 GENERAL

1.1 INSTRUMENTATION & CONTROLS SYSTEM FUNCTIONAL REQUIREMENTS

A. General:

1. Programmed systems are a part of the instrumentation and controls system. The supplier of the programmed systems shall meet all the applicable requirements of Section 40 90 00, except where those requirements are modified by this Section.
2. This Contract makes improvements at GWA's water sites, in support of gathering process data for use by GWA.
3. This Contract includes physical installations at the sites. The Contractor is also responsible for coordinating work by others, as part of the "delivery" of data from the sites to GWA.
4. In addition to requiring a fully documented and tested system at project completion, it is the intent of these requirements to ensure that programmed systems are complete, documented, and tested prior to shipping systems to the jobsite. The documentation requirements are significant and require planning to ensure that submittals are provided sufficiently in advance of certain activities.
5. Functional requirements of the I&C system are depicted primarily in the interconnection schematics, and the following loop specifications (also referred to as control strategies).
6. Nomenclature in the interconnection schematics and loop specifications generally follows Instrument Society of America (ISA) standards as covered in document ISA S5.1.
7. Incorporate the results of the workshops specified in Section 40 96 36.

B. Definitions

1. The terms "Loop Descriptions," "Control Strategies" are synonymous.
2. Hardwired Functions are those functions that do not utilize software functionality but are implemented with individual analog components and discrete control components. Examples of analog components are individual process controllers, analog switches, and analog indicators. Examples of discrete components are relays, switches, indicating lights, and digital displays. Hardwired Functions are specifically depicted on control diagrams as such, all other functions shall be Software Functions.
3. Hardwired interlocks are safety or protective features that will interrupt operation of equipment in all operating modes with no required operator intervention.
4. Software Functions are those functions implemented as control source code (e.g., RTU/PLC ladder logic) and operator interfaces (e.g., SCADA computers, panel-mounted graphical displays).
5. Software interlocks are safety or protective features that will interrupt operation of equipment when the RTU/PLC has control.
6. A "permissive" is differentiated from an "interlock", in that a permissive need only be satisfied at the commencement of the control action. Thereafter, if the condition is no longer satisfied, it has no effect (i.e. it does not block the control action).
7. OIP – Operator Interface Panel, a graphical interface local to and specific to the local process. This project includes OIP's and configuration thereof.

8. HMI – Human Machine Interface, a graphical workstation also known as "Workstation," "SCADA Workstation," with a view of the entire system. HMI's can take on the character of a "view node" for operators' use, or "engineering development workstation" for other purposes. HMI configuration is required with this project but will be accomplished by GWA and its consultants. The process monitoring and control functions and the local OIP displays, are to be developed under this project with consideration of GWA's HMI standards.
9. Mobile Device – A portable computer or other handheld roving device with access to the SCADA system. Mobile devices provide functions including access to the SCADA system wireless or wired connections. (This project includes no mobile devices.)

C. Use of Owner Standards:

1. Where Owner standards are available, receive and incorporate the standards into submittals and control system implementation. Standards may be provided as formal standards documentation, or in the form of documentation of similar installations.
2. Any documentation or standards provided by the Owner will not reduce the requirements for this project. Provide all required and specified functions, regardless of whether or not standards are furnished.
3. Standards apply to items such as the following:
   a. Wire colors and numbering
   b. Signal/variable descriptions/tagnames
   c. Program organization and annotation
   d. Screen layouts and conventions

D. General Functions at Operator Interface Panels and RTU's:

1. This project makes use of RTU's for all site programmed functions, and OIP's at each site for the principal local operator interface.
2. The operator interface panels (OIP's) shall be used to display statuses and alarms, and shall provide the primary operator interface for RTU functions. The OIP's shall provide a complete view of local site operation.
3. Displays shall be consistent with and conform to GWA standards and practices, including those at the supervisory level (by others). Included are display characteristics such as organization and display-to-display relationships, layout, dimensional depictions, use of color, and other characteristics as applicable.
4. Provide RTU and OIP functions as described in this Section.

1.2 WORK INCLUDED

A. This Section covers programming and process loop definitions, for a complete operational control system. Provide labor and materials as required for complete operating programmed systems, including all of the control functions described in Section 40 90 00. The Contractor shall furnish and install all hardware described in Section 40 94 43 and provide software for a complete operational system, including all program development, installation, testing and commissioning.

B. This Section covers items, including the following:

1. Process loop specification

2. RTU Programming Software
3. RTU and OIP Programming and Configuration
4. Ethernet Switch Configuration
5. Firewall Configuration
6. Radio/Router Configuration

C. This Section includes all applicable requirements of Section, 40 90 00, including but not limited to submittals, O&M manuals, and warranty.

D. The Contractor shall furnish all hardware required to operate the Programed Systems described herein, including RTUs, OIPs, network switches, firewalls, routers, radios, measuring instruments and all other associated accessories and appurtenances required to accomplish the described functionality.

E. The Contractor shall test and commission the Programmed System in accordance and using the procedures described in Section 40 96 37.

F. The Contractor shall provide a fully functioning, documented system.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 26 05 53 – Identification for Electrical Systems

C. Section 26 43 13 – Surge Protection Devices

D. Section 40 90 00 – Industrial Instrumentation & Process Controls

E. Section 40 94 43 – Programmable Logic Process Controllers

F. Section 40 96 36 – Process Control Integration

G. Section 40 96 37 – Process Control System Testing

1.4 SUBMITTALS

A. General

1. Provide complete submittals for programmed systems covered under this Section. Where programmed systems are part of a system also having hardwired instrumentation and controls, these requirements apply to the combined hardwired and programmed system, complete.
2. Submittals shall meet the applicable requirements of Section 40 90 00.

B. Submittals shall be coordinated with and reflect the results of workshops specified in Section 40 96 36.

C. Programming – Related Submittals:

1. Submittals shall demonstrate the Contractor's proposed format for the RTU program and shall show a typical program table of contents, program organization, annotation, cross-references, and a complete depiction of a representative program:
2. Comply with the applicable requirements associated with programming developing and conforming to standards, workshops, and related submittals as specified in Section 40 96 36.
3. In addition to the work and submittals required therein, provide as a summary a "roll up" of the decisions in an Application Program Format Submittal.

D. Develop detailed site-by-site, function-by-function loop descriptions based on the information in the Contract Documents, including the requirements herein and the results of workshops, and submit.

1. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls shown on the P&IDs and as otherwise included in the project:
    a. Include all functions depicted or described in the Contract Documents.
    b. Include the following within each loop description:
        1) All requirements specific to that loop.
        2) Common control requirements applicable to that loop.
        3) List of all ranges, setpoints, timers, values, counters, etc.
2. Where there are similar loops with identical control, such as multiple loops for individual equipment or process units, only one loop description need be developed, and the remaining loops may reference that loop description.
3. Format loop descriptions as follows, and organize them with a Table of Contents, page numbers, and footers.

E. Loop description format:

1. Loop number and title.
2. Site name/ID.
3. References:
    a. P&ID's
    b. Loop Diagram(s)
    c. Other references as applicable
4. Abstract:
    a. General description of how the loop works, what devices are involved, and how the process will be monitored/controlled. This is a "plain language" description.
5. Instruments:
    a. Table of instruments with the following:
        1) Instrument function/process variable(s)
        2) Instrument tag
        3) Range
        4) Units
        5) Setpoint(s), where applicable
6. Equipment:
    a. Table of equipment with following:
        1) Common name

2) Tag
3) Nominal capacity/rating if available
4) CMMS ID if available

7. Hardwired control:
   a. Detailed description of the control functions at a local level.
   b. Function of local operator interfaces.
   c. Operation of hardwired field pilot controls:
      1) Pushbuttons.
      2) Selector switches.
      3) Potentiometers.
      4) Pilot lights, indicators, and other displays.
8. Hardwired interlocks:
   a. Explanation of the operation of system hardwired permissives and interlocks.
   b. If overrides are available, note them.
9. RTU functions:
   a. Detailed description of the control functions that are under control of the RTU.
   b. Operator inputs to the control logic, manual/auto selection, sequence selection, setpoint inputs, etc.
   c. Supervisory manual controls.
   d. Automatic controls, including software interlocks, sequencing, etc.
   e. Setpoints, alarms, etc.:
      1) Include units and ranges for analog values.
      2) Include span and range for analog inputs and outputs.
      3) Include operating point and deadband for discrete inputs, and identify conditions where contacts are open, and when they close.
      4) Note any special signal conditioning
   f. Control sequences.
   g. Failure responses:
      1) Equipment
      2) Instruments
      3) Communications
      4) Loss of controlled variable
      5) Etc.
10. OIP functions:
    a. Detailed description of the operator controls of graphical interfaces local to the process. (The descriptions can be covered in part with RTU functions if doing so improves clarity.)
    b. Setpoints, alarms, etc.
    c. Access privilege restrictions, structure (logins, etc.).
11. SCADA (supervisory) functions:
    a. Detailed description of supervisory functions. (The descriptions can be covered in part with RTU functions if doing so improves clarity.)
    b. Setpoints, alarms, etc.
    c. Access privilege restrictions, structure (logins, etc.).
12. Indicators and alarms:
    a. List any indicators and alarms specific to the loop that are not covered in the common Control Strategies.
13. Failure modes:

a. List any failure modes specific to the loop that are not covered in the common Control Strategies.

F. UPS Load Calculations:

1. For each UPS, prepare and submit load calculations which demonstrate rating and duration.
2. Calculations shall be correlated with panel temperature calculations required in Section, 40 90 00, to demonstrate that the requirements can be met at the projected panel internal temperatures. If temperature deviating is applicable, include that in the calculations.
3. Should calculations show that additional battery modules or larger UPS's are needed, coordinate physical sizes. If necessary, furnish additional enclosure(s) and interconnection as needed.

1.5 WORKSHOPS

A. Section, 40 96 36 includes workshops. Incorporate workshop results into Loop Descriptions.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide all first-quality new materials, free from any defects, and suitable for the intended use and the space provided. Provide materials approved by UL wherever standards have been established by that organization.

B. Furnish and install all incidental items not specifically shown or specified which are required by good practice to provide the complete systems specified herein.

C. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

D. In addition to the requirements of this Section, the work covered in this Section includes the applicable requirements of Sections 40 90 00 and 40 94 43 for the following work

2.2 STANDARD PRODUCTS

A. Unless otherwise indicated, provide materials and equipment which are products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest design that conforms to these Specifications.

2.3 ENCLOSURES

A. Unless indicated otherwise, provide suitable mounting and enclosure systems for all devices and equipment.

B. All enclosures shall be in accordance with the requirements in Sections 40 90 00 and 40 94 43.

2.4 NAMEPLATES, NAME TAGS, AND SERVICE LEGENDS

A. Unless otherwise noted, provide nameplates, name tags, and labels as specified in Section 26 05 53.

B. All components provided under this Section, both field- and panel-mounted, shall be provided with permanently mounted name tags bearing the entire tag number of the component. Panel-mounted tags shall be plastic or metallic fastened with stainless steel screws or drive pins; field-mounted tags shall be stamped stainless steel affixed with stainless steel wire.

2.5 ELECTRONIC FILES OF APPLICATIONS AND DEVELOPMENT SOFTWARE

A. Applications software consists of those programs and other files which accomplish the specific functions of the programmed system. Development software consists of those programs and other files which provide the framework and tools used to create applications software.

B. Provide files on CD-ROM or other medium compatible with the systems on this project.

C. Provide all registered versions of software required to develop, modify, operate, and maintain the programmed system, including applications and development software, compilers/decoders/interpreters, operating systems, communications programs, utility programs, documentation programs, etc.

D. Provide licensing and registration for all programs, including documentation substantiating each license and registration. Register all software to the Owner. Where software applications are available in different licensing and use versions (i.e., client-server, multiuser, single user, development, runtime, 500 point, unlimited point, etc.), provide the Owner with the most comprehensive license/version available, with a minimum of three simultaneous users.

E. Program versions shall be the latest available at the start of factory testing.

PART 3 EXECUTION

3.1 GENERAL

A. Work shall be performed in a workmanlike manner by craftsmen skilled in the particular trade. Work shall be performed in accordance with the Drawings, the Specifications, the manufacturers' recommendations, and the best practice of the trade. Completed work shall present a neat and finished appearance.

B. Coordinate the work covered in this Section with the Owner and the work of other trades to avoid conflicts, errors, delays, and unnecessary interference during construction.

C. During construction coordinate with the Owner, other members of the Contractor's organization, and with the Engineer to establish ranges, scaling, and setpoints.

3.2 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss, damage, and the effects of weather. Prior to installation, store items to be installed in indoor locations. Items subject to corrosion under damp conditions and items containing insulation, such as control panels and instruments, shall be stored in indoor, heated, dry locations.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Keep openings in boxes or equipment closed during construction.

3.3 MATERIAL AND EQUIPMENT INSTALLATION

A. Follow the manufacturer's installation recommendations, unless otherwise indicated. Follow the Engineer's decision, at no additional cost to the Owner, wherever any conflict arises between the manufacturer's instructions, State, or other codes and regulations, and these Contract Documents. Keep a copy of the manufacturer's installation instructions available on the jobsite for review at all times.

3.4 WORKSHOPS

A. Organize and participate in workshops as specified in Section 40 96 36.

3.5 GENERAL PROGRAMMING TECHNIQUES

A. Displays shall conform to standards and practices in use elsewhere within GWA.

B. Password protection shall conform to standards and practices in use elsewhere within GWA.

C. The general requirements described herein are minimum. Provide functionality which also meets existing practices, and where otherwise required.

D. Conform to tagging/identification defacto and published standards.

E. Store all adjustable parameters in the RTU and configure so that an operator with sufficient security access can change the parameters from the HMI or OIP. Update and display the current value at all locations, regardless of where the last change was made.

F. Calculated values:

1. Program calculations such that division by zero errors cannot occur.
2. Prevent calculations from generating values that exceed the limits of the equipment or data-type structures (integers) internal to the RTU.

3.6 COMMON CONTROL FUNCTIONS

A. Incorporate common control functions into all control loops and devices and into the control programming, whether or not specifically shown in specific Loop Descriptions or elsewhere in the Contract Documents.

B. Inputs/Outputs:

1. For all monitored analog values:
    a. Monitor, scale, and display all analog inputs.
    b. Provide “open wire” and “out-of-range” alarms for all analog inputs.
    c. Convert all values to engineering units within the RTU.
    d. Totalize flows in the RTU logic:
        1) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
        2) Where no totalizer input is shown, integrate the analog input over time.
        3) Display totals on the OIP.
        4) Archive totals to the historical database through SCADA (by others).
    e. Calculate hourly, daily, and monthly averages:
        1) Calculations shall be performed by the RTU.
        2) Display averages on the OIP, and archive through SCADA (archiving by others).
    f. Calculate minimum and maximum values for each hour, day, and month:
        1) Calculations shall be performed by the RTU.
        2) Display minima and maxima on the OIP, and archive through SCADA (archiving by others).
    g. Generate an alarm whenever an override value is in use.
2. Analog data processing:
    a. Engineering units conversion – Use engineering units for all analog point values. Convert analog inputs to engineering units.
    b. Analog magnitude checking – Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.
    c. Analog value quality – Monitor analog values received at each RTU from analog inputs or communications from another PLC or RIO, and generate alarms for the following conditions:
        1) Rate of change in excess of acceptable limit – Provide a separate rate limit for each value.
        2) Stale value – For analog signals that come from analog inputs or calculations using analog inputs, which are expected to have some variation each time the input is read, alarm when there is no change in the value for 10 times the normal expected scan or communication update.
3. Analog input filtering:

a. For each analog input, provide an adjustable first order filter for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering affect.
b. Monitor analog input signal quality:
    1) Over range: The input value is above the normal range (typically over 21mA).
    2) Under range: The input value is below the normal range (typically under 3mA, indicating a probable broken connection).
    3) Generate alarms for over or under range inputs.
    4) Do not use over or under range values for control or calculation purposes.
    5) Where a second instrument is provided to monitor the same condition (a redundant instrument, or additional instruments furnished for averaging or different operating modes), and has a valid signal, use that input for control.
    6) Otherwise, hold all outputs affected by the signal at their last values before the signal went out of range.

4. Monitor and display all discrete inputs. Provide "debouncing" time delays in the range of 10-250 msec.
5. Discrete inputs that are latched in the hardwired system shall not also be latched in the control program. Coordinate programming with control diagrams.
6. Provide totalizers for applicable analog inputs such as FLOW and POWER. Totalizers shall be represented as "Yesterday's Total," "Today's Accumulated," and "Running Accumulated." ("Running Accumulated" shall be password-enabled resettable.)
7. Provide high/low discrete alarms for all analog inputs with alarms derived within the RTU. Alarm setpoints shall be adjustable. In addition, provide HIGH-HIGH and LOW-LOW alarms, as applicable to each process.
8. For all alarms, provide time delay setpoints in the range of 2-60 seconds to prevent nuisance alarms due to transients. Time delay setpoints for each alarm shall be adjustable.
9. With the exception of equipment TROUBLE alarms, all alarms shall be configured such that they can be individually inhibited.

C. Communications:

1. Develop OIP screens to display communication errors and communications status.

D. Loss of Power:

1. Provide RTU logic which suppresses alarming during power losses, to avoid alarm storms. Valid alarms not due to power loss events should be left intact.

E. Other Common Control Functions:

1. The requirements above are partial. Provide programming to the best practices of the Industry, including other common control functions.

3.7 PRV AND RESERVOIR LOOP DESCRIPTIONS

A. GWA Reservoirs and PRV's are largely passive (monitoring) in nature. The Common Control Functions cover most requirements for those sites. From these requirements, and the other specified activities including workshops, develop typical loops descriptions covering the following:

1. Level monitoring and alarming.
2. Flow monitoring, totalizing, and alarms.
3. Pressure monitoring and alarming.
4. Descriptions to cover the remaining analog and discrete inputs.
5. Other descriptions as required.

3.8 COORDINATED FUNCTIONS

A. This project, and other similar projects, will result in integration with SCADA a growing list of GWA sites. As part of this project, allow for and provide up to three additional functions which go beyond the boundaries of the RTU's furnished and installed under this project. Candidate functions will be identified in the course of the workshops.

B. Below are examples of the types and complexity of functions which could be added:

1. Site-by-site interlocking, based on process values and/or equipment statuses.
2. Calculation of area-wide flows, usages. For example, within RTU's integrating and manipulating level changes and flows on a daily basis, to develop volumetric/usage summaries.
3. Alternate control schemes (or different process values to be used in control) to be used on loss of primary controlled variable. For example, automatically switching from level control at a reservoir to local pressure control.
4. Time of use, and/or other limitations for equipment operations.
5. Variations in setpoints based on the availability (or not) of commercial power.
6. Other coordinated or advanced functions.

3.9 RTU PROGRAMMING AND CONFIGURATION

A. Program the RTU in conformance with industry best practices, GWA standards, and the requirements of this and other specification Sections.

B. Put in place all required functions/configurations to support communications, in accordance with workshop results.

3.10 OPERATOR INTERFACE PANEL (OIP) CONFIGURATION

A. Configure the OIP in conformance with industry best practices, GWA standards, and the requirements of this and other specification Sections.

B. Provide process screens consistent with those in use at SCADA. To the extent practical, achieve uniformity between this project and other related projects. Conform to published and defacto conventions, and workshop results.

C. Provide personal protection on setpoints to the extent GWA practices so dictate.

D. Provide an RTU status screen, showing processor burden, memory utilization, and other statistics.

E. Provide a communications status screen.

F. Provide setup screens as required.

G. Configure navigation in conformance with GWA published and defacto conventions, and workshop results.

3.11 ETHERNET SWITCH CONFIGURATION

A. Configuration is by GWA.

B. Schedule and coordinate with GWA's work.

C. Record the configuration settings; include in project as-built documentation.

3.12 FIREWALL CONFIGURATION

A. Configuration is by GWA.

B. Schedule and coordinate with GWA's work.

C. Record the configuration settings; include in project as-built documentation.

3.13 RADIO/ROUTER CONFIGURATION

A. Configuration is by GWA.

B. Schedule and coordinate with GWA's work.

C. Record the configuration settings; include in project as-built documentation.

3.14 TESTING

A. General

1. Testing shall be done in accordance with Section 40 96 37.
2. Testing, test plans, and test reports shall be provided by the Contractor as specified herein. The Contractor shall perform tests as required to demonstrate that the equipment and systems covered in this Section operate safely and meet the requirements of these Specifications. The Contractor shall provide labor, instruments, and other material to complete the tests.
3. Test plans and test reports shall be submitted as formal submittals and shall meet all applicable requirements of the Article, SUBMITTALS.
4. Tests and test plans shall be in the cause and effect format. The person conducting the test shall initiate an action (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

5. Tests and test plans shall be integrated across equipment and systems. The Contractor shall coordinate and integrate the documentation and efforts of suppliers and subcontractors to achieve unified tests and test plans.

B. Factory Testing

1. Factory testing of programmed systems shall fully test all system functions from the point of external connections (interface terminal strips or other points of connection) to operator monitoring and control devices such as operator interface panels, indicators, statuses, and alarms.
2. System inputs and outputs shall be simulated and monitored using hardware devices; observing only variable statuses internal to the program is not acceptable.
3. The testing requirements herein apply to all programmed systems.
4. Undertake factory testing as called for in Section 40 96 37.

C. Operational Readiness Test (ORT)

1. Undertake operational readiness tests as called for in Section 40 96 37.

D. Functional Acceptance Test (FAT)

1. Undertake functional acceptance tests as called for in Section 40 96 37.

E. 14-Day Operational Test

1. Undertake 14-day operational tests as called for in Section 40 96 37.

3.15 FIELD SUPPORT

A. Provide the services of experienced, factory-trained service engineers or technicians to assist with installation, checkout, startup, and testing of each installation.

3.16 TRAINING

A. Provide the services of an experienced, factory-trained service engineer or technician, other than a sales representative, to train the Owner’s personnel in operation, maintenance, and troubleshooting of the systems and equipment specified in this Section.

B. Provide three (3) 8-hour days minimum of onsite training in the maintenance of programmed systems and control system components, with emphasis on the RTU system.

END OF SECTION 409630

SECTION 409636 – PROCESS CONTROL INTEGRATION

PART 1 GENERAL

1.1 This Specification outlines requirements associated with programmed system integration. This project relies on work by the Contractor, and work by others, to meet project objectives.

1.2 This project supports GWA's goal of making water process data available to GWA's software water modeling system. The project results in improvements at GWA's remote sites which will make critical process information available for acquisition. The signal pathway from the process to GWA's Supervisory Control and Data Acquisition (SCADA) system and then to the water model, and this Contract's role for each element, are as follows:

DESCRIPTION	THIS CONTRACT'S ROLE
Process Monitoring (At Remote Sites)	
Instruments	Furnish and install instruments, plus interconnection conduit and wire. Start up and test.
Remote Terminal Units (At Remote Sites)	
RTU	Furnish and install RTU.
Local display (Operator Interface Panel)	Furnish and install local graphical display.
RTU Programming	Provide all data structures and configuration for the RTU. Accept signals, filter/debounce, scale, and make signals available to the GWA/GPA Supervisory Control and Data Acquisition (SCADA) system.
Local display (OIP) configuration	Furnish display configuration software. Develop graphical displays, consistent with GWA standards, and with consideration for similar supervisory displays developed by others.
Communications Interfaces (At Remote Sites)	
Network interconnection between devices at the sites.	Install physical interconnection between RTU and network switch, network switch and firewall, firewall and radio/router, and radio/router and antenna.
Network switch	Furnish and install. Coordinate with GWA for configuration by GWA IT.
Firewall	Furnish and install. Coordinate with GWA for configuration by GWA IT.
Radio/Router	Furnish and install. Coordinate with GWA/GPA for configuration by GWA IT.
Antenna	Furnish and install.
Island-Wide Mesh Network	

DESCRIPTION	THIS CONTRACT'S ROLE
Transmission of data	All aspects of communications/communications management are by GWA/GPA.
Supervisory System	
Receipt of data, data management, and data structures within the SCADA system	By GWA's supervisory system vendor, under GWA's supervision.
Displays, screens, alarm notification	By GWA's supervisory system vendor, under GWA's supervision.
Report generation (electronic and hardcopy)	By GWA's supervisory system vendor, under GWA's supervision.
Transmission of process data from SCADA to the water model	Will be manual uploads of electronic outputs from above, to water model. By GWA.
Water Model	
Inputting data from SCADA	By GWA.
Interpreting, recalibrating model as data are available	By GWA and its consultants.
Startup And Testing	
Site-by-site startups, testing, documentation.	Coordinate and execute.
Start up and test end-to-end signal transmission from instruments, to RTU, through the communications system, and to supervisory databases and thence data export for use in GWA's hydraulic water model.	Coordinate and oversee the entire process, including the work by GWA/GPA, and its consultants.

1.3 RELATED PROJECTS

A. This project is part of development of GWA's SCADA system. GWA's SCADA objectives include uniformity in the following areas:

1. Key components
2. Programming structure and techniques
3. Identification (physical labeling and within the programmed environment)
4. Communications management and techniques
5. Graphical displays (local and supervisory)
6. Controls
7. Alarm notification
8. And other aspects of programmed systems

B. The Contractor and subcontractors/suppliers shall meet the requirements in this Section and elsewhere to achieve uniformity across GWA facilities and projects, including the following projects:

1. Pressure Zone Realignment – Phase 2 (this project)
2. Central Reservoirs Project – Tamuning and Manenggon Reservoirs
3. Pressure Zone Realignment - Phase 1
4. Central Reservoirs Project – Hyundai, Tumon, and Chaot Reservoirs
5. SCADA projects/supervisory work by GWA and its consultants

6. Other construction projects

C. These Contract Documents include requirements for receiving standards, conducting workshops, documenting decisions including those which comprise defacto standards, and developing related deliverables. Other project(s) have similar requirements. GWA, at its sole discretion, may elect to combine selected workshops across contracts, as a means to enhance consistency. The Contractor and its subs shall cooperate in GWA's pursuit of joint workshops, with such joint efforts not diminishing the Contractor's responsibilities for preparation and documentation of workshop results.

1.4 SITES INCLUDED

A. For automation and data acquisition, this Pressure Zone Realignment project is part of GWA's larger goal of integrating sites with GWA's SCADA system and with the hydraulic model. The list below identifies sites included in this project, as well as other closely-related sites.

SITES	THIS CONTRACT'S ROLE
Dairy Road PRSV	Included in this project
Army Drive PRSV	Included in this project
Gayinero PRSV	Included in this project
Larson Road PRSV	Included in this project
Latte Heights BPS and PRSV	Included in this project
Hawaiian Rock PRSV	Included in this project
Mangilao Tanks	Included in this project
Volcano PRSV	Included in this project
Pago Bay PRSV	Included in this project
Manenggon Reservoirs	Not included (part of Central Reservoirs project).
Tamuning Reservoirs	Not included (part of Central Reservoirs project).
Kaiser Reservoir	Not included (part of Pressure Zone Realignment – Phase 1).
Mangilao Reservoirs	Not included (part of Pressure Zone Realignment – Phase 1).
Astumbo Reservoirs	Not included (part of Pressure Zone Realignment – Phase 1).
Yigo Reservoirs	Not included (part of Pressure Zone Realignment – Phase 1).
Barrigada Pump Station and Reservoirs	Not included (part of Central Reservoirs project).
Hyundai Pump Station and Reservoir	Not included (part of Central Reservoirs project).
Tumon Reservoir	Not included (part of Central Reservoirs project).
Choat Reservoirs	Not included (part of Central Reservoirs project).
Carnation PRVs	Not included (part of Pressure Zone Realignment – Phase 1).
Terao PRV	Not included (part of Pressure Zone Realignment – Phase 1).
St. John's PRV	Not included (part of Central Reservoirs project).
Okkodo PRV	Not included (part of Pressure Zone Realignment – Phase 1).
MaiMai PRV	Not included (part of Pressure Zone Realignment – Phase 1).
Pale San Vitores PRVs	Not included (part of Central Reservoirs project).
Dero Road PRV	Not included (part of Central Reservoirs project).
Ysengsong PRV	Not included (part of Pressure Zone Realignment – Phase 1).
Clara PRV	Not included (part of Pressure Zone Realignment – Phase 1).

1.5 COORDINATION AND SCHEDULING

A. The Contractor shall schedule and manage all activities identified herein, which are necessary to complete the data delivery from origins to the supervisory system and thence to the water model.

B. The Contractor shall schedule, prepare agendas, conduct, and prepare minutes for coordination workshops. The workshops shall be attended by:

1. Contractor's Project Manager
2. Contractor's Programmer
3. GWA representatives
4. GPA representatives
5. Other parties as required

C. These workshops shall be in addition to any other specified or required meetings for general project scheduling and coordination. These workshops shall be dedicated to the system integration topics touched on in this Specification, with the objective of resolving who is accomplishing the activities, making technical decisions, documenting those decisions, and identifying and overcoming any obstacles. Allow for the following:

1. Workshop #1 – Overview:
   a. Review workshop series, context
   b. Related projects, project schedules, required coordination
   c. Existing standards (published/defacto)
   d. Status of Island-wide communications
   e. Status of GWA SCADA
   f. Information requests
   g. Workshop #2 preparations
   h. Set workshop dates, attendees
   i. Other topics, as required
2. Workshop #2 – Communications, general.
3. Workshop #3 – Communications, DNP3 configurations.
4. Workshop #4 – RTU configuration/programing, data types, data mapping, data management.
5. Workshop #5 – Local Graphical Operator Interface.
6. Workshop #6 – Supervisory system (graphics, databases, alarm notification coordination with work at each site).
7. Workshop #7 – Supervisory outputs for use in Water Model.
8. Workshop #8 – Testing, parties involved and their roles, acceptance criteria.
9. Workshop #9 – To be determined.

Allow 4 hours for each workshop. Tailor the agendas as needed, with the topics above representing the general scope of discussions. Agendas and minutes shall comprise formal submittals. Receive and incorporate review comments.

D. Communications – GPA/GWA Antenna and Router Locations:

1. Each site includes a site-radio/router communications system, which will interface with the GWA/GPA Island-wide mesh-network system. At least 4 weeks prior to Workshop #2, prepare and submit a table of sites, with the following columns (the Contractor shall complete Items 1 and also 2, and input any other known information):
    a. Site name/ID
    b. Site Latitude/Longitude
    c. Nearest GPA router
        i. ID
        ii. Location (narrative description)
        iii. Location (latitude/longitude)

2. GWA will fill in known answers and will provide the table as a discussion item in Workshop #2. Additional GPA routers may be required, which will be coordinated and installed outside of this Contract.

E. Communications – DNP3 Configuration:

1. At least 4 weeks prior to Workshop #3, issue an RFI requesting standards and direction on DNP3 configurations. The RFI shall include a list of sites, their site types, and locations. The RFI shall be suitable for GWA to forward to its consultants and to GPA, with the goal of soliciting provisional answers in advance of Workshop #3.

F. Communications – Time Synchronization:

1. At least 4 weeks prior to Workshop #4, issue an RFI requesting GWA direction on time synchronization. Specifically, the methodology for setting time within the RTU, and required handshaking with the supervisory system for master time. The RTU shall be suitable for forwarding by GWA to its consultants, with the goal of soliciting provisional answers in advance of Workshop #4.

G. RTU Configuration:

1. At least 4 weeks prior to Workshop #4, issue an RFI requesting example RTU code and structure, and standards to the extent they are available. The RFI shall be suitable for forwarding to GWA's consultants. Should a suitable example be available, GWA will provide it. To the extent practical, achieve uniformity between this project and other projects.

2. At least 4 weeks prior to Workshop #4, issue an RFI requesting control strategy format examples and standards.

H. OIT Graphics and Supervisory System:

1. At least 4 weeks in advance of Workshop #5, issue an RFI requesting example remote site graphical displays and standards to the extent they are available, and the corresponding supervisory displays. The RFI shall include a list of sites and their site types. Reference applicable P&ID's for direction on the process configurations. The RFI shall be suitable for GWA to forward to its consultants. Should a suitable example(s) and/or standards be available, GWA will provide it/them.

I. The Contractor shall develop and maintain a DECISION LOG and ACTION LIST throughout the project, and periodically review the documents with project stakeholders. The Contractor shall identify information needed, deadlines for such information, and formally declare and record those deadlines in the ACTION LIST. The Contractor shall actively pursue resolution of outstanding items.

J. The DECISION LOG and meeting minutes shall fully capture the technical decisions. These documents shall be usable by GWA, its consultants, and other Contractors as a means to achieve and verify consistency among projects.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 STANDARDS, GENERAL

A. Limited standards exist. Request applicable standards prior to workshops as specified. Where no standard has been previously developed, the Contractor shall develop and submit their proposed approaches in advance of applicable workshops. Revise following workshops, and as-built at project conclusion, as brief standards:

1. RTU program organization.

2. RTU programming techniques.

3. Local graphical operator interface configuration:
   a. Layout
   b. Navigation
   c. Colors
   d. Animation
   e. Depictions
   f. Alarming
   g. Setpoints
   h. Passwords/privilege/protection
   i. Consistency with supervisory layout
   j. Other display topics

4. Data mapping and structure at the point of demarcation in the RTU (where the communications system “picks up” values).

5. RTU input/output data management:
   a. Debouncing
   b. Scaling
   c. Detection/management on loss of input
   d. Related topics

6. File naming, file management.

7. Configuration management and recordkeeping (RTU’s, communications, instrument scaling, etc.)

8. Other topics as covered in workshops.

3.2 IDENTIFICATION STANDARDS

A. Identification standards apply to physical labeling in the field (instruments, equipment, panels, wiring, etc.), and representations in the programmed environment.

B. Comply with GWA’s identification standards.

C. In the course of the work, it is expected that the Contractor will come across identification topics not covered by the standards, and/or where conflicts or edits are required. The Contractor shall develop solutions to each issue and edit the Standards with tracking for the solutions. At project completion, submit the tracked identification standards document.

3.3 RTU PROGRAMMING

A. Conform to the requirements herein, as well as those in Section 40 94 43 and Section 40 96 30.

B. To the extent practical, achieve uniformity between this project and other projects.

C. The following program organization guidelines comprise general direction on the approach to RTU programming. The guidelines are indicative of the degree of structure, with GWA standards and workshops furthering the concepts to a GWA-specific structure. Incorporate the functions described in Section 40 96 30. Programming shall be done to the best practices of the industry.

1. Configure tasks/routines as needed.

2. Standard Program Sections:
   a. System: The first program called on every scan. It is responsible for initializing values, performing housekeeping, global definitions, functions that are required on a global level. Call other routines as applicable.
   b. IO_Mapping: This program is responsible for moving data from physical modules into the internal controller tags where it can be acted on by the program logic. Changes in the I/O configuration may require corresponding changes be done within this routine. Input filtering may reside here.

c. Control Modules: The processing of field equipment is simplified by using object oriented programming techniques. This program is where object oriented programming code would be developed.
d. Process Modules: Application logic unique to this program is organized here. This will be a collection of routines that orchestrate the interaction of objects managed by the previous program.

3. Other Logic/Routines: The following programs may be required depending on process requirements:
   a. Message: This program manages all inter-processor messaging between the main processor and other processors within the system. Most water remote sites will have one processor and not require this section but future treatment plants and larger sites may have multiple processors that require this function.
   b. Security: This program is only present if there is a need to interface controller points to a security system. This could be a future requirement.
   c. Protocol Interface: If there is a need to interface to Modbus communications or similar protocol due to interfacing with packaged systems, management of the interface used is placed here.
   d. Alarming: Alarm detection shall take place in controller logic and not rely on HMI software. Alarm conditions are determined by the controller and shall result in controller bits being set.
   e. Other functions as needed, including those called for under Section 409630.

4. Annotation:
   a. The program shall be uniformly, logically, and completely annotated.

5. Provide other structure and functions as required.

3.4 RADIO/ROUTER ANTENNA AND ORIENTATION

A. The Contractor shall furnish and install the radio/router antenna.

B. Contribute in the field, at each site, with GWA and GPA representatives. In some cases, the “nearest” router, and/or evaluation of potential obstructions, has yet to be settled. Assist in assessing best antenna locations, adjust as needed from what is shown on the Contract Documents, and record the results. This field coordination and determining required adjustments are included in the Contract. Should a material change in quantities or level of difficulty as compared to the Contract Documents be required (for example conduits become larger or shorter than what is shown), inform GWA for resolution and direction.

C. As part of Contractor-developed shop drawings, submit antenna locations and orientations. Receive GWA’s direction and include accordingly.

3.5 DNP3 COMMUNICATIONS PROTOCOL

A. The communications system makes use of DNP3 communications protocol, with required configurations at the supervisory level, as well as at the remote site level. The Contractor is not responsible for developing overall DNP3 philosophies and resulting configurations. However, the

Contractor shall receive and implement configurations within the site's components as directed by GWA, and document the results.

3.6 TESTING

A. Provide test procedures as formal submittals; execute testing, and submit results.

B. Tests involve members of the Contractor's organization, GWA, other Contractors, GPA, and other stakeholders. The Contractor shall coordinate and supervise all testing, including the roles by others.

C. Testing of field wiring is covered in Section 26 05 19.

D. RTU and programmed systems testing, both in the factory and in the field, is covered in Section 40 96 37.

END OF SECTION 409636

SECTION 409637 – PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers testing requirements associated with the data collection system, which is integral with GWA's Supervisory Control and Data Acquisition (SCADA) system. As covered in Section 40 96 36, the Contractor is required to coordinate the work under this project with SCADA. The control system overall encompasses field devices (instruments, motor starters, VFD's, equipment, package panels, etc.) interconnecting wiring between field devices and control panels/RTU's, communications, networking, and all aspects of the integrated system. This Section covers tests associated with data collection functions which are part of SCADA, including testing of data transmission from origins to final destinations, within and beyond the Contractor's physical installation scope.

B. This Section also includes selected related startup requirements.

1.2 RELATED REQUIREMENTS

A. Refer to Section 26 05 00 for requirements associated with coordinating, planning, and scheduling the work.

B. Workshops are specified in Section 40 96 36. Coordinate the work specified in this Section with workshop preparations and workshop results.

1.3 SUMMARY OF TESTING

A. Testing falls into the following general categories:

1. FACTORY TESTS: Factory tests are conducted offsite, executed in advance of installations. Objectives include inspection and checking assemblies and workmanship, confirming functionality, and making necessary corrections in the factory environment. Factory testing shall be scheduled well ahead of the project critical path, and in advance of related field activities. For example, control panels are often desired to be available in the field early, to allow conduit work to commence. Factory testing must be planned and executed early to support these early installations. Factory testing is a critical aspect of successful SCADA installations, and it is for both the Contractor's and the Owner's benefit. Accordingly, factory testing will not be abbreviated.
2. OPERATIONAL READINESS TESTS (ORT): This general term covers a wide range of field tests which are prerequisites to putting systems into service. ORT are preceded by installations and startup of devices, equipment, and systems. ORT comprise the formal confirmation that the devices, equipment, and systems are ready to operate. At the conclusion of the ORT, the complete interconnected system is expected to be ready to be placed under the "authority" of supervisory monitoring and where applicable manual and

automatic control, with all monitoring, protections, and interlocks to protect the process and the equipment.

3. FUNCTIONAL ACCEPTANCE TESTS (FAT): Functional Acceptance Tests confirm that required monitoring, data collection, and manual and automatic functions are in place, responses to normal and abnormal conditions are tested, and that the systems perform as an integrated whole.
4. OPERATIONAL TESTS: Operational Tests put the tested systems into service, to confirm that under normal "real world" conditions the systems perform as expected.

B. This Article summarizes selected testing requirements. Provide all testing specified here and elsewhere in these Specifications. Integrate testing across devices, equipment, sources of supply, and systems, regardless of where specified.

	Where Executed		**Minimum Schedule Allowance**	
	Factory	**Field**	**Unwitnessed**	**Witnessed**
FACTORY TESTS				
RTU Panel Shop Test (RPST)	✓		As Needed	Note 1
Integrated Software Shop Test (ISST):				Note 2
Software Continuity Test – ISST– A	✓		As Needed	
Software Readiness Test – ISST– B	✓		As Needed	
System Interconnected Test – ISST-C	✓		As Needed	
System Remote Access Test – ISST-D	✓		As Needed	
SCADA User Interface Check – ISST-E	✓		Not needed	
OPERATIONAL READINESS TESTS (ORT)			**Minimum Schedule Allowance**	
Instrument calibrations, ranging		✓	As required	
RTU Panel Installed Test (RPIT)		✓	As required	
Wireless Network Readiness Test (WRT)		✓	As required	
SCADA System Readiness Test (SSRT)		✓	As required	
Loop Acceptance Test (LAT)		✓	As required	
Other tests as specified		✓	As required	
FUNCTIONAL ACCEPTANCE TESTS				
Functional Acceptance Test (FAT)		✓	As required	
OPERATIONAL TESTS				
14-day Operational Test		✓	14 days per site	

C. Testing Notes:

1. RTU Panel Shop Test (RPST) duration shall be as needed, but shall allow no fewer than 6 working days total for all RPST's.

2. Integrated Software Shop Test (ISST) duration shall be as needed, but the Contractor shall allow no fewer than 10 working days total for the ISST. Note that this duration is intended to also allow for related checkout and testing, specified herein, which covers aspects of the SCADA system outside of this Contract's scope of supply. In addition, the ISST provides a forum for GWA review and initiation of changes, as specified.
3. Minimum durations are for preliminary scheduling purposes only. The Contractor shall assess the likely time required, and include in schedules the minimum durations above the Contractor's actual forecast, whichever is longer. In addition, as successful completion of a number of the tests are prerequisites for subsequent tests, the Contractor shall include in the overall project schedule allowances for submission and approval of test results.

1.4 TEST PROCEDURES

A. Develop test procedures, and further develop and tailor the forms to this project's requirements.

B. Where witnessed testing is preceded by unwitnessed testing, results of unwitnessed tests shall be submitted and favorably reviewed prior to undertaking witnessed testing. In the schedule, allow for the contractually permitted review times.

1.5 SUBMITTALS

A. Test procedures and test reports shall be provided as formal submittals. After completion of each test, the Contractor shall prepare a test report and shall submit it for review. Components and subsystems requiring factory testing shall not be shipped until the applicable tests have been successfully completed and the test report has been favorably reviewed by the Engineer.

B. The Contractor's urgency to ship equipment, devices, and systems does not comprise an acceptable reason to hasten, abbreviate, or defer factory testing or its documentation.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT AND MATERIALS

A. Furnish all required test materials and equipment. The Contractor shall provide labor, computers, instruments, simulators, switch boxes, switches, radios/routers, jumpers, cabling, networks, power supplies, and other material to complete the tests.

B. Each unit of test equipment used shall have a certified calibration report traceable to the National Institute of Standards and Technology (NIST) and issued within 12 months of the testing date. Test instrument accuracies shall be appropriate for the devices under test. Analog devices shall be tested at three equally spread points (0%, 50%, and 100%) over the full range.

PART 3 EXECUTION

3.1 TESTING, GENERAL

A. The Contractor shall coordinate testing and documentation requirements among subcontractors and suppliers, and shall ensure that the parties contractually responsible for any aspect of the items under test fully support testing, including participating in the development and execution of integrated test procedures.

B. Owner representatives shall have the option of witnessing any test.

C. Perform tests as required to demonstrate that the equipment and systems operate safely and meet the requirements of these Specifications. If any component or subsystem fails tests, the Contractor shall correct the problem and shall repeat the test until it is successful.

D. Tests and test plans shall be in the cause-and-effect format. The person conducting the test shall initiate an action (cause), upon the systems or subsystems. When the systems or subsystems produce the correct result (effect), the specific test requirements will have been satisfied. Test procedures shall have individual line item checkoffs. For example, portions of testing where successive devices are energized should have a unique line for each step, with line-by-line signoffs. Blanket procedures are not acceptable.

E. Test plans shall be complete, stand-alone. Test plans shall include I/O designations, tag numbers, terminal numbers, pages, register addresses, setpoints, screen identification, etc., as needed to accomplish this stand-alone goal.

F. Test plans shall include the following:

1. Cover sheet.
2. Table of responsibilities.
3. Narrative test introduction describing setup, testing protocol, resources required.
4. Drawings/documentation/lists associated with the equipment, devices, circuits, and systems under test.
5. Cause-and-effect line-by-line test procedures.

G. Some test content is to be developed by others in those cases explicitly identified herein. Make available to others electronic versions of cover sheets, formats, Word documents, Excel checklists, and other test documents prepared in the course of meeting the specified requirements. To the extent practical, these formats will be used to achieve consistency in test documentation.

3.2 FACTORY TESTING, GENERAL

A. Factory testing shall be executed on the Island of Guam. In the event that the test facility is off Island, the Contractor shall:

1. Book and pay directly for airline travel and overnight accommodations for two people, plus provide local transportation to and from the testing facility.

2. Pay the Owner $160 per hour, times two for two people, for travel to/from Guam to the testing facility.
3. Pay the Owner $200 per diem times two for two people for the full duration of the off Island testing period.

B. Factory testing of SCADA systems shall fully test all system functions from the point of external connections (interface terminal strips or other points of connection) to operator monitoring and control devices such as indicators, statuses, SCADA displays, and alarms.

C. System inputs and outputs shall be imposed and monitored at the field terminal connections; observing only variable statuses internal to the program is not acceptable.

D. Where tests involve checking of hardwired logic depicted on elementary (schematic) diagrams, in lieu of extensive narrative, the Drawings may be used. In this case, include a general narrative procedure, include Drawings, and mark off each device or contact and/or combination as effect on the control circuit is verified. Provide sheet-by-sheet signoffs.

E. Where radio/router links are part of SCADA, substitute connections between devices shall be provided where it is not possible or practical to test the radios/routers themselves during factory testing. If substitute communications links are used, to the extent practical restrict communications bandwidth to simulate actual field conditions. Communications protocols of the substituted connections shall be identical to protocols to be used in the field.

F. Keep a daily log of factory testing. Include dates, times, those present, activities, statuses, observations, and other facts relevant to testing. Submit the daily log with test results.

3.3 RTU PANEL SHOP TEST (RPST)

A. The RPST is part of FACTORY TESTING.

B. The Contractor shall perform the RPST on each RTU panel, using a test plan prepared by the Contractor. The test plan shall be expanded and adapted as needed for each RTU panel.

C. The test shall confirm that all RTU panel equipment has been completely and correctly assembled and functions properly, prior to shipment to the field.

D. The RPST shall be first executed unwitnessed, followed by formal submission of test results.

E. The RPST will then be witnessed by Owner’s representatives. If any component or subsystem fails the RPST, the Contractor shall correct the problem and shall repeat the test until it is successful.

F. The RPST shall include the following phases, as described in this Specification:

1. Preparation.
2. Documentation Review.
3. Physical Inspection.
4. Electrical Testing.
5. Control Wiring Verification.

6. Hardwired Logic and Pilot Device Testing.
7. RTU I/O Verification.
8. UPS Verification.
9. 24-hour Energization.

G. Preparation:

1. The test procedure shall identify all required tools, instruments, networks, meters, jumpers, documentation, forms, procedures, and other items needed.
2. The test procedure shall identify access requirements, and safety and emergency procedures.
3. Execute preparations. Verify prior to commencing tests that preparations are complete.

H. Documentation Review:

1. The test procedures shall include step(s) with checkoffs to verify that correct and complete documentation is on hand. Allow for adequate copies of documents for those present for testing.

I. Physical Inspection:

1. Confirm panel internal layout against shop drawings.
2. Confirm external layout against shop drawings.
3. Confirm panel size, mounting.
4. Confirm panel labels/certifications.
5. Confirm existence of heating, ventilation, thermostat(s), filters, etc.
6. Aesthetics:
    a. Verify that there are no scratches or paint defects.
    b. Verify that there are no pencil marks or eraser marks.
    c. Verify that components are mounted square and symmetrical.
    d. Verify that nameplates meet specified requirements and are straight, legible, spelled correctly, and agree with Drawings.
    e. Verify operation of latches/handles/locks.
    f. Verify access and serviceability of components and devices.
    g. Confirm bracing, devices, anchorage, fastening.
7. Installation Readiness:
    a. Confirm that dimensions for conduit entry areas shown on footprint Drawings are correct and clear for use by the installer.
    b. Verify that no special provisions are needed for shipping or installations; or if needed, they are accounted for.
    c. Confirm that the panel physical size is as needed. Confirm that the panel will fit in the required space, and that the panel can be physically transported and moved into the space.
    d. If the panel is a backpanel to be installed in an existing enclosure, check arrangement, sizes, bolt locations, etc.

J. Control Wiring Verification:

1. With the panel de-energized, confirm each control wire at each end, as follows.

2. Use the elementary (shop) drawings for recordkeeping, using a yellow highlighter to track the work. Highlight each wire as checked.
3. At each termination:
    a. Pull.
    b. Verify no loose strands.
    c. Verify wire marking, and coincidence with shop drawings.
    d. Verify terminal number.
    e. Verify wire color.
4. At conclusion, initial and date the drawing(s) used to track the work.

K. Electrical:

1. Pre-energization:
    a. Verify circuit breaker locations and sizes.
    b. Verify fuse locations and sizes.
    c. Verify UPS general arrangement, size, connections, physical restraints, and agreement with Drawings.
    d. Verify transformer general arrangement, connections, and agreement with Drawings.
    e. Verify power supply general arrangement, connections, and agreement with Drawings.
    f. Verify wire colors.
    g. Verify wire labels, type, inscriptions.
    h. Verify terminal labels, field and internal.
    i. Verify ground connections, lugs, buses.
    j. Verify shielding, in particular single point of connection.
    k. Verify spare terminals.
    l. Review 2-wire/4-wire connections for instruments, power supplies arrangement, and fusing. Review terminal provisions allowing for future 4-wire connections where 2-wire connections are initially provided.
    m. Verify networked and related interconnections within the panel:
        1) Switches.
        2) Radios/routers.
        3) RTU networks.
        4) Other devices and interconnections.
2. Other Ratings:
    a. Verify panel NEMA rating.
    b. Verify temperature ratings of devices, with particular attention to networked components. Include ratings in test documents and in O&M documents.
    c. Review panel heating and cooling calculations, and predicted maximum/minimum temperatures.
    d. Verify ratings of dc power supplies, and confirm adequacy.
    e. Verify ratings of UPS's.
    f. Verify heater and fan ratings, as applicable.
3. Energization: The power distribution is to be systematically energized and voltages measured until the system is fully energized. All circuit breakers start in the OFF position. The following summarizes general steps for power distribution verification which shall be adapted to panel-specific requirements:
    a. Verify continuity for all DC commons, ground, and AC neutrals.

b. Verify that the panel's temporary input power is connected correctly and is the correct voltage, phase-to-phase, phase-to-neutral, phase-to-ground (as applicable).
c. Close the panel's main circuit breaker(s).
d. Verify that voltages at downstream circuit breakers are correct.
e. Close downstream circuit breakers.
f. Verify that power feeding interruptible and uninterruptible power supplies is correct.
g. Turn on power supplies if they are not already on.
h. Verify that voltages at distribution terminals are correct, including AC and DC.
i. Energize any remaining hardware such as the RTU, network devices.
j. Verify that UPS arrangements allow for bypassing the UPS. Where such a bypass is effected by a cord-and-plug bypass, check locations and lengths.

L. Pilot Device Testing:

1. Using the elementary (schematic) diagrams as the guide and for recordkeeping, verify on a device-by-device basis each rung of ladder logic. General requirements are described here. The test procedure shall enumerate the manner in which the tests will be undertaken and recorded.
2. Generally, "make" each rung (which will energize the relay or device), then verify each component in the string that is needed for continuity. Break/remove jumpered inputs, and see that the rung is no longer made, and highlight the device under test.
3. Check lights, switches, and push buttons.
4. Check sealing circuits and resets.
5. Check indicators and displays, using current/voltage sources as required.
6. Verify that contacts used in switching analog signals meet the specified requirements.

M. RTU I/O Verification:

1. Prepare a checking form for RTU I/O verification. Provide a programming computer, suitably configured, to observe register statuses and force outputs. The following summarizes the general steps to verify the RTU inputs and outputs; the Contractor shall develop detailed procedures and checklists:
   a. Discrete Inputs (DI) are checked with jumper wires at the field terminal blocks, or at the operator devices where the devices are part of the control panel:
      1) Where indicators are available, observe illumination on the input module to confirm the wiring.
      2) Observe state within RTU registers to ensure that the inputs have been mapped correctly.
   b. Discrete outputs (DO) are verified by forcing the output using a programming computer:
      1) Output relays should energize and, depending on contact configuration, provide continuity or an open circuit at field terminals in the control panel when forced. Verify.
2. Analog Inputs (AI) shall be verified using a digital loop calibrator to source a 4-20mA signal:
   a. Connect a loop calibrator (signal generator) to panel external terminals to provide the signals.
   b. Verify values within the RTU for 4mA, 12mA, and 20mA signals (0%, 50%, and 100% of full scale).

c. Verify out-of-range alarms.

3. Analog outputs (AO) are verified by forcing the output using a programming computer:
   a. Output signals are measured using a digital loop calibrator set to measure in the milliamp range.
   b. Output signals are verified for 4mA, 12mA, and 20mA signals (0%, 50%, and 100% of full scale).

N. UPS Verification:

1. Confirm discrete/networked UPS interface(s).
2. Remove commercial power; perform a UPS power duration test. Measure voltages/currents with readings taken every 5 minutes, or more frequently as appropriate. Verify against product published capacities.
3. As with all factory tests specified herein, execute the tests unwitnessed, submit results, and then execute witnessed. For the UPS duration test, provide comprehensive unwitnessed testing and test results. The Owner shall have the option of abbreviating the witnessed execution, with demonstration that the witnessed test results are tracking the unwitnessed test results.

O. 24-Hour Energization:

1. Following successful completion of the tests above, leave the panel energized for 24 hours. At the end of the interval, confirm that components remain powered up, and that none are in failed states.

P. After completion of the witnessed RPST, the Contractor shall prepare a test report and shall submit it for review. Subsequent factory testing shall not be commenced until the RPST has been successfully completed, although testing can commence immediately following a successful RPST, prior to formal submission of witnessed RPST results.

3.4 INTEGRATED SOFTWARE SHOP TEST (ISST)

A. The ISST is part of factory testing. The ISST involves work by the Contractor, plus work by others. The Contractor shall plan and oversee the entire ISST, including work by others.

B. The Contractor shall perform the ISST on the interconnected SCADA system using comprehensive test plans prepared by the Contractor, with test inserts by others. Test plans and results shall be formal submittals.

C. Allow the minimum duration for the witnessed ISST, as specified.

D. The test plans shall demonstrate that each component and system within the control system fully functions and meets the requirements of the Drawings and Specifications. General approaches to testing are not acceptable—the test plan shall lay out comprehensive testing on an activity-by-activity, point-by-point basis.

E. All networked devices shall be included in the tests. Communications links and components shall be included in the factory testing to verify the system, as a whole, operates correctly. The

Contractor shall coordinate and include provisions for simulating networked interfaces. The Contractor shall provide temporary cabling and interfaces to mock-up the field conditions.

F. Test plans shall include tag numbers for equipment, instruments, alarms, displays, operator interfaces, etc.; input/output addresses and ranges; out-of-range alarms; display ranges; and setpoints. Test plans shall be self-contained and shall be in sufficient detail to require little or no referencing to Contract Documents and/or other submitted documents during testing. All values, including ranges and setpoints, shall be included in submitted test plans so that the expected cause-and-effect relationship can be verified prior to the tests.

G. The Contractor shall coordinate and facilitate assembly of test procedures and test setups to prove data continuity from RTU panel terminals, to the OIP, and to the supervisory (SCADA) system. The factory mockup shall include:

1. All RTU panels including OIP's.
2. All site communications/networking equipment.
3. Either GWA/GPA-furnished access point radios/routers to simulate the other end of the communications links, or hardwired networking as a proxy.
4. GWA/GPA-furnished SCADA server(s) and networking hardware as proxies to the equipment at the Gloria P. Nelson Building. The Contractor shall also make available at their test facility a high-speed Internet connection at the test facility for GWA/GPA's use. At GWA's discretion, as an alternative to the "proxy" servers, conduct tests using the actual servers via the Internet connection.

H. The Integrated Software Shop Test consists of six software subtests:

1. Software Continuity Test (ISST-A)
2. Software Readiness Test (ISST-B)
3. System Interconnected Test (ISST-C)
4. System Remote Access Test (ISST-D)
5. SCADA User Interface Check (ISST-E)

I. The ISST's comprise an opportunity for Owners' representatives to be exposed to and operate the SCADA system, including local graphics and supervisory graphics, and all monitoring and control functionality. The ISST is not only for the Contractor's benefit to prove out functions, but for GWA's benefit as an initial exposure to the system. The Contractor shall anticipate that the ISST will not proceed at the ideal pace, due to Owner involvement, questions, and changes. The Contractor shall allow the durations as specified. The Contractor shall allow adequate time to make changes and corrections, and update/edit/correct drawings, control descriptions, and other documentation. The Contractor shall allow the following for Owner discretionary items, which fall above and beyond work required under the Contract Documents:

1. RTU Program Changes: 40 man-hours for a programmer, project-wide.
2. OIP screen changes: 40 man-hours for a programmer, project-wide.
3. RTU-panel Hardwired Changes: 8 hours for a technician, plus $200 materials and components, average per panel (the total can be allocated to any combination of work and panels for any combination of sites).

4. Documentation Updates: To document the Owner-initiated changes above, in addition to the allowances for the work project-wide, allow for 8 hours programmer, 8 hours clerical/word processing, and 8 hours draftsperson to update documentation.

J. Developing the scopes of the changes will occur during the ISST, as part of the ISST. The time allowances are for making and documenting the changes, and related testing if such testing occurs following the ISST.

K. The allowances above are not for corrections or fixes to Contractor's work but are for Owner initiated changes which affect and change items previously made firm through the submittal or workshop process. The intent of the allowance is to provide an efficient technique to respond to Owner requested changes which become evident in the course of factory or field testing. Such changes are a normal (and desirable) aspect of SCADA integrations, needed to deliver a high-functioning end-product.

L. Project documentation, including drawings, shall be updated for all changes made during testing. Documentation shall be updated and (re)distributed to Contractor personnel and installers following testing. Provide version control.

M. The allowances are applied to owner-initiated rework of previously completed Contractor work. During testing as these items come up, review with Owner's representatives the scopes of the changes, and document the changes and level of effort to implement them. The Contractor shall track work against the allowances. The allowance is to be considered in aggregate, with the total hours and total materials/expenses comprising the benchmark against which time spending against the allowance is needed. If the project total exceeds the allowance, then handle the work as would be done with any contract change. If the projected total is less than the allowance, no change in Contract price will be made.

3.5 ISST SETUP

A. The Contractor shall furnish and put in place all required test support provisions and develop all required test support simulators and interfaces. The following are representative requirements:

1. Physical space, dry, with adequate lighting, and free from temperature extremes or excessive wind.
2. Test procedures, lists, reference documentation. Instrumentation calibration/scaling references.
3. Tables, chairs.
4. 120-volt power source(s) and distribution.
5. Physical jumpers. Number and label jumpers, for accounting following testing (to avoid inadvertently leaving a jumper in place).
6. 4 to 20mA adjustable current source(s).
7. Current meter(s) and voltmeter(s).
8. Programming computers, to monitor and force values.
9. Predeveloped test user interfaces (such as pushbutton, selector switch, and indicating light assemblies, or equivalent), to provide convenient forcing and observation of values, where applicable.
10. Running log of physical jumper placements.

11. Running log of virtual jumpers.
12. Provisions to simulate other networked devices, as applicable.
13. Provisions to simulate radios/routers.
14. Provide color printers/cartridges/paper, which are not the project's, for printing screenshots and other documentation as test recordkeeping and punchlists.
15. Other hardware, devices, programming, setup, as required.
16. Space and interconnection provisions for GWA/GPA provided servers.
17. Internet connection and cabling.

B. Perform a pretest inventory:

1. Check components against Bills of Materials.
2. Perform a visual inspection of each device.
3. RTU programming:
    a. Review platforms, versions.
    b. Inventory RTU-related documentation, versions; confirm version control is in place.
4. Review networking setup:
    a. Check against block diagrams.
    b. Check against network diagrams from workshops.

3.6 SOFTWARE CONTINUITY TEST (ISST-A)

A. The Software Continuity Test shall verify signals from the hardware environment through the software environment, and also prove out routine and repeated functions.

B. Check RTU initialization:

1. Power up each RTU, and check that it proceeds to a running state without intervention.
2. Check successful execution of RTU self-checks.
3. Check indicators on the RTU components.

C. Check SCADA initialization (by GWA/GPA):

1. Power up servers, switches, and other SCADA devices from unpowered states, and check that each server and application proceed to a running state without intervention.
2. Check successful execution of self-checks.
3. Check indicators.
4. Verify initiation of SCADA software packages on the servers, as well as any other software required to be running to support SCADA.
5. Check server internal configurations/inventory and O.S. Syslog error checks.

D. Perform I/O checking. RTU I/O checking shall follow the general structure of previously executed RPST I/O checking. The RPST and ISST-A I/O testing together result in I/O being checked:

1. In the hardwired environment:
    a. Physical signals.
    b. Congruence with loop diagram terminal numbers/I/O point ID's.
2. As an appearance in a known, listed RTU location, unscaled.

3. Within the RTU, following signal conditioning and scaling.
4. Within the OIP:
    a. Graphical/numeric depiction.
5. Within SCADA:
    a. Graphics screen(s).
    b. Historian.
    c. Alarm screens.
    d. Remote alarm notification.

E. Verify all Discrete Inputs/Outputs for:

1. Presence in RTU.
2. Depiction on OIP.
3. SCADA screen functions, tag number, description.
4. Discrete alarms.
5. Presence in historian.
6. Remote alarm notification.

F. In conjunction with discrete inputs, check equipment runtime meters and start counters:

1. Presence in RTU and scaling.
2. Data type.
3. OIP screen functions.
4. SCADA screen functions, precision, units, tag number, description, scaling, and resets.
5. Presence in historian and scaling.

G. Verify all Analog Inputs for:

1. Presence in RTU.
2. Data type.
3. Proper RTU and SCADA scaling.
4. OIP functions.
5. SCADA screen functions, precision, units, tag number, description, and scaling.
6. Out of range alarms.
7. Presence in historian and scaling.

H. Verify Analog Outputs for:

1. Presence in RTU.
2. Data type.
3. RTU scaling.
4. OIP functions.
5. SCADA screen functions, precision, units, tag number, description, and scaling.
6. Presence in historian and scaling.

I. For flow totalizers, verify:

1. Presence in RTU and scaling.
2. OIP functions.

3. SCADA screen functions, precision, units, tag number, description, and scaling.
4. Totalization of flow inputs.
5. Totalization of calculated (summed) flows.
6. Resets of flow totals.
7. Zeroing for “near-zero” flow figures.
8. Out-of-range alarms.
9. Presence in historian, and scaling.

J. Verify System Statuses:

1. SCADA status screens.
2. RTU module failure. Alarms and displays.
3. RTU system failure. Alarms and displays.
4. Communications failure (SCADA to RTU) for each RTU.
5. Network monitoring, network device failures.
6. Other failures.

K. Verify other functions as required.

3.7 SOFTWARE READINESS TEST (ISST-B)

A. The Software Readiness Test shall cover derivatives of the basic inputs and outputs, to establish the prerequisites to successful automatic operation.

B. Verify Analog Alarms:

1. SCADA screen functions:
   a. Alarm indicators, appearance, text, tags.
   b. Alarm summary display.
   c. Alarm history display.
   d. Alarm acknowledgment.
   e. Remote alarm notification.
   f. Alarm delays as required.
2. Setpoints:
   a. User Access/privilege.
   b. Units, precision.
   c. Input range limiting.
   d. Alarm setpoint limits.
3. Process variable alarms.

3.8 SYSTEM INTERCONNECTED TEST (ISST-C)

A. This testing shall include normal operations as well as failures of the interconnected system, and also includes network benchmark testing. Prior to scheduling testing, solicit and incorporate GWA’s test procedures. Procedures should completely verify normal interconnected functionality, individual failures, multiple failures, and restarts. The following tests are representative.

B. This test is largely for the benefit of GWA/GPA, as part of their role in effecting overall SCADA integration. The Contractor's participation is one of support.

C. Communications:

1. Verify OIP and SCADA screen functions.
2. Obtain real-time status information for networked devices, print screen.
3. Control network component failure.
4. Supervisory network component failure.
5. SCADA master time test:
   a. All computers and RTU's shall be shown to automatically update in accordance with SCADA practices in use.
6. Test failure and restoration of each communications link. Verify locally cached data is properly uploaded.

D. RTU fail and recovery:

1. Verify OIP and SCADA screen functions.
2. Power down, then power up each RTU and verify alarms.
3. Verify alarm masking on loss of power (only alarm the power loss).

E. Fail each power supply or bus, observe and record system response.

F. Verify proper restart(s) following loss of/restoration of commercial power with no manual intervention (other than actions required to simulate loss and restoration of power during testing).

G. SCADA component fail:

1. Verify OIP and SCADA screen functions.
2. Fail each server, verify alarm and functionality. Restore, confirm resumption of functions.
3. Fail each network switch/device and verify response. Restore, confirm resumption of functions.
4. Simulate the historian architecture, including data paths. Fail each historian, and related servers, and verify response. Restore, confirm resumption of functions.

H. Network Performance:

1. Test all elements of the Ethernet network system to ensure the system meets functional requirements of the SCADA system. Testing shall include:
   a. Network devices bench tests: Power up every network device and review the following:
      1) Hardware/software inventory: All devices present and configured.
      2) All device hardware and line cards power up properly and successfully pass self-test diagnostics.
      3) Syslog error checking.
   b. Circuit/Link tests: All circuits/links wireless and wired should be passing traffic in an error-free state. Use industry-approved testing tools to test:
      1) Throughput
      2) Delay

3) Packet loss
4) Jitter
5) Errors

c. Routing tests:
1) Adjacencies
2) Convergence
3) Routing table consistency
4) Traffic reroutes around link failures.

d. Traffic tests: End-to-end traffic testing to all end points.

e. Network service tests:
1) Per GWA/GPA requirements.

I. Power Recovery/Response:

1. Power up the entire system from a power down state and verify automatic restart of all communications and SCADA functions such that the entire SCADA system is functional.

3.9 SYSTEM REMOTE ACCESS TEST (ISST-D)

A. The SCADA System Remote Access Test shall verify components related to remote access. The first aspect is remote notification of any alarms assigned to be called out (typically high priority alarms); the second aspect is remote access to the SCADA graphical user interface. Provide testing of firewall appliances.

B. This test is largely for the benefit of GWA/GPA, as part of their role in effecting overall SCADA integration. The Contractor's participation is one of support.

C. Solicit GWA's test procedures, and support tests of the following:

1. Alarm Notification:
a. Select an alarm condition that is identified as requiring remote notification.
b. Activate selected alarm condition, and verify the alarm is received via mobile device(s).
c. Acknowledge alarm, and verify alarm callout ceases.
d. Repeat activation of alarm condition, but do not acknowledge alarm. Verify alarm remote notification is re-initiated and/or notification is received at secondary device, or call is initiated to second recipient as required.
e. Repeat test for every alarm condition requiring remote notification.

2. SCADA Remote Access:
a. Power on Remote Access Device.
b. Initiate a connection to SCADA via Terminal Services or methodology in use.
c. Log on.
d. Verify that the HMI opens automatically.
e. Log into the HMI using SCADA login credentials.
f. Verify live data are updating on the screen.
g. Demonstrate remote setpoint adjustment capability (with appropriate privilege).

3.10 SCADA USER INTERFACE CHECK (ISST-E)

A. Coincidental with the ISST and/or following the ISST, execute a checklist which compares site arrangements with the SCADA screens with OIP screens, on a screen-by-screen, point-by-point basis. And even though configuration of the SCADA screens is not in this Contractor's scope, the checking of these screens, with the participation of GWA representatives, is in this scope. Prepare checklists which cover all aspects of the user interface, including the following:

1. System-wide characteristics:
    a. Screen layouts, consistency.
    b. Use of colors, animation.
    c. Structure, size, locations of popups.
    d. Navigation.
    e. Depictions of static/dynamic/invalid values.
    f. Login/logout.
    g. Security/access/limitations.
    h. Results from workshops, meetings, other decisions.
    i. Other characteristics.
2. Screen-by-screen review:
    a. Provide checkoffs screen-by-screen, with locations to note deficiencies, corrections, etc.
    b. As part of ISST-E, assemble the following documents:
        1) Standards.
        2) Workshop agendas, minutes.
        3) Other materials documenting user-interface decisions.
    c. Review the documents above, markup, confirm that the SCADA system conforms to the decisions and/or update the documents to match the approach taken.

3.11 STARTUP

A. Following installations, prior to any testing, perform all required startup activities. Where called for elsewhere in these Specifications, provide the services of factory-trained specialists.

B. As part of startup checkout, calibrate each instrument and prepare a datasheet as shown in Section, 40 90 00. For instruments furnished under this project, perform startup calibration and testing as recommended by the manufacturer. In all cases, verify that field scaling, scaling within the RTU, and scaling in SCADA are consistent.

C. Field Calibration Testing:

1. Field test and calibrate all control systems and instrumentation in accordance with the reviewed Test Procedure submittals and the manufacturer's instructions.
2. Field test/calibration datasheets shall be submitted to the Engineer to show that the equipment has achieved the specified performance and accuracy. Specifically indicate analog channel scale values at zero and span on datasheets.
3. Accuracy shall be within the specified tolerance. Accuracy shall also be within the manufacturer's stated tolerance.
4. Field testing shall include all discrete and analog loops.

3.12 FIELD TESTING OVERLAP WITH FACTORY TESTING

A. Some of the field tests overlap with factory tests. The Contractor is encouraged to approach the testing in a holistic and structured manner, to enjoy economies in test procedure development and execution.

B. The Owner will consider abbreviating selected field tests for cases where the functions were fully factory tested. Any proposal for abbreviation shall be made as part of formal test procedure submittals. Examples include testing of hardwired functions which are wholly within an enclosure, repetitive functions, and other functions where field performance is expected to be redundant with and exactly match what is seen in the factory.

C. The Owner is under no obligation to agree to abbreviate field testing. The Contractor is advised that well-structured and comprehensive factory tests, with disciplined and complete recordkeeping, increase the likelihood that certain tests can be abbreviated in the field.

D. Factory tests shall not be abbreviated.

3.13 OPERATIONAL READINESS TESTING (ORT)

A. All equipment and systems shall be inspected and tested to show that they are ready for operation. This process includes installation and manufacturer/supplier recommended work, followed by a series of formal Operational Readiness Tests (ORT). The Contractor shall provide labor, equipment, and material to perform the ORT. The ORT may be broken into multiple ORTs, to test portions of the project as they become available. Each ORT shall be tailored to the configuration at hand.

B. The tests shall be performed from test plans prepared by the Contractor.

C. Due to the nature of startups, equipment and systems may become available for ORT at various times. ORT need not occur at one time, but the test records must be cohesive and integrated.

D. Keep a daily log for ORT.

3.14 INSTRUMENT ORT'S

A. Start up, calibrate, and range all instruments, setpoint controls, power supplies, and other electrical and electronic devices that require calibration, configuration, or setup.

3.15 RTU PANEL INSTALLED TEST (RPIT)

A. RTU Panel Installed Tests are part of the ORT. The Contractor shall inspect the installed RTU panels and verify the following:

1. The cabinet and components are not damaged.
2. Any items removed for shipping were re-installed.

3. All components are installed, and field wiring has been completed.

B. The Contractor shall terminate power source, test voltages/phasing, energize the cabinets, and power up the components.

C. Verify that all power supplies are operating.

D. Verify that all RTU components are installed and are operating.

E. Verify that all communications and networking components are installed and communicating with other components.

F. Verify that all field wiring is terminated and is in agreement with the Drawings in existence, size, color, and wire labels.

G. Verify each networked connection within the RTU.

H. Power up network components on each end of each cable. Verify indications showing continuity. End-to-end test each cable with industry standard test equipment, and certify each.

I. Using shop drawings, schedules, and/or Contract Drawings, perform a wire-by-wire, patch cable-by-patch cable verification of interconnection. Verify each existence/label in the field, and place checkmarks on the Drawings and schedules to indicate agreement for:

1. Color
2. Wire Identification
3. Port Identification

J. Submit test results. Incorporate the marks/results into as-built project records.

3.16 WIRELESS NETWORK READINESS TEST (WRT)

A. Wireless Network Readiness Tests are part of the ORT. Prior to testing, solicit GWA/GPA test procedure contributions. The Contractor's baseline requirement (regardless of any GWA/GPA input), is to verify connectivity of the site with the Island-wide mesh network.

B. Prepare and submit a procedure, checklist, and accompanying drawings for the WRT in advance of the WRT, for each site.

C. Energize the components at each site and verify correct labeling, addressing, and configuration. Archive configurations for delivery to the Owner with the test results submittal, and include the configuration files in the O&M manual both in print form and digital form usable for restoring the components to service should it require future replacement.

D. For each site, verify proper configuration and operation of the network, including (but not limited to) the following:

1. Verify connectivity from the site node to the Island-wide mesh network.

2. Verify signal strength.
3. For roving access, verify signal strength throughout the designated local service area.
4. Utilize GPA's wireless system reporting and management software wherever useful to assist in qualification of the wireless paths and routing. Incorporate the reports in the testing protocol and final submittal.
5. Testing is to include throughput, delay, jitter, packet loss and errors and/or other parameters. Test results should be compared to benchmarks and differences noted in the test submittal.

3.17 LOOP ACCEPTANCE TEST (LAT)

A. Loop Acceptance Tests are part of the ORT. Loop acceptance tests shall track signals from the points of origin in the field, through hardwired circuits in to RTU inputs, at RTU registers, and further in the supervisory environment including displays, databases, and alarm notification. The tests shall prove coincidence, senses, scaling, and continuity to all locations within the hardware and software environments. The test forms shall, by their structure, illustrate this continuity.

B. To completely execute the Loop Acceptance Test (LAT), all other ORT must be essentially complete to provide the full signal path from origin to destination.

C. For convenience, LAT may be split up between areas, sites, and other boundaries. For example, LAT may first be executed to RTU registers, then later picked up at RTU registers and tracked to locations and functions within the supervisory environment. For this approach, use a portable computer with RTU software to observe and force values within the RTU. Test records shall explicitly show the points of demarcation and include verification of the boundary points with each successive test.

D. Provide detailed test forms for LAT, including checkoff boxes for each signal tested, at each location. Test records shall be logical and complete and provide evidence of continuity of signals from origin to each ultimate destination.

E. For each and every analog and discrete circuit, verify the proper operation of all hardwired circuits, functions, and logic.

F. Each analog loop shall be tested at three points: Zero, midspan, and span. Overall loop accuracy shall fall within the sum of the accuracies of the loop components.

G. For each and every analog and discrete circuit, perform end-to-end testing. This includes, but is not limited to, all local control panels, MCCs, and hardwired circuits in control panels. For each input, activate the signal at the primary field device, either by creating necessary process and equipment conditions or by disconnecting the wires at the field device and simulating the input signal. Given the factory testing observed inputs within the RTU environment, the LAT may observe the "effects" within the supervisory environment including displays, local alarm notification, remote alarm notification, and data history. For each output signal from the RTU, activate the RTU output signal using functions available at the supervisory level, or in cases where they are not available, by using the RTU programming software, and verify proper receipt of the signal at the controlled device in the field, either by observing equipment operation or by disconnecting the wires at the equipment and verifying proper receipt of the signal. Verify proper signal receipt at all intermediate devices, such as indicators, signal trip and relay modules, etc.

H. LAT shall be witnessed by the Owner's representative. Contractor shall provide all necessary personnel to perform LAT without assistance from Owner or the Engineer.

I. In general, the LAT is a two (or more) person test. The Contractor shall provide personnel to operate equipment or simulate signals that are to be verified as part of this test. The Contractor shall record test results, both locally and at a SCADA workstation at the Gloria P. Nelson Building. The Contractor shall provide cell phones or voice radios for test coordination and execution.

3.18 FUNCTIONAL ACCEPTANCE TEST (FAT)

A. Following the ORT, perform functional testing in accordance with the requirements specified herein.

B. Testing shall be performed by the Contractor and shall be coordinated with testing of equipment and systems covered under other sections of these Specifications.

C. With the sequential commissioning of sites, the FAT will need to be executed in multiple sessions over the course of the project. The procedures similarly can be developed and submitted in portions, but the final test record shall be comprised of a single integrated record. The Contractor is encouraged to submit a representative FAT procedure for review prior to developing all FAT procedures.

D. For each FAT portion, the Contractor shall prepare a test plan and shall submit it for review at least 30 days before testing is performed. As part of the test plan, the Contractor shall list the personnel who will be present to assist with and witness the functional testing. This list shall include any Contractor's personnel, subcontractors, suppliers' representatives, and other necessary personnel.

E. Testing shall operate all equipment and systems over the full operating ranges, shall demonstrate proper operation of alarms and indicators, and, in general, shall demonstrate that the equipment and systems meet the requirements of the Drawings and Specifications.

F. Functions need to be verified locally (at the OIP) and at the supervisory (SCADA) level. Even though SCADA screen development is not by the Contractor, at the time of executing the FAT the screens and related structures should be fully up and running, and the Contractor's procedures and test execution shall verify all site functions both locally and at SCADA. GWA will provide Contractor access to a SCADA workstation at the Gloria P. Nelson Building, and the Contractor shall verify functionality both locally and within the supervisory system. The Contractor shall provide voice radios or cell phones for test coordination.

G. Each alarm configured for remote notification shall be tested, with validation of notification details, including tracking of delays from initiation to receipt, acknowledgment, and other aspects of alarm notification.

H. Actual process conditions should be used where feasible. Where not feasible, process conditions can be imposed by simulation and/or software forcing. The Contractor shall keep a detailed log of each forced jumper/simulation and at the end of testing, review the log and check off the removal of each force.

I. If any equipment or system fails the test, the Contractor shall correct the problem and shall repeat the test until it is successful.

J. Testing shall be performed in the presence of the Engineer and Owner.

K. Keep a daily log for the FAT.

L. After completion of the FAT, the Contractor shall prepare a test report and shall submit it for review. The system will not be accepted before the functional testing is successfully completed and the test report submitted to and reviewed by the Engineer.

3.19 14-DAY OPERATIONAL TEST

A. Following successful FAT, commence the 14-day Operational Test.

B. During the test period, Contractor's portion of the SCADA system is expected to operate free of errors and omissions, with the exception of the permissible communications error rates noted herein.

C. Should any failures occur during the test period they shall be documented, remedied, and applicable FAT on other tests undertaken.

D. Failures will be reviewed by the Owner and the Engineer to determine if they warrant restart of the 14-day operational test. Whether a failure warrants a restart shall be at the discretion of the Owner and the Engineer. Generally, significant failures will warrant a restart to the 14-day operational test.

3.20 FIELD SUPPORT

A. Provide the services of experienced, factory-trained service engineers or technicians to assist with installation, checkout, startup, testing, and support of each installation, as specified in Section 40 90 00.

3.21 SUBMISSION OF INTEGRATED TEST RECORDS

A. Testing will occur at various locations and times throughout the development and commissioning process.

B. Test plans and test reports shall be submitted as the project progresses, as specified.

C. At the conclusion of the project, assemble an integrated test record, covering the following tests:

1. Volume 1 – Factory Tests
2. Volume 2 – Operational Readiness Tests
3. Volume 3 – Functional Acceptance Tests and Operational Tests

D. Provide a summary sheet at the beginning of each test, which includes the following:

1. Test name.
2. Area(s) covered.
3. Test date(s).

E. Organize the material logically, with printed tabs.

F. Submit one bound hardcopy, and electronically as pdf's.

G. In addition, as specified elsewhere, provide as-built project records, including tabulations of device configurations and settings.

END OF SECTION 409637

Contractor to submit product data for GWA review and confirmation prior to ordering. The following is an example of an manufacturer order form.

Endress+Hauser
People for Process Automation

Number
Dated
Valid to

External Sales

Inside Sales
Telephone

If you have any concerns about the suitability of the items on this quote for your application, get in touch. We will be happy to discuss any questions you may have.

Summary

Item	Qty	Product	Delivery time	Net value (USD)
10	1 PC	Promag W 500, 5W5B3H, DN300 12" 5W5B3H-4LQ8/101 (5W5B3H-CSEEMABAAFBAD5DUA1KGAA2 +AACBDBDHECI7L463Z1Z2) Electro-Magnetic, Premium		Unit price
20	1 PC	Promag W 500, 5W5B3H, DN300 12" 5W5B3H-4LQ8/101 (5W5B3H-CSEEMABAAFBAD5DUA1KGAA2 +AACBDBDHECI7L463Z1Z2) Electro-Magnetic, Premium		Unit price

Endress+Hauser Inc.
Toll Free - 888-ENDRESS
FAX - 317-535-8498
www.us.endress.com

Regional Centers:
East - Chalfont, PA 18914
Gulfcoast - Pearland, TX 77047
Midwest - Greenwood, IN 46143
West - Pearland, TX 77047

Remit To:
ENDRESS+HAUSER -DEPT 78795
P.O. Box 78000
DETROIT, MI 48278-0795

Total prices:	
Logistic Service	
Net value	
Sales Tax Total	
Total including tax (USD)	

Consignee

Payment term

Incoterms

Warranty

Delivery time

Details

Item	Qty	Product	Net value (USD)
10	1 PC	Promag W 500, 5W5B3H, DN300 12" 5W5B3H-4LQ8/101 (5W5B3H-CSEEMABAAFBAD5DUA1KGAA2 +AACBDBDHECI7L463Z1Z2) EDI-Orderref.: 2003357371-0010 Unit price Electromagnetic flowmeter Inline version. Application: Dedicated to the measurement of industrial or municipal water and wastewater. International drinking water approvals. Installation length: DVGW/ISO conform. Remote version. 4-line display, touch control. :: Specialist for Water + Wastewater; remote version with up to 4 I/Os. :: Constant accuracy with 0 x DN inlet run and no pressure loss (optional).	

Delivery time 28 wrk.day(s)

Order code description

CS	Approval; Transmitter; Sensor: CSA C/US; Cl.I Div.2,NI; Cl.I Div.2
E	Design: Fixed flange
E	Power Supply: 100-230VAC
MA	Output; Input 1: Modbus RS485
B	Output; Input 2: 4-20mA
A	Output; Input 3: W/o;
A	Output; Input 4: W/o;
F	Display; Operation: 4-line illum.; touch control
B	Integrated ISEM Electronic: Transmitter
A	Transmitter Housing: Alu, coated
D	Sensor Junction Housing: Polycarbonate, sensor fully welded
5	Cable, Sensor Connection: 650.00 ft remote coil and signal cable
D	Electrical Connection: Thread NPT1/2
U	Liner: Polyurethane
A1K	Process Connection: Cl.150, carbon steel, flange ASME B16.5
G	Electrodes: 1.4435/316L, bullet nose
A	Calibration Flow: 0.5%

Item	Qty	Product	Net value (USD)

A2	Device Model: 2
AA	>Operation Language Display: English
CB	>>Sensor Option: IP68, Type 6P, Fact-potted corrosion protection EN ISO 12944 C5-M/Im1
DB	>>Customized Parameterization: Output 2
DH	>>Customized Parameterization: Display; Totalizer
EC	>>Application Package: ECC electrode cleaning
I7	>>Service: Product documentation on paper
L4	>>Additional Approval: NSF 61 drinking water approval
63	>Firmware Version: 01.05.zz, Modbus RS485, DevRev06
Z1	>>Marking: Tagging (TAG), see additional spec.
Z2	>>Marking: Bus address, see additional spec.

Details

Curr. output 1	Volume flow	
Current span	4...20 mA NAMUR	
4 mA value	10,000.00000-	USgal/min
20 mA value	10,000.00000	USgal/min
Failsafe mode current output	Max.	
Damping output 1	1.00000	s
Format display	1 value large + 2 values	
Value 1 display	Volume flow	
Value 2 display	Totalizer 1	
Value 3 display	Totalizer 2	
Value 4 display	None	
Display damping	1.00000	s
Totalizer 1		
Unit		USgal
Operating mode totalizer	Forward flow total	
Failure mode	Stop	
Totalizer 2		
Unit		USgal
Operating mode totalizer	Reverse flow total	
Failure mode	Stop	
Totalizer 3		
Unit		USgal
Operating mode totalizer	Net flow total	
Failure mode	Stop	

Device 1

Bus address (50098736)

3

Item	Qty	Product	Net value (USD)

1x TAG-stainless steel label (50105107)

FIT-201

Santa Rita Inlet

Country of origin:	Country of dispatch:	HS-Code:
FR	US	9026105000

CH Dual-Use Goods List to Iran-Regulation; not listed
CH Dual-Use Goods List; not listed
EC Dual-Use Goods List to Iran-Regulation; not listed
EC Dual-Use Goods List to Russia-Regulation; not listed
EC Dual-Use Goods List; not listed

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20 1 PC Promag W 500, 5W5B3H, DN300 12"
5W5B3H-4LQ8/101
(5W5B3H-CSEEMABAAFBAD5DUA1KGAA2
+AACBDBDHECI7L463Z1Z2)

EDI-Orderref.: 2003357371-0020 Unit price

Electromagnetic flowmeter
Inline version.
Application: Dedicated to the measurement of industrial or municipal water and wastewater.
International drinking water approvals.
Installation length: DVGW/ISO conform.
Remote version.
4-line display, touch control.
:: Specialist for Water + Wastewater; remote version with up to 4 I/Os.
:: Constant accuracy with 0 x DN inlet run and no pressure loss (optional).

Delivery time 28 wrk.day(s)

Order code description

CS Approval; Transmitter; Sensor: CSA C/US; Cl.I Div.2,NI; Cl.I Div.2
E Design: Fixed flange
E Power Supply: 100-230VAC

Item	Qty	Product	Net value (USD)
MA		Output; Input 1: Modbus RS485	
B		Output; Input 2: 4-20mA	
A		Output; Input 3: W/o;	
A		Output; Input 4: W/o;	
F		Display; Operation: 4-line illum.; touch control	
B		Integrated ISEM Electronic: Transmitter	
A		Transmitter Housing: Alu, coated	
D		Sensor Junction Housing: Polycarbonate, sensor fully welded	
5		Cable, Sensor Connection: 650.00 ft remote coil and signal cable	
D		Electrical Connection: Thread NPT1/2	
U		Liner: Polyurethane	
A1K		Process Connection: Cl.150, carbon steel, flange ASME B16.5	
G		Electrodes: 1.4435/316L, bullet nose	
A		Calibration Flow: 0.5%	
A2		Device Model: 2	
AA		>Operation Language Display: English	
CB		>>Sensor Option: IP68, Type 6P, Fact-potted corrosion protection EN ISO 12944 C5-M/Im1	
DB		>>Customized Parameterization: Output 2	
DH		>>Customized Parameterization: Display; Totalizer	
EC		>>Application Package: ECC electrode cleaning	
I7		>>Service: Product documentation on paper	
L4		>>Additional Approval: NSF 61 drinking water approval	
63		>Firmware Version: 01.05.zz, Modbus RS485, DevRev06	
Z1		>>Marking: Tagging (TAG), see additional spec.	
Z2		>>Marking: Bus address, see additional spec.	

Details

Curr. output 1	Volume flow
Current span	4...20 mA NAMUR
4 mA value	10,000.00000- USgal/min
20 mA value	10,000.00000 USgal/min
Failsafe mode current output	Max.
Damping output 1	1.00000 s
Format display	1 value large + 2 values
Value 1 display	Volume flow
Value 2 display	Totalizer 1
Value 3 display	Totalizer 2
Value 4 display	None

Item	Qty	Product	Net value (USD)

Display damping	1.00000 s	
Totalizer 1		
Unit	USgal	
Operating mode totalizer	Forward flow total	
Failure mode	Stop	
Totalizer 2		
Unit	USgal	
Operating mode totalizer	Reverse flow total	
Failure mode	Stop	
Totalizer 3		
Unit	USgal	
Operating mode totalizer	Net flow total	
Failure mode	Stop	

Device 1

Bus address (50098736)

4

1x TAG-stainless steel label (50105107)

FIT-202

Santa Rita Outlet

Country of origin:	Country of dispatch:	HS-Code:
FR	US	9026105000

CH Dual-Use Goods List to Iran-Regulation; not listed
CH Dual-Use Goods List; not listed
EC Dual-Use Goods List to Iran-Regulation; not listed
EC Dual-Use Goods List to Russia-Regulation; not listed
EC Dual-Use Goods List; not listed

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BID FORM

ARTICLE 1 - BID RECIPIENT

1.01 This Bid is submitted to:

Guam Waterworks Authority
Gloria B. Nelson Public Service Building
688 Route 15, Mangilao, Guam 96913

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a Contract with Buyer in the form included in the Bidding Documents to furnish the Goods and Special Services as specified or indicated in the Bidding Documents, for the prices and within the times indicated in this Bid, and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 - BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Buyer.

ARTICLE 3 - BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, the related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date

B. Bidder has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided and become familiar with and is satisfied as to the observable local conditions that may affect cost, progress, or the furnishing of Goods and Special Services, if required to do so by the Bidding Documents, or if, in Bidder's judgment, any local condition may affect cost, progress, or the furnishing of Goods and Special Services.

C. Bidder is familiar with and is satisfied as to all Laws and Regulations in effect as of the date of the Bid that may affect cost, progress, and the furnishing of Goods and Special Services.

D. Bidder has carefully studied, considered, and correlated the information known to Bidder; information commonly known to sellers of similar goods doing business in the locality of the Point of Destination and the site where the Goods will be installed or where Special Services will be provided; information and observations obtained from Bidder's visits, if any, to the Point of Destination and the site where the Goods will be installed or Special Services will be provided; and any reports and drawings identified in the Bidding Documents regarding the Point of Destination and the site where the Goods will be installed or where Special Services will be provided, with respect to the effect of such information, observations, and documents on the cost, progress, and performance of Seller's obligations under the Bidding Documents.

E. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution (if any) thereof by Engineer is acceptable to Bidder.

F. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing the Goods and Special Services for which this Bid is submitted.

ARTICLE 4 - BIDDER'S CERTIFICATIONS

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Buyer, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process.

ARTICLE 5 - BASIS OF BID

5.01 Bidder will furnish the Goods and Special Services in accordance with the Contract Documents for the following price(s):

GUAM WATERWORKS AUTHORITY
PRESSURE ZONE REALIGNMENT CONSTRUCTION PHASE 1
GWA Project No. W18-001-BND

BID SCHEDULE

Interested Bidders must complete Table A. All blanks in the tables must be filled out.

Definitions:

LS = lump sum

TABLE A
BID SCHEDULE

(BASE BID ITEMS NO. 1 – 18)

Item No.	Description	Quantity	Unit	Extended Amount
1.	Mobilization, as specified in the Contract Documents.	1	LS	$ _____
2.	Bonds and insurance.	1	LS	$ _____
3.	Permits.	1	LS	$ _____
4.	Training budget (SCADA, meters, control valve, and pump manufacturer training off-island including training cost, airfare, hotel, car rental and per diem)	1	LS	$ 120,000
5.	Asan Meter:			
	5.1 Traffic control	1	LS	$ _____
	5.2 Stainless steel meter box	1	LS	$ _____
	5.3 20” meter	1	LS	$ _____
	5.4 Concrete pedestal	1	LS	$ _____
	5.5 Site and pavement restoration	1	LS	$ _____
	5.6 Commissioning/demonstration	1	LS	$ _____
	5.7 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____

Item No.	Description	Quantity	Unit	Extended Amount
6.	Talofofo Meter:			
	6.1 Traffic control	1	LS	$ _____
	6.2 Meter vault installation	1	LS	$ _____
	6.3 Meter, piping and connections	1	LS	$ _____
	6.4 Site and pavement restoration	1	LS	$ _____
	6.5 Potholing	1	LS	$ _____
	6.6 Commissioning/demonstration	1	LS	$ _____
	6.7 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____
7.	Sinajana Meter:			
	7.1 Traffic control	1	LS	$ _____
	7.2 Meter vault installation	1	LS	$ _____
	7.3 Meter, piping and connections	1	LS	$ _____
	7.4 Site and pavement restoration	1	LS	$ _____
	7.5 Potholing	1	LS	$ _____
	7.6 Commissioning/demonstration	1	LS	$ _____
	7.7 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____
8.	East Agana Meter:			
	8.1 Traffic control	1	LS	$ _____
	8.2 Meter vault installation	1	LS	$ _____
	8.3 Meter, piping and connections	1	LS	$ _____
	8.4 Site and pavement restoration	1	LS	$ _____
	8.5 Potholing	1	LS	$ _____
	8.6 Commissioning/demonstration	1	LS	$ _____
	8.7 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____

Item No.	Description	Quantity	Unit	Extended Amount
9.	Dairy Road PRSV:	1	LS	$ _____
	9.1 Potholing	1	LS	$ _____
	9.2 Traffic control	1	LS	$ _____
	9.3 Abandonment of pipe	1	LS	$ _____
	9.4 Vault	1	LS	$ _____
	9.5 12" PRSV	1	LS	$ _____
	9.6 12" meter	1	LS	$ _____
	9.7 Piping and connections	1	LS	$ _____
	9.8 SCADA, instrumentation and controls	1	LS	$ _____
	9.9 Commissioning/demonstration	1	LS	$ _____
	9.10 Site and pavement restoration	1	LS	$ _____
	9.11 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____
10.	Army Drive PRSV:			
	10.1 Potholing	1	LS	$ _____
	10.2 Traffic control	1	LS	$ _____
	10.3 Abandonment of pipe	1	LS	$ _____
	10.4 Vault	1	LS	$ _____
	10.5 8" PRSV	1	LS	$ _____
	10.6 12" PRSV	1	LS	$ _____
	10.7 8" meter	1	LS	$ _____
	10.8 12" meter	1	LS	$ _____
	10.9 Piping and connections	1	LS	$ _____
	10.10 Electrical system	1	LS	$ _____
	10.11 SCADA, instrumentation and controls	1	LS	$ _____
	10.12 Commissioning/demonstration	1	LS	$ _____
	10.13 Site and pavement restoration	1	LS	$ _____
	10.14 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____
11.	Tri-Intersection PRV Abandonment:			
	11.1 16" PRV removal	1	LS	$ _____
	11.2 Pipe and valve removal	1	LS	$ _____
	11.3 Pipe and connections	1	LS	$ _____
	Subtotal	1	LS	$ _____

Item No.	Description	Quantity	Unit	Extended Amount
12.	Gayinero PRSV:			
	12.1 Potholing	1	LS	$ _____
	12.2 Traffic control	1	LS	$ _____
	12.3 Vault	1	LS	$ _____
	12.4 12” meter	1	LS	$ _____
	12.5 12” PRSV	1	LS	$ _____
	12.6 Piping and connections	1	LS	$ _____
	12.7 Demolish vault and piping	1	LS	$ _____
	12.8 Electrical system	1	LS	$ _____
	12.9 SCADA, instrumentation and controls	1	LS	$ _____
	12.10 Commissioning/demonstration	1	LS	$ _____
	12.11 Site and pavement restoration	1	LS	$ _____
	12.12 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____
13.				
	Route 15 Connection:			
	13.1 Potholing	1	LS	$ _____
	13.2 Traffic control	1	LS	$ _____
	13.4 Piping and connections	1	LS	$ _____
	13.5 Instrumentation	1	LS	$ _____
	13.6 Commissioning/demonstration	1	LS	$ _____
	13.7 Site and pavement restoration	1	LS	$ _____
	Subtotal	1	LS	$ _____
14.				
	Larson Road PRSV/Meter			
	14.1 Potholing	1	LS	$ _____
	14.2 Traffic control	1	LS	$ _____
	14.3 Vault	1	LS	$ _____
	14.4 6” meter	1	LS	$ _____
	14.5 Piping and connections	1	LS	$ _____
	14.6 6” PRSV	1	LS	$ _____
	14.7 Electrical system	1	LS	$ _____
	14.8 SCADA, instrumentation and controls	1	LS	$ _____
	14.9 Commissioning/demonstration	1	LS	$ _____
	14.10 Site and pavement restoration	1	LS	$ _____
	14.11 site Survey	1	LS	$ _____
	Subtotal	1	LS	$ _____

Item No.	Description	Quantity	Unit	Extended Amount
15.	Nimitz Hill Waterline and PRSV	1	LS	$ _____
	15.1 Potholing	1	LS	$ _____
	15.2 Traffic control	1	LS	$ _____
	15.3 Vault	1	LS	$ _____
	15.4 Piping and connections	1	LS	$ _____
	15.5 6" PRSV	1	LS	$ _____
	15.6 Waterline replacement	1	LS	$ _____
	15.7 Service and waterline connection	1	LS	$ _____
	15.8 Commissioning/demonstration	1	LS	$ _____
	15.9 Site and pavement restoration	1	LS	$ _____
	15.10 Site survey for PRSV	1	LS	$ _____
	Subtotal	1	LS	$ _____
16.	Latte Height PRSV			
	16.1 Potholing	1	LS	$ _____
	16.2 Traffic control	1	LS	$ _____
	16.3 Infill wall	1	LS	$ _____
	16.4 Piping and connections	1	LS	$ _____
	16.5 8" PRSV	1	LS	$ _____
	16.6 8" meter	1	LS	$ _____
	16.7 Electrical system	1	LS	$ _____
	16.8 SCADA, instrumentation and controls	1	LS	$ _____
	16.9 Commissioning/demonstration	1	LS	$ _____
	16.10 Site and pavement restoration	1	LS	$ _____
	Subtotal	1	LS	$ _____
17.	Hawaiian Rock PRSV			
	17.1 Potholing	1	LS	$ _____
	17.2 Traffic Control	1	LS	$ _____
	17.3 Vault	1	LS	$ _____
	17.3 Piping and connections	1	LS	$ _____
	17.4 16" PRSV	1	LS	$ _____
	17.5 16" meter	1	LS	$ _____
	17.6 Electrical system	1	LS	$ _____
	17.7 SCADA, instrumentation and controls	1	LS	$ _____
	17.8 Commissioning/demonstration	1	LS	$ _____
	17.9 Site and pavement restoration	1	LS	$ _____
	17.10 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____

Item No.	Description	Quantity	Unit	Extended Amount
18.	Mangilao Tanks Meter Vault			
	18.1 Potholing	1	LS	$ _____
	18.2 Traffic control	1	LS	$ _____
	18.3 Vault	1	LS	$ _____
	18.4 Piping and connections	1	LS	$ _____
	18.5 10" meter	1	LS	$ _____
	18.6 16" meter	1	LS	$ _____
	18.7 Electrical system	1	LS	$ _____
	18.8 SCADA, instrumentation and controls	1	LS	$ _____
	18.9 Commissioning/demonstration	1	LS	$ _____
	18.10 Site and pavement restoration	1	LS	$ _____
	18.11 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____
19.				
	Volcano PRSV:			
	19.1 Potholing	1	LS	$ _____
	19.2 Pipe abandonment	1	LS	$ _____
	19.3 Traffic control	1	LS	$ _____
	19.4 Vault	1	LS	$ _____
	19.5 8" PRSV	1	LS	$ _____
	19.6 8" meter	1	LS	$ _____
	19.7 Electrical system	1	LS	$ _____
	19.8 SCADA, instrumentation and controls	1	LS	$ _____
	19.9 Commissioning/demonstration	1	LS	$ _____
	19.10 Site and pavement restoration	1	LS	$ _____
	19.11 Site survey	1	LS	$ _____
20.	Subtotal	1	LS	$ _____
	Pago Bay PRSV:			
	20.1 Potholing	1	LS	$ _____
	20.2 Pipe abandonment	1	LS	$ _____
	20.3 Traffic control	1	LS	$ _____
	20.4 Vault	1	LS	$ _____
	20.5 16" PRSV	1	LS	$ _____
	20.6 16" meter	1	LS	$ _____
	20.7 Electrical system	1	LS	$ _____
	20.8 SCADA, instrumentation and controls	1	LS	$ _____
	20.9 Commissioning/demonstration	1	LS	$ _____
	20.10 Site and pavement restoration	1	LS	$ _____
	20.11 Site survey	1	LS	$ _____
	Subtotal	1	LS	$ _____

Table A Base Bid Subtotal $_____

Table A Additive Bid Subtotal $_____

Table A Base Bid and Additive Bid Total $_____

TOTAL BASE BID PRICE FOR THE BID SCHEDULE

For the lump sum of

$_____

(Price in Figures)

_____

(Price in Words)

This Contract will be awarded to the lowest responsive and responsible bidder based on the total Base Bid Schedule. Determination of the lowest responsive and responsible bidder will be in accordance with the provisions of the Bid Documents.

Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all unit price Bid items will be based on actual quantities, determined as provided in the Contract Documents. Bidder also acknowledges that each unit price includes an amount considered by Bidder to be adequate to cover Bidder's overhead and profit for each separately identified item.

ARTICLE 6 - TIME OF COMPLETION

6.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedule set forth in Article 5 of the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 - ATTACHMENTS TO THIS BID

7.01 The following documents are attached to and made a condition of this Bid:

A. Required Bid security in the form of _____.

B. List of Proposed Major Suppliers;

C. Required Bidder Qualification Statement with Supporting Data; and

ARTICLE 8 - DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 9 - BID SUBMITTAL

9.01 This Bid submitted by:

If Bidder is:

<u>An Individual</u>

Name (typed or printed): _____

By: _____

(Individual's signature)

Doing business as: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____ _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____

(Signature of general partner - attach evidence of authority to sign)

Name (typed or printed): _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Corporation

Corporation Name: _____

State of Incorporation: _____

Type (General Business, Professional, Service, other): _____

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(CORPORATE SEAL)

Attest _____

(Signature of Corporate Secretary)

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Limited Liability Company (LLC)

LLC Name: _____

State in which organized: _____

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

A Joint Venture

First Joint Venturer Name: _____ (SEAL)

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

Second Joint Venturer Name: _____ (SEAL)

By: _____

(Signature - attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

_____

Phone: _____ Facsimile: _____

E-mail address: _____

Phone and Facsimile Number, and Address for receipt of official communications to Joint Venture: _____

_____

_____

(Each joint venturer must sign. The manner of signing for each individual, partnership, corporation, and limited liability company that is a party to the joint venture should be in the manner indicated above.)