GUIDE TECHNICAL SPECIFICATIONS

FOR CONSTRUCTION OF

WASTEWATER TREATMENT PLANT AT

HIRAM CLARKE BUS OPERATION FACILITY

PROJECT NO. 7018000058

ON BEHALF OF

METRO

METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, TEXAS

MAY 2019

CivilTech Engineering, Inc.
Firm Registration No. F-382
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PART 1 - GENERAL

1.01 DESCRIPTION

A. Location

The Hiram Clarke Bus Facility Wastewater Treatment Plant Replacement project is located at 4175 Uptown Drive, Houston, Texas 77045.

B. General

The Scope of Work for this Project shall consist of providing all supplies, support services, data, labor, tools, materials, equipment, supervision, construction and all else required to prepare the site and construct the Hiram Clarke Bus Facility Vehicle Wash Water Treatment Plant.

C. Project Scope

The Work shall include, but not be limited to, the following major items, to the extent specified and indicated:

1. Provide administration and construction support services to complete work.

2. Clear and grub the area of vegetation, shrubs, debris and existing trees and bushes not designated to remain.

3. Ensure the protection of trees, shrubs, vegetation, structures, and facilities where indicated.

4. Perform required earthwork, including excavation, embankment, backfill and compaction.

5. Perform soil stabilization as required for structural slab.

6. Construct buried conduit and piping.

7. Construct concrete slab structure.

8. Install wastewater treatment equipment.
9. Install process piping.
10. Install tank and equipment monitoring system.
11. Install electrical equipment, conduit, and wiring.
12. Construct building structure and roof.
14. Remove existing treatment equipment and properly dispose.
15. Provide lighting electrical facilities and systems.
16. Construct influent and effluent piping from/to existing treatment facility.
17. Provide a clean Site during the Work and prior to written acceptance by METRO.

1.02 QUALITY ASSURANCE

A. The Work shall comply with the requirements of the Contract Documents including cited national specifications and standards; state and local government authority codes, regulation, and specifications.

B. In case of conflicts or discrepancies between cited national and local standards, local requirements shall govern unless otherwise directed in writing. All conflicts shall be brought to the attention of METRO in writing for resolution.

1.03 OTHER REQUIREMENTS

A. A CPM for the Project shall be submitted in accordance with Section 01311 - CPM Schedule of these specifications.

B. Except as otherwise specified or indicated, the following shall be provided as part of the Project:

1. Labor, management, and superintendence as required to complete the work.
2. Construction supplies, equipment, products, tools, machinery, materials, and all appurtenances necessary to execute and complete the Work of the Contract.
4. Other facilities and services as necessary to execute and complete the Work of the Contract.

5. All governmental permits, licenses and fees required for execution and completion of the Work, in the Contractor's name.

C. The City of Houston and any affected utility owner shall be notified not less than 14 days prior to starting work in an area in which a utility may be located. Notices shall be in writing. An affected utility owner and METRO shall be notified 72 hours prior to commencing construction operations.

D. The Contractor shall prosecute the Work as indicated, in accordance with the Contract Documents, and in a timely manner so as to ensure coordination of all parts of the Work with work of other parties under adjoining and interfacing contracts, including governmental bodies and utility companies.

E. Proposals for scheduling work at times other than the normal work period of a calendar day shall be submitted to METRO not less than 48 hours in advance of those times. Such proposals shall outline all special precautions to be taken to control the hazards presented by prosecuting the Work at times other than the normal work period of a calendar day. The proposal shall include supplementary lighting of work areas, availability of medical facilities, security precautions and all other precautions necessary.

F. Construction equipment and vehicles which exceed the weight, size and noise limitations of the authorities having jurisdiction shall not be operated outside the Construction limits of the Site. Refer to Section 01560 - Environmental Impact Controls of these Specifications.

1.04 DEFINITIONS

A. CONSTRUCTION DRAWINGS: All professional design drawings, exclusive of Shop Drawings, prepared for parts of the Work not indicated on METRO-furnished Drawings. Construction Drawings become part of the Contract Drawings upon written approval of that Drawing by METRO.

B. CONTRACT DOCUMENTS: Documents applicable to and specified to an individual Contract, normally consisting of, but not necessarily limited to, the Agreement or Contract, Standard Technical Specifications, Contract Drawings, and errata thereto. Addenda to the Contract Documents issued prior to the Bid date will become part of the Contract Documents. Change orders issued after Contract execution will become part of the Contract Documents.

C. CONSTRUCTION SPECIFICATIONS: Normally consisting of the technical specifications prepared to cover corresponding construction operations, materials,
workmanship, and/or service performance required to produce the work.

D. CONTRACT DRAWINGS: The plans, profiles, cross-sections, elevations, schedules and details which show locations, character, dimensions and arrangements of the parts of the Work, including, METRO-furnished Drawings, approved Construction Drawings and approved Shop Drawings. Unless otherwise defined, the term Drawings shall mean the Contract Drawings.

E. CONTRACTOR: The individual, firm, partnership, or corporation, or combination thereof, private, municipal, or public, including joint ventures, who, as an independent contractor, has entered into a contract with METRO to carry out the intent of the Contract Documents.

F. DAYS: Whenever used in the Contract Documents, "days" means calendar days.

G. ENGINEER: For definition refer to Article 1, Definitions of the Proposed Contract, of the Invitation for Bid.

H. FURNISH: Except as otherwise defined, term "furnish" is used to mean supply and delivery to Project Site, ready for unloading, unpacking, assembly, installation, and so forth, as applicable in each instance.

I. INSTALL: Except as otherwise defined, term "install" is used to describe operations at Project Site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

J. INSTALLER: The term "installer" is defined as the entity (person or firm) engaged by the Contractor, its subcontractor or sub-subcontractor for performance of a particular unit of work at the Project Site, including installation, erection, application and similar required operations. It is a general requirement that installers be qualified in the operations they are engaged to perform.

K. METRO-FURNISHED DRAWINGS: The METRO Standard Drawings, furnished under separate cover.

L. PROJECT (WORK): The providing of construction, labor, materials, equipment, and compliance with contractual requirements as specified and indicated in the Contract Documents to produce the Work, ready for intended use. Project includes Transit Center and such other work as identified in the Contract Documents. "Project" and "Work" shall have the same meaning as used in these Specifications.

M. PROVIDE: Except as otherwise defined, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

N. SHOP DRAWINGS: Drawings furnished by the Contractor to illustrate specific parts
of the Work not indicated on the Contract Drawings of the Construction Drawings. Shop Drawings include drawings, diagrams, illustrations, schedules, charts, brochures, tables and other data graphically indicating and describing fabrication and installation of specific portions of the Work. Shop Drawings become part of the Contract Drawings upon written approval of that Drawing by METRO.

O. SITE: The tract of real estate in possession of METRO, where the Work is to be performed for METRO, within the indicated limits, in accordance with the terms of the Contract, and as required by the Contract Documents. The term "Site" is defined as the space available to the Contractor for performance of the Work, either exclusively or in conjunction with others performing other work adjacent to the Project. The extent of the Project Site as shown on the Drawings, may or may not be identical with the description of the land upon which the project is to be built.

1.05 INTERPRETATION

A. Final Authority

Where "indicated," "specified," "detailed," "required," "directed," "requested," "authorized," "permitted," or phrases of similar import are used, it shall be understood that the reference is made to the elements of the Contract Documents as interpreted by METRO, unless stated otherwise. However, no such implied meaning shall be interpreted to extend the Engineer's responsibility into the Contractor's area of construction supervision.

B. Imperatives

The word "shall" is an auxiliary verb which expresses mandatory requirements on the part of the contractor. The word "will" is an auxiliary verb which expresses probable intent or action on the part of METRO. The word "may" is an auxiliary verb which expresses permissible requirements on the part of the party addressed in the Contract. A statement of requirements for the performance of the Contract in the imperative mood shall be interpreted by the Contractor as if the verb "shall" is included in such statement (e.g., "submit all test results" shall have the same meaning as "Contractor shall submit all test results."). Imperative language is used generally in these Specifications. Except as otherwise indicated, requirements expressed imperatively shall be performed by the Contractor.

C. References

References to prime Articles include Articles under the Article referenced, e.g., a reference to Article 1.05 is also a reference to Articles 1.05, A through H.

D. Methods and Means
Interpretations, directions, observations, and suggestions of the Engineer shall not be construed as dictating, controlling, directing, or supervising the Contractor's methods, means, techniques, sequences, and procedures.

E. Approved and Approvals

Where used in conjunction with METRO's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations of METRO responsibilities and duties as specified in the Contract Documents. In no case will "approval" by METRO be interpreted as a release of Contractor from responsibilities to fulfill requirements of Contract Documents. The requirement to submit a document or Drawing to METRO for review and approval shall not be interpreted to imply automatic approval thereof by METRO. METRO may invoke or defer such action regarding approvals as it deems necessary.

F. Overlapping and Conflicting Requirements

Where compliance with two or more industry standards or sets of requirements is specified or indicated, and overlapping of those different standards or requirements establishes different or conflicting minimums or levels of quality, the most stringent requirement is intended and will be enforced by METRO, unless specific language in the Contract Documents clearly indicates that a less stringent requirement is to be fulfilled. Refer apparently-equal but-different requirements, and uncertainties as to which level of quality is more stringent, to METRO for a written decision before proceeding with the Work in question.

G. Minimum Quality/Quantity

In every instance, the quality level or quantity indicated or specified is intended to be the minimum for the work to be performed or provided. Except as otherwise indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable limits. In complying with these requirements, indicated numerical values are either minimums or maximums as noted, or as appropriate for context of the requirements. Refer instances of uncertainty to METRO for a written decision before proceeding with the Work in question.

H. Specialist Assignments

In certain instances, Specification text requires that specific work is to be performed by specialists of expert entities (e.g., Installer, Landscape Architect, Geotechnical Consultant), who shall be engaged for the performance of that work. Such assignments shall be recognized as special requirements over which the Contractor has no option. These requirements shall not be interpreted so as to conflict with the
enforcement of building codes and similar regulations governing the Work; they are also not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party involved in a specific unit of work is recognized as "expert" for the indicated process or operation. Nevertheless, the final responsibility for fulfillment of the Contract requirements shall remain with the Contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01010
SECTION 01040
PROJECT COORDINATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the minimum administrative and supervisory requirements necessary for integration and coordination of work on Project including, but not limited to, the following:

1. Project Meetings
2. Outside Agencies
3. Quantity Measurements
4. Special Reports
5. Conservation and Salvage

B. Work Included: To enable orderly review during progress of the work and to provide for systematic discussion of problems, the Engineer will conduct project meetings throughout the construction period.

C. Related Work

1. Documents affecting work of this Section include, but are not necessarily limited to, Contract Articles, Drawings and Technical Specifications.

2. The Contractor's relations with his subcontractors and materials suppliers, and discussions relative thereto, are the Contractor's responsibility and normally are not part of project meetings content.

1.02 QUALITY ASSURANCE

A. For those persons designated by the Contractor to attend and participate in project meetings, provide required authority to commit the Contractor to solutions agreed upon in the project meetings.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:
1. **Agenda Items:** To the maximum extent practicable, advise the Engineer at least 24 hours in advance of project meetings regarding items to be added to the agenda.

2. **Minutes:** The Engineer will compile minutes of each project meeting, and will furnish one copy to the Contractor.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - MEETINGS**

3.01 **MEETING SCHEDULE**

A. Except as noted below for Pre-construction Meeting, project meetings shall be called throughout the progress of the work as deemed necessary by the Engineers.

B. Coordinate as necessary to establish mutually acceptable schedule for meetings.

3.02 **MEETING LOCATION**

A. The Engineer will establish meeting location. To the maximum extent practicable, meetings will be held at the job site.

3.03 **PRE-CONSTRUCTION MEETING**

A. Pre-construction Meeting will be scheduled by METRO prior to the Notice to Proceed.

1. Provide attendance by authorized representatives of the Contractor and major subcontractors.

2. The Engineer will advise other interested parties.

B. Minimum Agenda: Data will be distributed and discussed on at least the following items:

1. Organizational arrangement of Contractor’s forces and personnel, and those of subcontractors and materials suppliers.

2. Channels and procedures for communication.

3. Construction schedule, including sequence of critical work.
4. Contract Documents, including distribution of required copies of original Documents and revisions.

5. Processing of Shop Drawing and other data submitted for review.

6. Processing of Change Orders, Bulletins, and field decisions.

7. Rules and regulations governing performance of the work.


9. Other contracted related items such as conflicts/compatibility problems, weather limitations, manufacturer recommendations, acceptance of substrates/adjoining work, temporary facilities, space and access limitations, governing regulations and inspection/testing requirements.

3.04 PROJECT MEETINGS

A. Attendance

1. The Contractor’s Project Manager and/or Superintendent shall represent the Contractor at all project meetings throughout progress of the work.

2. Subcontractors, materials, suppliers, and others may be invited to attend those project meetings in which their aspect of the work is involved.

B. Minimum Agenda

1. Review, revise as necessary, and approve minutes of previous meetings.

2. Review progress of the work since last meeting, including status of submittals for approval.

3. Identify problems which impede planned progress.

4. Develop corrective measures and procedures to regain planned schedule.

5. Complete other current business.
C. Revisions to Minutes

1. Unless published minutes are challenged in writing prior to the next regularly scheduled progress meeting, they will be accepted as properly stating the activities and decisions of the meeting.

2. Persons challenging published minutes shall reproduce and distribute copies of the challenge to all indicated recipients of the particular set of minutes three working days prior to next regularly scheduled meeting.

3. Challenge to minutes shall be settled as priority portion of "old business" at the next regularly scheduled meeting.

PART 4 - OUTSIDE AGENCIES

4.01 Contractor shall interface with outside agencies as required for Contract conformance. Contractor shall appraise/copy METRO on all correspondence, between Contractor and governing agencies, which is necessary to meet the terms of this Contract.

4.02 Contractor shall coordinate the inspection of work from all outside governing agencies as required.

PART 5 - QUANTITY MEASUREMENTS

5.01 The Contractor shall supply necessary manpower, equipment, and tools to assist METRO representative in the field measurement of Contract pay quantities.

PART 6 - SPECIAL REPORTS

6.01 REPORT TIMING

A. Contractor shall submit special reports directly to METRO within one (1) day of an occurrence on the site. A copy of the report shall also be submitted to the other entities that are affected by the occurrence within one (1) day.

6.02 REPORTING UNUSUAL EVENTS

A. When an event of an unusual, unscheduled, or significant nature occurs at the Site, Contractor shall prepare and submit a special report. Such special report shall list chain of events, and times of occurrence, persons participating, action by Contractor's personnel, an evaluation of the results or effects and similar pertinent information.
6.03 REPORTING ACCIDENTS

A. Contractor shall prepare and submit reports of accidents at Site and anywhere else related work is in progress. Report shall record and document names, dates and actions. For this purpose, "accident" is defined to include events where personal injury is sustained, or property loss of substance is sustained, or where the event posed a significant threat of loss or personal injury. Reporting shall comply with requirements of OSHA and other local authorities having jurisdiction.

PART 7 - CONSERVATION AND SALVAGE

7.01 GENERAL

A. During supervision and administration of the work, construction operations shall be carried out with the maximum possible consideration given to conservation of materials. In addition, maximum consideration shall be given to salvaging materials and equipment involved in performance of the work, but not incorporated therein. Disposition of salvage materials which are METRO's property shall be as directed in writing by METRO.

END OF SECTION 01040
SECTION 01051

GRADES, LINES AND LEVELS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the establishing of grades, lines and levels with the exception of primary control monuments and bench marks established by METRO.

1.02 PAYMENT

A. Cost of replacing established control monuments and bench marks damaged or destroyed by the construction operations will be deducted from payments due and from payments becoming due the Contractor. Neither additional compensation nor extension of time will be granted for suspending the Work to reestablish primary controls.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 CONSTRUCTION LINES AND GRADES

A. METRO will provide or have provided property corners, basic reference points or bench marks as necessary to establish proper control. The Contractor shall carefully preserve such marks and points. If it becomes necessary for the Contractor to remove or disturb a primary control or reference point, the Contractor shall notify METRO before removing or disturbing said control or reference point. If stakes, monuments, marks or points are carelessly or willfully disturbed by the Contractor, the cost of replacing such stakes, monuments, marks or points shall be charged to the account of the Contractor.

B. The Contractor shall proceed, from the controls established to make surveys and layouts as necessary to conform to the requirements of the Contract Documents and shall use qualified surveying and other personnel for making such surveys and layouts. The Contractor shall be responsible for and shall make all layouts and surveys necessary for the proper performance of the Work. The Contractor shall furnish, establish and maintain in good order, survey control points as required for the completion of the Work, subject to approval of METRO as to point location, sufficiency and adequacy. However, such approval by METRO shall not relieve the
Contractor of responsibility for accuracy of survey work and compliance with the Contract Documents.

C. METRO may check surveys and layouts made by the Contractor prior to approving any of the Work. The Contractor shall give sufficient advance written notice to METRO to enable such checking prior to commencing any work. When requested by METRO, the Contractor shall furnish assistance as required for checking purposes.

D. The Contractor shall furnish skilled labor, instrument platforms, ladders, temporary structures and lighting necessary for making and maintaining points and lines in connection with the required surveys.

E. METRO may direct the Contractor's attention to errors or omissions in lines or grades, but failure of METRO to point out such errors or omissions shall neither give the Contractor any right or claim nor shall in any way relieve the Contractor of contractual obligations and responsibilities hereunder.

END OF SECTION 01051
SECTION 01205
PROJECT TESTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the testing responsibilities and guidelines for the Contractor.

1.02 METRO'S INDEPENDENT TESTING LABORATORY

A. METRO will employ an Independent Testing Laboratory (ITL) to perform testing of materials.

B. The ITL shall not be authorized to revoke, modify, or release any requirement of the Specifications, nor to approve or accept any portion of the Work.

1.03 CONTRACTOR DUTIES

A. Contractor may employ a Testing Laboratory Service (TLS), to ensure Contract Document compliance for areas not covered by METRO's ITL.

B. The Contractor shall fully cooperate with any ITL employed by METRO.

C. Contractor shall provide access for METRO's ITL representative to obtain samples of materials proposed for use and which are required to be tested. Contractor shall cooperate in obtaining material samples for testing. Advise METRO's ITL at least 48 hours in advance to allow for test completion and personnel assignments.

D. Representatives of METRO's ITL shall have access to the Work at all times. The Contractor shall provide for and facilitate such access in order that METRO's ITL may properly perform its functions.

1.04 SPECIAL INSTRUCTIONS

A. Inspections or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

B. When initial tests indicate noncompliance with the Contract Documents, any subsequent retesting occasioned by such noncompliance will be performed by the ITL and the cost thereof borne by the Contractor.
C. The Contractor shall immediately notify METRO in writing, if, at any time during construction, the concrete resulting from the approved mix design proves to be unsatisfactory for any reason. The Contractor's Testing Laboratory Service shall modify the design, subject to written approval, until a satisfactory concrete mix is obtained.

D. If, as determined by the Engineer, concrete of poor quality or workmanship has been placed, additional tests shall be made as directed by the Engineer and at the expense of the Contractor. Tests may be compression test on cored cylinders, ASTM C 42, or load tests as outlined in ACI 318, Section 20.3.

E. The Contractor shall be furnished copies of all test reports by the Engineer. The Contractor may use these reports for his own convenience, but at his own risk.

END OF SECTION 01205
SECTION 01311
CONSTRUCTION SCHEDULE

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for the Construction Schedule.

1.02 QUALITY ASSURANCE
A. The scheduling approach shall be either a formal Critical Path Method (CPM) computerized schedule or a progress chart in a bar chart format of suitable scale to indicate appropriately the percentage of Work scheduled for completion by any given date during the construction period.

1.03 SUBMITTALS
A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Within 10 days after the effective date of the Notice to Proceed, five copies of a Schedule showing Contractor's planned operations and his planned general approach to the Work, for METRO review.

2. If the Schedules are not submitted when required, progress payments may be withheld.

PART 2 - PRODUCTS

2.01 CONSTRUCTION SCHEDULE
A. The Construction Schedule, either computer generated CPM or bar chart shall contain the following as a minimum:

1. A list of the different types of work activities or work elements.

2. The start and completion of each work activity.

3. Logical dependencies (ties) indicating what work must be accomplished before other work can begin.
4. The "weighing" or relative worth of each work activity or work element in relation to the total project cost.

2.02 CONSTRUCTION SCHEDULE SUPPORTING DATA

A. Written supporting data such as the proposed number of days per week on which work will be performed, planned number of shifts per day and number of hours per shift shall be furnished with the Construction Schedule. Unusual or unique situations or constraints shall be described.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to performing the Work of this Section, the Contractor shall thoroughly study the sequence-of-work, R-O-W availability, utility and other work which interface with this Contract.

B. The Schedule shall be maintained by the Contractor, on a monthly basis, throughout the duration of the Contract, showing the current and forecasted status compared to the original schedule.

3.02 PROGRESS REPORTING AND CHANGES

A. Monthly Site progress meetings shall be held on dates mutually agreed to by METRO and the Contractor. The Contractor’s CPM consultant, if Contractor has engaged such consultant, may be required to attend such progress meeting. Presence of subcontractors during progress meeting is optional, unless specifically required by METRO. Additional meetings may be required by METRO. The Contractor shall have his copies of the Schedule and other data required by this Section, accurately filled in and completed prior to the meeting. Work progress will be reviewed by METRO to verify:

1. Percentage for completed and partially completed activities.

2. Remaining duration required to complete each activity started, or scheduled to start, but not completed.

3. Identification of any problems that have developed or are anticipated in the next reporting period.

B. In addition to the foregoing, the Contractor shall submit a narrative report and an annotated schedule to METRO once each month. The narrative report shall include a description of the amount of progress during the last month in terms of completed
activities, a description of problem areas, current and anticipated delaying factors, estimated impact on performance of other activities and completion dates and an explanation of corrective actions taken or proposed. All proposed changes in activity duration or activity dependence shall be submitted to METRO for review.

C. If, in the opinion of METRO, the Contractor has fallen behind the approved schedule, the Contractor shall take steps necessary to improve his progress, including those that may be required by METRO, without additional cost to METRO. Such METRO requirements may include an increase in the number of shifts, an increase in the number of hours or days of work and/or the amount of construction plant. The Contractor shall submit, for METRO approval, a supplementary schedule demonstrating how the approved rate of progress will be regained.

D. Failure of the Contractor to comply with METRO's requirements under this clause shall be grounds for termination of the Contractor's right to proceed with the work, or any separable part of it, in accordance with the default terms of this Contract.

3.03 REVISIONS TO APPROVED SCHEDULE

A. If Contractor desires to change the approved schedule, METRO shall be notified in writing stating reasons for proposed change. If METRO considers the change to be of a major nature, METRO may require Contractor to revise and submit for approval, at no additional expense to METRO, all of the affected portion of the Construction Schedule to show effect on entire Project. A change may be considered to be of a major nature if either the time estimated to be required for an activity or the sequence of activities is varied to a degree that there is reasonable doubt by METRO that the Contract completion date, or dates, will be met.
SECTION 01340

SHOP DRAWINGS, PRODUCT DATA, SAMPLES AND RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for preparing and submitting Shop Drawings, product data, samples and Record Documents required by the Contract Documents.

1.02 SHOP DRAWINGS

A. General

Shop Drawings shall be identified by cross references to Contract Drawing numbers and to Technical Provisions Section and page numbers. The maximum size of Shop Drawings shall be 22 in. x 34 in.

B. Changes

Changes in products for which Shop Drawings have been reviewed and approved will not be permitted, unless those changes have been submitted to and approved in writing by METRO, as specified in Section 01630 - Products and Substitutions of these Specifications.

C. Quality Assurance

Shop Drawings shall be prepared to a standard of quality as set forth in the latest revision of DOD-STD-100, Military Standard Engineering Drawing Practices. Drafting quality shall enable microfilming in accordance with applicable standards of the National Microfilm Association.

D. Coordination

Submittals hereunder shall be coordinated with the requirements of Section 1340 - Shop Drawings, Project Data Samples and Record Documents, and Section 01700 - Project Closeout of these Specifications.
1.03 PRODUCT DATA

A. Manufacturer’s standard schematics, drawings, diagrams, details, procedures, instruction, schedules, illustrations, calculations and other descriptive data shall be modified to delete information which is not applicable to the Project and to highlight project-related pertinent information. Dimensions, coordination, clearances, performance characteristics and capacities, interfaces, limitations, precautions, wiring diagrams, inputs, outputs and controls shall be shown.

B. Notarized Certificates of Compliance shall be submitted for those products for which no samples or test results are specified. Notarized Certificates shall demonstrate proof positive of compliance of product with specification requirements and shall be signed by an authorized representative of the manufacturer. One copy of such certificates shall accompany each lot of product delivered to the Site. METRO may refuse the use of certain products where the only basis of compliance is a certificate of Compliance.

C. Part replacement and maintenance data for products shall be as specified in Section 01730 - Operating and Maintenance Data of these Specifications.

1.04 SAMPLES

A. Samples shall be of size and quantities to clearly illustrate full color range and functional characteristics of products and materials, with complete accessories or attachment devices. After review and written approval by METRO, samples may be used in construction, if not damaged and as directed by METRO.

B. Changes in products for which samples have been approved will not be permitted, unless those changes have been reviewed and approved in writing by METRO.

1.05 SUBMITTAL RESPONSIBILITY

A. Deviations in submittals from requirements of the Contract Documents shall not be relieved by METRO review and approval of submittals, unless those specific deviations have been acknowledged and waived in writing by METRO.
1.06 LIMITED APPROVALS

A. All Shop Drawings, product data and samples submitted by the Contractor shall illustrate details of work, equipment, materials, products, systems, designs or workmanship that the Contractor intends to use in order to comply with the design concept established in the Contract Documents. METRO's review of these submittals is only for the limited purpose of checking the same for conformity with the design concept of the Work as established in the Contract Documents, and is not intended to be for the purpose of determining the accuracy of other matters that they may be contained in such submittals, including but not limited to such matters as dimensions, quantities, performance of equipment and systems designed by the Contract, Contractor-furnished engineering and design, construction means, methods, techniques, sequences, procedures or safety precautions, the correctness of which shall be the sole responsibility of the Contractor. METRO will undertake its review within ten working days so as to cause minimum delay. METRO's review of a specific item shall not indicate approval of an assembly of which the item is a component or in which it functions.

1.07 SUBMISSION REQUIREMENTS

A. Submittals, including test results and Certificates of Compliance, shall be made in sufficient time before the work covered by the submittal is scheduled to be performed. Times may be mutually agreed upon so as not to delay the Project Schedule. Unless otherwise directed, submittals for a given Technical Section of these Specifications shall be completed in one submission.

1.08 DISTRIBUTION OF APPROVED SUBMITTALS

A. Ten (10) copies of Shop Drawings and product data bearing the Contractor's stamp of approval and signature shall be transmitted to METRO. METRO shall return three (3) copies of Shop Drawings and product data to the Contractor approved as noted.

1.09 RECORD DOCUMENTS

A. One record copy of all Contract Documents, Shop Drawings, and one set of full-size Contract Drawings shall be maintained at the Site. A set of the Contract Documents, including a full-size set of the Contract Drawings, shall be annotated by the Contractor to indicate the following.

1. Horizontal and vertical location of underground facilities and utilities.

2. Location of utilities, equipment and appurtenances concealed in construction as referenced to visible and accessible features of the construction.
3. Field changes of dimensions, details, locations and substitutions, as changes occur.

4. Details not on original Contract Drawings.

5. All other changes as required to result in a complete set of Record Documents to reflect "as built" conditions of the Project.

6. All changes and notations to record drawings shall be made with red erasable pencil and dated.

7. Record Drawings shall be kept current and shall be reviewed by METRO or METRO's representative for being up to date prior to the approval of any progress payment.

B. All such documents shall be stamped "Record Documents" and kept available for examination by METRO. Record Documents shall be maintained in a dry, clean and legible condition.

C. One copy of all certificates for installed material, mill certificates, weight tickets, product modifications, and related documents shall be maintained and submitted to METRO for inclusion in the Record Documents.

D. A clean reproducible copy of the Record Documents shall be transmitted to METRO at the time of Project closeout. Record Documents shall become the property of METRO. Refer to Section 01700 - Project Closeout of these Specifications for detailed closeout requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01340
SECTION 01380
CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for taking and submission of construction photographs in color.

1.02 QUALITY ASSURANCE
A. Photographs shall be clean, sharp and shall clearly show details. Appropriate filtration shall be used to reduce haze and ghosts.

1.03 SUBMITTALS
A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Before starting Work, within 10 days after starting Work, and within the first 10 days of each month thereafter, three prints and the negative of each construction photograph as follows:

a. In sets with each photograph numbered in sequence beginning with the numeral one.

b. Each photograph shall be enclosed in a clear plastic protector punched to fit a standard 8-1/2 in. by 11 in. three ring binder.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHS
A. Each photographic print shall be standard commercial quality, in color, 8 in. by 10 in., single weight glossy paper.
B. Each print shall be identified on the back of the print with the following information typed in a 2 in. by 4 in. box in the lower right hand corner:

METROPOLITAN TRANSIT AUTHORITY
HARRIS COUNTY, TEXAS

Contract No.: ____________________________
Contract Title: ____________________________
Contractor: ______________________________
Photograph No.: ________ Date: __________
Description: ______________________________

2.02 NEGATIVES

A. Negatives shall be a minimum of 2 inches by 2 inches.

B. Negatives shall be submitted to METRO with the photographs.

PART 3 - EXECUTION

3.01 INITIAL PHOTOGRAPHING

A. Pre-construction photographs shall be taken of the entire Site before starting the Work and prior to disturbing the Site in any manner.

3.02 PROGRESS PHOTOGRAPHING

A. A minimum of 10 photographs shall be made prior to construction. After construction operations have been started at the Site, photographs shall be taken each month, with a sufficient number of views, no less than 10, to indicate progress in construction.

B. METRO shall direct views to be photographed and number of photographs required.

END OF SECTION 01380
SECTION 01451

PROJECT QUALITY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

A. In addition to the CONTRACT ARTICLE, "INSPECTION OF CONSTRUCTION", this section specifies the Contractor Quality Control (CQC) requirements for the Work of this Contract.

B. The Contractor is responsible for quality control and shall establish and maintain an effective quality control system to perform inspections, tests, and retesting in the event of failure for items of work, including that of subcontractors, to ensure compliance with the Contract.

1.02 CONTRACTOR QUALITY CONTROL ORGANIZATION

A. The Contractor shall provide a Contractor Quality Control Manager (CQCM), to provide inspection of the Work. After METRO's approval of the individual, the Contractor shall appoint the CQCM by a letter addressed to the CQCM and signed by an Officer of the construction firm. The CQCM shall report directly to an officer of the firm. An alternate CQCM shall be designated in the event that the CQCM is temporarily absent from the work site.

B. The minimum qualification requirements for the CQCM follow:

The CQCM shall have a minimum of 6 years combined experience in construction management and construction quality control. The CQCM shall be experienced in the construction of complex public works projects, including roadways, bridges, embankments and drainage systems. Experience is required in the handling of product submittals, interpretation of contract documents, and in the testing of construction materials.

C. METRO's Approval of CQCM: CQCM qualification statement must be detailed to show actual related experience in performing similar duties and responsibilities. Construction activities shall not begin until a CQCM is approved by METRO. The Contract time will not be extended for failure to propose an acceptable CQCM.
1.03 CONTRACTOR QUALITY CONTROL (CQC) PLAN

A. The Contractor shall furnish two copies of the CQC plan to METRO for review and acceptance. METRO will not issue the Notice to Proceed until the CQC plan has been received.

B. The CQC plan shall detail the procedures, instructions, and reports to be used to assure compliance with the Contract. Construction shall not be started until the CQC plan is accepted. The CQC Plan shall include:

1. The letter appointing the CQCM, signed by an officer of the firm, which outlines the CQCM's duties, responsibilities, and authority, to include the authority to direct removal and replacement of any defective work and a Resume of the CQCM.

2. A listing of the definable features of work (DFW) for which the QC inspection process will be applied.

3. Procedures for documenting:
   a. Quality Control Operations
   b. Inspections
   c. Testing - to include acceptance test performed by the Contractor (e.g., hydrostatic testing of water lines, leak testing of sanitary sewers, etc.)

4. A list of all tests to be performed to meet the requirements of the contract specifications. The list shall give the test name, specification paragraph containing the test requirements and the personnel and laboratory responsible for each type of test. The list of tests shall include, in addition to the specified, those required at successive stages of the performance of the Work occurring in the field to document progressive quality of the Work, such as compaction tests in various lifts in backfilling of a trench or the subgrade prior to construction of a facility.

5. Procedures for documenting:
   a. Changes to drawings and specifications.
   b. Handling, storage and delivery of supplies and materials.
   c. Release for shipment of fabricated items.
   d. Evidence of compliance.
   e. Corrective action.
   f. Calibration/certification of measuring equipment.
   g. Audit.
C. METRO's acceptance of the CQC plan is conditional and will be predicated on satisfactory performance during construction. METRO reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

PART 2 - PRODUCTS (Not Used.)

PART 3 - EXECUTION

3.01 CONTROL DOCUMENTATION

A. Prior to the commencement of construction activities, the Contractor shall meet with METRO's Quality Assurance Staff to discuss the quality control requirements. The purpose of the meeting is to develop a mutual understanding relative to details of the system. Subcontractors involved in quality control should have their responsible personnel attend this meeting. The CQCM shall prepare and distribute minutes of this QA/QC coordination meeting.

B. Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The CQCM shall document all CQC meetings and provide copies of the minutes to METRO. A log of preparatory and initial inspections shall be maintained by the CQCM. At least three phases of control shall be conducted by the CQCM for each definable feature of work as follows:

1. PREPARATORY PHASE (PREWORK MEETING): In the presence of METRO's designated representative, Contractor shall perform a preparatory inspection before beginning any work on any definable segment of work. Include in preparatory inspection a review of the Contract requirements, the review of approved shop drawings and other submittal data, assurance that required control testing is to be provided, a physical examination to ensure that all materials and equipment conform to approved shop drawings and submittal data and assurance that all required preliminary work has been completed. CQCM shall prepare minutes of this meeting and provide copies to METRO within seven calendar days.

2. INITIAL PHASE: In the presence of METRO's designated representative, Contractor shall perform an initial inspection as soon as a representative segment of the particular item of work is underway. Include in initial inspection performance of scheduled tests, examination of the quality of workmanship, a review for omissions or dimensional errors, and approval or rejection of the initial segment of the Work. Where applicable, standards of
acceptance shall be mutually agreed upon. Initial phase inspections are to be logged and reported in daily CQC reports.

3. FOLLOW-UP PHASE: Contractor shall perform follow-up inspections daily, and more frequently as necessary, and include continued testing and examinations to ensure continued compliance with the Contract requirements. Results to be noted in daily CQC reports.

C. METRO shall have access to all work areas during the Contractor's working time and shall have the right to monitor the methods and procedures used to construction related activities and testing. METRO shall be given 24 hour notice in advance of inspections.

D. The CQCM shall submit daily CQC reports to METRO identifying prime and subcontractor personnel and equipment on the Site, idle equipment and personnel, material deliveries, weather conditions, work accomplished, inspections and tests conducted, results of inspections, nature of defects found, causes for rejection, and corrective actions taken, together with the following certification: "I hereby certify that this report is complete and accurate and that all materials and equipment incorporated in the work and workmanship are in full compliance with the contract documents except as noted above". This certification shall be signed on behalf of the Contractor by the CQCM. The Contractor shall use METRO's CQC Report or approved equal. The Contractor shall submit the CQC Report each day for the preceding day's activities.

E. The Contractor shall maintain adequate records to provide evidence of quality and accountability. These records shall include results of inspections, material and acceptance tests, process controls, certification of processes and personnel, discrepant material (including records of disposition), and other quality requirements defined in the Contract. These records shall be maintained, completed, and available to METRO at all times during the performance of the Contract.

3.02 TESTING OF MATERIALS

A. The Contractor shall perform inspections, tests and other services to ensure that all work conforms to Contract requirements. Where required by the specifications to conduct such testing, the Contractor shall request the services of an independent testing laboratory employed and paid for by METRO. The Contractor shall direct it's requests for testing to METRO's Resident Engineer. The testing work performed by METRO's independent laboratory will be under the general direction of the Resident Engineer. Tests performed by the Contractor shall be documented. Notification shall be given to the Resident Engineer of acceptance testing to enable the tests to be witnessed by the QA representative.
B. Repeat Tests and Inspections:

The testing laboratory will perform acceptance tests and inspections as directed only once at no cost to the Contractor. The Contractor shall be responsible for the cost of all repeat acceptance tests and inspections. The Contractor shall be responsible to make corrections to nonconforming materials and workmanship.

C. Coordination:

It shall be the Contractor’s responsibility to cooperate and coordinate with the testing laboratory to perform the tests specified by the Contract or required by the Engineer to verify that the Contractor’s quality control measures and/or performance are adequate to provide a product which conforms to the contract requirements. A list of tests which the Contractor understands it is to perform to meet the contract requirements shall be furnished as a part of its CQC plan to the Engineer. For collection of test samples, conducting field tests, etc., the testing laboratory shall be given twenty-four (24) hours notice.

3.03 SUBMITTALS

A. The CQCM shall certify all submittals required by the technical sections of the Contract by the Contractor in accordance with the Contractor Quality Control plan and submit as specified in Section -1340, "SHOP DRAWINGS, PRODUCT DATA, SAMPLES & RECORD DOCUMENTS". Clearly mark each item proposed to be incorporated into the Project, identify on the submittals and catalog cuts and cross-reference to the drawings and Specifications so as to identify clearly the use for which it is intended. Maintain at the Worksit an up-to-date submittal status log showing the status of all submittals required by the Contract.

B. Certified Test Reports: Before delivery of materials and equipment, submit for approval certified copies of the reports of all tests listed in the technical sections (and referenced publications). Accompany test reports with certificates from the manufacturer certifying that the material and equipment proposed to be supplied is of the same type, quality, manufacturer and make as that tested.

C. Manufacturer’s Certificates of Conformance or Compliance: Preprinted certifications are not acceptable. The originals of all manufacturer’s certifications shall name the appropriate item of equipment or material, specification, standard or other document specified as controlling the quality of that item and have attached thereto certified copies of test data upon which the certifications are based. Furnish all certifications signed by the manufacturer’s official authorized to sign certificates of conformance or compliance.
D. Laboratory Reports: The Contractor shall provide reports which cite the Contract requirements, the test or analysis procedures used, the actual test results, and include a statement that the item tested or analyzed conforms or fails to conform to the specification requirements.

3.04 NOTIFICATION OF NONCOMPLIANCE

METRO will notify the Contractor of any noncompliance with the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to comply promptly, METRO may issue an order stopping all or part of the work until satisfactory corrective action has been taken.

3.05 COMPLETION INSPECTION

At the completion of all work or any increment thereof established by a completion time stated in CONTRACT ARTICLE, "PERIOD OF PERFORMANCE", or Specification Section 01700, "PROJECT CLOSEOUT", the CQCM, along with METRO's Quality Assurance Representative, shall conduct a completion inspection of the work and develop a "punch list" of items which do not conform to the approved plans and specifications. Such a list shall be included in the CQC documentation and shall include the estimated date by which the deficiencies will be corrected. The completion inspection and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 GENERAL

No separate measurement is made for this section. The payment for work in this section is incidental to the total bid for the project.

END OF SECTION 01451
SECTION 01452

CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

A. In addition to the CONTRACT ARTICLE, "INSPECTION OF CONSTRUCTION", this section specifies the Contractor Quality Control (CQC) requirements for the Work of this Contract.

B. The Contractor is responsible for quality control and shall establish and maintain an effective quality control system to perform inspections, tests, and retesting in the event of failure for items of work, including that of subcontractors, to ensure compliance with the Contract.

1.02 CONTRACTOR QUALITY CONTROL (CQC) PLAN

A. The Contractor shall furnish two copies of the CQC plan to METRO for review and acceptance.

B. The CQC plan shall document the Contractor's policy statement regarding quality, identify the Contractor's representative responsible for CQC activities and contain a listing of definable features of work for which preparatory and completion inspections shall be conducted and documented.

C. METRO's acceptance of the CQC plan is conditional and will be predicated on satisfactory performance during construction. METRO reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

PART 2 - PRODUCTS (Not Used.)

PART 3 - EXECUTION

3.01 CONTROL DOCUMENTATION

A. Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. METRO's Resident Engineer will ensure that all CQC
meetings and inspections are properly documented and copies provided to all parties.

B. In the presence of METRO’s designated representative, Contractor shall perform a CQC inspection before beginning work on each definable feature of work. Include in the inspection a review of:

1) Contract Documents
2) Approved Shop Drawings and data submittals
3) Manufacturer’s recommended installation procedures
4) Manufacturer’s certified test reports and certificates of conformance and compliance for materials and equipment
5) Physical examination of conformed materials and equipment
6) Request for services of independent testing laboratory
7) Procedures, tolerances and standards established

C. METRO shall have access to all work areas during the Contractor's working time and shall have the right to monitor the methods and procedures used in construction related activities and testing. METRO shall be given 24 hour notice in advance of inspections.

D. The Contractor shall maintain adequate records to provide evidence of quality and accountability. These records shall include results of inspections, material and acceptance tests, process controls, certification of processes and personnel, discrepant material (including records of disposition), and other quality requirements defined in the Contract. These records shall be maintained, completed, and available to METRO at all times during the performance of the Contract.

3.02 TESTING OF MATERIALS

A. The Contractor shall perform inspections, tests and other services to ensure that all work conforms to Contract requirements. Where required by the specifications to conduct such testing, the Contractor shall request the services of an independent testing laboratory employed and paid for by METRO. The Contractor shall direct it's requests for testing to METRO's Resident Engineer. The testing work performed by METRO's independent laboratory will be under the general direction of the Resident Engineer.

B. Repeat Tests and Inspections:

The testing laboratory will perform acceptance tests and inspections as directed only once at no cost to the Contractor. The Contractor shall be responsible for the
cost of all repeat acceptance tests and inspections. The Contractor shall be responsible to make corrections to nonconforming materials and workmanship.

C. Coordination:

1. It shall be the Contractor's responsibility to cooperate and coordinate with the testing laboratory to perform the tests specified by the Contract or required by the Engineer to verify that the Contractor's quality control measures and/or performance are adequate to provide a product which conforms to the contract requirements. For collection of test samples, conducting field tests, etc., the testing laboratory shall be given twenty-four (24) hours notice.

3.03 SUBMITTALS

A. Certify submittals required by the technical sections of the Contract by the Contractor in accordance with the Contractor Quality Control plan and submit as specified in Section -1340, "SHOP DRAWINGS, PRODUCT DATA, SAMPLES & RECORD DOCUMENTS". Clearly mark each item proposed to be incorporated into the Project, identify on the submittals and catalog cuts and cross-reference to the drawings and Specifications so as to identify clearly the use for which it is intended. Maintain at the Worksite an up-to-date submittal status log showing the status of all submittals required by the Contract.

B. Certified Test Reports: Before delivery of materials and equipment, submit for approval certified copies of the reports of all tests listed in the technical sections (and referenced publications). Accompany test reports with certificates from the manufacturer certifying that the material and equipment proposed to be supplied is of the same type, quality, manufacturer and make as that tested.

C. Manufacturer's Certificates of Conformance or Compliance: Preprinted certifications are not acceptable. The originals of all manufacturer's certifications shall name the appropriate item of equipment or material, specification, standard or other document specified as controlling the quality of that item and have attached thereto certified copies of test data upon which the certifications are based. Furnish all certifications signed by the manufacturer's official authorized to sign certificates of conformance or compliance.

D. Laboratory Reports: The Contractor shall provide reports which cite the Contract requirements, the test or analysis procedures used, the actual test results, and include a statement that the item tested or analyzed conforms or fails to conform to the specification requirements.

3.04 NOTIFICATION OF NONCOMPLIANCE
METRO will notify the Contractor of any noncompliance with the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to comply promptly, METRO may issue an order stopping all or part of the work until satisfactory corrective action has been taken.

3.05 COMPLETION INSPECTION

At the completion of all work or any increment thereof established by a completion time stated in CONTRACT ARTICLE, "PERIOD OF PERFORMANCE", or Specification Section 01700, "PROJECT CLOSEOUT", the Contractor, along with METRO's representative, shall conduct a completion inspection of the work and develop a "punch list" of items which do not conform to the approved plans and specifications. Such a list shall be included in the CQC documentation and shall include the estimated date by which the deficiencies will be corrected. The completion inspection and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 GENERAL

No separate measurement is made for this section. The payment for work in this section is incidental to the total bid for the project.

END OF SECTION 01452
SECTION 01505
MOBILIZATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the mobilization of the construction facilities and equipment at the Work Site; the requirements for materials and supplies necessary for the prosecution of the work, but not to be incorporated in the Work; the construction of temporary buildings and facilities; the requirements for personnel and facilities for work preparatory to commencing the Work; and demobilization. Mobilization also includes the following:

1. Providing construction fences and gates or repairing any existing fencing used for construction site security.

2. Providing a field office for the exclusive use of METRO if called for and as specified in Section 01590.

1.02 SUBMITTALS

A. Provide a layout of the proposed construction site including fences, roads, parking, temporary buildings and material storage areas within 7 days after the effective date of the Notice-to-Proceed.

PART 2 - PRODUCTS

2.01 FACILITIES AND EQUIPMENT

A. Construction facilities and equipment shall be of the capacity, type, quality and function suitable for, and provided in the quantity necessary for, timely prosecution of the Work.

PART 3 - EXECUTION

3.01 GENERAL

A. The location of construction facilities and equipment shall be subject to approval by the Engineer prior to commencing operations.

B. The construction facilities, including equipment and personnel, shall not only have sufficient excess capacity to permit the work to progress and to be completed within the time stipulated in the Contract, but shall also have sufficient excess capacity for emergencies and overloading.
C. METRO shall have the right to inspect, and will reject, construction facilities and equipment which are unsafe, improper, or inadequate. Rejected construction facilities and equipment shall be brought to acceptable condition, or shall be removed from the work site and replaced with acceptable items. Neither increase in Contract time nor cost will be allowed for delays occasioned by such rejection.

3.02 DEMOBILIZATION

A. Upon completion of the work, the Contractor shall remove construction facilities, equipment, materials, supplies, temporary buildings and other items necessary for mobilization and the area restored to acceptable conditions as directed.

B. Contractor shall submit all required Record Documents and reports.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. MOBILIZATION of the construction facilities and equipment shall be measured per Lump Sum, in place at the work site.

B. PERMITS AND FEES will not be separately measured for payment, but shall be included in the measurement for each item requiring permitting.

4.02 PAYMENT

A. The basis for payment shall be the lump sum, fixed price for “Mobilization” as it appears on the bid form, which shall be full compensation for furnishing all labor and materials necessary for timely preparation and prosecution of the work, including demobilization. Contractor shall receive partial payments for staged mobilization.

1. The Contractor shall receive 25% of lump sum payment when the contractor mobilizes on the work site.

2. The Contractor shall receive 50% of lump sum payment upon receipt and approval by METRO of the following items, as applicable:
   a. Safety Program;
   b. Contractor’s Quality Control Plan;
   c. Initial Construction Photographs;
   d. Preliminary Construction Schedule and Billing Forecast;
   e. Construction Schedule;
   f. Submittal Schedule.

3. The Contractor shall receive 25% of the lump sum payment when demobilization including all required submittals is complete.

END OF SECTION 01505
SECTION 01510

TEMPORARY UTILITIES AND OTHER FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing, maintaining and removing temporary utility services, construction facilities, protection provisions and support facilities for construction and testing.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. NECA: National Electrical Contractor's Association


2. NFPA: National Fire Protection Association

   a. 10: Standard for Portable Fire Extinguishers.

   b. 70: National Electrical Code.


3. UL: Underwriters Laboratories


B. Temporary facilities shall comply with the applicable regulations and standards of the City of Houston, the requirements of the utility companies involved and the requirements specified herein.

C. Electrical facilities and their installation shall comply with the applicable requirements of the City of Houston, NFPA 70, UL, and NECA NJG-6, "Temporary Job Utilities and Services Guidelines".

Metropolitan Transit Authority/Standard Specification
D. The provision and installation of fire protection facilities for construction shall comply with the applicable requirements of the City of Houston, NFPA 10, NFPA 241, and the UL.

PART 2 - PRODUCTS

2.01 TEMPORARY SUPPORT FACILITIES

A. Temporary support facilities may include, but not be limited to, field offices, storage sheds, fabrication sheds, sanitary facilities, drinking water, first aid facilities, bulletin board, telephones, clocks, thermometer, project identification signs, clean-up facilities, waste disposal service, rodent/pest control and similar miscellaneous services, all as may be reasonably required for proficient performance of the Work and accommodation of personnel at the Site, including METRO personnel.

B. Discontinue and remove temporary support facilities, and make incidental similar use of permanent work of the Project, only when and in manner authorized by METRO; and, if not otherwise indicated, immediately before time of Substantial Completion. Locate temporary support facilities for convenience of users, and for minimum interference with construction activities.

2.02 TEMPORARY UTILITY SERVICES

A. Water Service

1. Water service shall comply with the applicable requirements of City of Houston, Public Works Department, Water Division.

2. Water shall be potable, from municipal supplies approved by the State or City Health Department.

B. Electrical Service

Electrical service shall comply with the applicable requirements of City of Houston, NFPA 70, Houston Lighting and Power Company, and NECA NJG-6, "Temporary Job Utilities and Services Guidelines".

C. Telephone Service

1. Telephone service shall comply with the applicable requirements of Southwestern Bell Telephone Company.

2. Provide two (2) phone lines to METRO's field office.
D. Contractor shall be responsible for all Temporary Utility Service Fees.

2.03 TEMPORARY CONSTRUCTION FACILITIES

A. Water Distribution System

A water distribution system shall be provided which is sufficient to provide the water needs for construction operations and Site fire protection.

B. Enclosures

Temporary enclosures shall be provided as needed and where required to ensure protection from inclement weather and unsatisfactory ambient conditions. Tarpaulins, where used, shall be UL labeled and have a flame spread of 15 or less.

C. Heating

Temporary heating shall be provided where necessary to ensure specified minimum ambient conditions for installation of materials. Fuel-burning heaters shall be equipped with individual-space thermostatic controls and be UL labelled. Spaces heated with fuel-burning heaters shall have adequate ventilation. Oil-fired heaters shall not be used.

D. Electrical Service Distribution System

1. An electrical service distribution system shall be provided which is sufficient to accommodate construction operations requiring electrical power, use of power tools, electric heating, lighting and start-up testing of permanent electric-powered equipment prior to connection to permanent electrical system.

2. Distribution system shall be weatherproof, grounded and provided with short circuit and overload protection. Outlets shall be spaced so that any area requiring power tools can be reached with a single 100 ft. extension cord.

3. Engine-driven power-generators shall be provided for power for electric welding.

E. Lighting

Lighting shall be sufficient to ensure proper workmanship throughout construction. Task lighting shall be provided as necessary.
F. Access Provisions

Ramps, stairs, ladders, sidewalk bridges and protection, and similar temporary access provisions shall be provided as required to safely perform the Work and facilitate its inspection.

G. Roads and Parking Areas

Temporary roads and parking areas shall be provided to service construction areas. Roads and parking areas shall be surfaced sufficiently to provide all-weather, uninterrupted access. Access to the site for construction vehicles and equipment shall meet the requirements of the project's storm water pollution prevention plan as specified in Section 01566 - Storm Water Pollution Prevention Plan.

2.04 TEMPORARY PROTECTION PROVISIONS

A. Telephone Service

Telephone service shall be provided, accessible to all construction personnel, for emergency use. Emergency telephone service shall have emergency telephone numbers prominently displayed. Emergency telephone numbers shall include METRO transit police, local police, ambulance, fire department, utility companies and other emergency telephone numbers as may be required.

B. Environmental Protection

Environmental protection shall be provided as specified in Section 01560 - Environmental Impact Controls of these Specifications.

C. Fire Extinguishers

Provide types, sizes, numbers and locations as would be reasonably effective in extinguishing fires during early stages at Project Site. Provide Type A extinguishers at locations of low-potential for either electrical or grease-oil-flammable liquids fires; provide Type ABC dry chemical extinguishers at other locations; comply with recommendations of NFPA No. 10. Post warning and quick-instructions at each extinguisher location, and instruct personnel at Project Site, at time of their first arrival, on proper use of extinguishers and other available facilities at Project Site. Post local fire department and METRO Transit Police call number on each telephone instrument at Project site.
2.05 TEMPORARY SUPPORT FACILITIES

A. Field Office

A field office shall be provided as specified in Section 01590 - Field Office of these Specifications.

B. Construction Support Facilities and Equipment

Construction support facilities and equipment shall be provided as specified in Section 01505 - Mobilization of these Specifications.

C. Sanitary Facilities

Temporary sanitary facilities shall be provided at accessible locations, and shall be secluded from public observation insofar as practicable. Facilities shall be relocated as the center of activity moves. Sanitary facilities shall be serviced as often as necessary to prevent accumulation of wastes and unsanitary conditions.

D. First Aid Facilities

First aid facilities shall be provided consisting of the following:

1. Supplies: Not less than one 16 unit first aid kit for each 50 persons, or fraction thereof, employed at the Site.

2. Personnel: Not less than one certified First Aid person for each 50 persons, or fraction thereof, employed at the Site. First aid personnel shall have valid certificates issued by the U.S. Bureau of Mines or the American Red Cross. First aid personnel shall be provided with a hard hat with the first aid emblem affixed. First aid personnel may be assigned other duties not interfering with their first aid duties.

E. Drinking Water

Drinking water shall be provided in dispenser-type units. Dispenser units shall have adequate supplies of paper cups and waste receptacles. Drinking water shall be cooled during hot weather.

F. Contract Identification Signs

Identification signs shall be provided and located as directed by METRO. Size of sign, wording, letter sizes, colors, layout, and construction shall be as shown on METRO Standard Drawing No. TRS-1053-2.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Temporary facilities shall be established prior to beginning construction operations requiring the use of the temporary facility.

B. Facilities shall be installed, operated, maintained and relocated as necessary. Installations shall be at locations which will be non-hazardous, sanitary, protective of persons and property and free of deleterious effects.

3.02 REMOVAL

A. Temporary facilities shall be removed when the need for the facility no longer exists. The area occupied by the facility shall be cleaned and restored to its original condition or as directed.

END OF SECTION 01510
PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for protecting trees indicated to be preserved.

1.02 QUALITY ASSURANCE

A. Reference Standard Applicable to this Section.


1.03 JOB CONDITIONS

A. Tree preservation measures shall be in place prior to start of work. Failure to comply will result in damages as outlined in Section 3.08 of these specifications.

B. Trees that have excavation within the tree protection zone or excavation adjacent to the tree protection zone shall be watered 2 times per week saturating soil to a depth of 6 inches. Watering shall occur from May 1 through October 1. During periods of rainfall, watering shall be suspended but continued within one week of no rainfall. Deep root injection watering shall be performed 1 time every month on these trees during this time period.

C. Contractor shall not physically damage bark, limbs or roots with construction equipment. Trees shall not be used to aid in construction by tying ropes, leaning equipment against trunks or limbs, cleaning equipment such as banging concrete screeds clean etc.

D. Contractor and subcontractors shall meet with METRO to review the Tree Preservation Plan for the site before startup of any site work (Worker Education Program). Contractor shall arrange the meeting with METRO to be held at METRO offices at 1201 Louisiana. At the meeting, METRO will review the Tree Preservation Plan and requirements of these specifications. For sub-contractors
not present or new sub-contractors, contractor shall arrange additional meeting(s) before these firms initiate any site work. Contractor shall provide updates to Tree Protection program through the course of construction at construction meetings.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Deep Root Fertilizer - "XL Injecto Feed (32-7-7), a product of Dogget Corporation, Lebanon, NJ, (201) 236-6335.

B. Mycorrhizal Fungi - MycorTree Saver Injectable, a product of Plant Health Care, Inc., Woodstock, GA (800) 421-9051.

C. Humic Acid - BioPak Water soluble powder, a product of Plant Health Care, Inc., Woodstock, GA (800) 421-9051.

D. Borer Pesticide: Contractor shall submit recommended treatment. METRO shall approve based upon effectiveness.

E. Natural Leaf Mulch - Partially decomposed leaf mulch consisting of organic material such as leaves, pine straw, pine cones, etc., gathered from project site or other "forest floor." Natural Leaf Mulch shall not contain twig or branches or newly ground material but may contain up to 50% commercial well-rotted bark mulch as specified in PLANTING WORK - SECTION 02980 of these Specifications.

F. Topsoil - As specified in PLANTING WORK - SECTION 02980 of these Specifications.

G. Drainage Fill - Selected stone or gravel, graded to pass a 3 inch sieve and retained on a 1 inch sieve.

H. Physical Barrier.

1. Stakes shall be as specified in PLANTING WORK - SECTION 02980 of these specifications for iron “T” stakes.

2. Fabric shall be a 4 ft. high heavy duty orange Polyethylene Fence.

3. Fabric shall be attached to posts with three nylon locking ties placed at top, bottom and center of fence. Top tie shall be placed so as to prevent slipping over top of steel post.
I. Signage - Plastic heavy gauge .060" semi-rigid with 3/16" I.D. corner eyelets for easy mounting with nylon ties. Signage shall be supplied by EMED CO., INC.; P.O.Box369; Buffalo, NY; 14240 or approved equal. Signage shall be 14” wide X 10” high with top edge aligned 6” from the top of the fence and at a maximum of 45’ on center unless otherwise directed by METRO. Signage shall be white plastic with green letters at size specified and shall read:

<table>
<thead>
<tr>
<th>LINE #</th>
<th>SIZE</th>
<th>TEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>METRO TREE</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>PROTECTION</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>ZONE</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>No construction in this area.</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Se prohibe construcion adentro.</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>For information call 713-739-4661.</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall not allow any vehicles, construction equipment, construction material, excavated material, refuse, debris of any type, or any foreign matter within the tree protection zone. Contractor’s workforce shall not be permitted to move material across tree protection zone nor will workers be permitted to access tree protection zone.

B. Protect tree root systems from damage due to run-off or spillage of noxious materials. Contractor shall be held financially responsible for failure to protect soils. If contractor contaminates soils, METRO shall hire independent firm to decontaminate soils at contractor’s expense. Permanent damage to trees will be accessed at a dollar value as outlined in Section 3.08 of these specifications.

1. Contractor shall not mix, place construction materials, or locate stored materials so as to permit runoff into root protection zone.

2. Construction equipment that leaks fluids is not permitted on the job site. Contractor shall continually inspect construction equipment for leaks and remove or repair equipment upon discovery.

3.02 PHYSICAL BARRIER

A. Each tree or group of trees to be preserved shall be provided with a physical barrier. The Barrier shall be placed in a continuous alignment along tree protection zone. Contractor shall stake locations of all physical barriers prior to final
installation and shall receive approval from METRO prior to placement of barriers. Unless otherwise specified by METRO, fence shall be placed a maximum of 6” from:

1. Root Prune Line.

2. Proposed Curb Line.

3. Edge of Existing Ditch.

B. Storage of materials or other articles will not be allowed inside a Barrier.

C. Contractor shall provide for maintenance and repair of fencing during site work construction. Damage to tree barriers during the progress of the Work shall be repaired at time of damage at no additional cost to METRO. Barrier shall be continual maintained to insure Barrier is true and perpendicular to ground plain.

D. Entryways into a protection zones shall not be provided in order to discourage traffic of any type. No access to fenced areas shall be permitted without prior approval of METRO.

E. Contractor shall remove fence after completion of the site work unless otherwise notified by the owner.

3.03 FERTILIZING

A. Preservation trees shall be treated as designated on the treatment schedule.

B. Injection of the fertilizer into the root zone of the tree shall consist of the following methods:

1. Mix in a tank with agitation capability:
   
   a. Fertilizer - 9 pounds by weight per 100 gallons water.
   
   b. Mycorrhizal Fungi - 6oz. per 100 gallons water.
   
   c. Humic acid - 1 lb. per 100 gallons water.

2. Inject the mixture on a 2.5 ft. square grid at 1/2 gallon of mix per hole or 8 gallons per 100 square feet.

3. Injection pressure shall be 100 - 150 PSI as soil conditions warrant.
4. Depth of injection shall be 6 - 12 inches.

5. Inject the root zone area, where possible, in the canopy area plus 10 feet beyond dripline, but not in root loss zone.

C. Contractor is responsible for mixing, applying and disposal of all chemicals in accordance with strict adherence to manufacturer's directions and or State and Federal Regulations.

3.04 CHEMICAL TREATMENT

A. Borers

1. Ninety (90) days after start of construction (that disturbs trees) spray trees that are to remain as follows: Spray Oaks for Bores. Spray trunks and branches over 2 inches diameter to run-off with approved Borer Pesticide.

2. Should it rain within six hours after application, trees shall be re-sprayed at Contractor's expense.

3. Repeat spray of Oaks upon completion of construction.

3.05 EXCAVATION AROUND TREES

A. No excavation or construction work within protection zones of trees is permitted without METRO approval. Where trenching for utilities is required within protection zones, contractor shall meet with METRO to determine most invasive method for installation. Contractor shall never cut main lateral roots over 1” or tap roots unless given METRO approval. Smaller roots under 1 inch in diameter which interfere with the installation of new work may be cut. In any case, if roots are encountered during construction, contractor shall stop work within area and receive direction by METRO.

B. Where excavating for new construction is required within the tree protection zone and as directed by METRO, hand excavate to minimize damage to root system. Use narrow spading forks and comb soil to expose roots. Cut roots over 1 inch in diameter with sharp pruning instruments. Do not chop roots.

C. Relocate roots in backfill areas wherever possible. If large main lateral roots are encountered, expose beyond excavating limits as required to bend and relocate without breaking. If roots are immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 3 inches back from new construction.
D. Do not allow exposed roots to be unprotected for more than 24 hours. Contractor shall provide temporary protection with earth cover, or pack with peat moss and wrap with burlap. Water and maintain exposed roots in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth. Cover exposed root areas with plastic sheeting that is staked to the ground.

E. Prune branches to balance loss to root system caused by damage or cutting as directed by METRO.

3.06 GRADING AROUND TREES

A. Maintain existing grade within the tree protection zones. If contractor perceives from drawings that final grade will differ more than 3” either below or above existing grade, contractor shall contact METRO prior to initiating work and receive METRO approval to commence with work. Contractor shall not establish grades if this dimension is violated.

B. Contractor shall coordinate with METRO all grading operation within tree protection zones.

3.07 REPAIR AND REPLACEMENT OF TREES

A. Contractor shall contact METRO within 24 hours if trees are damaged during construction. Repair trees damaged by construction operations as directed by METRO within 24 hours of direction. Repair work shall be subject to approval by METRO.

B. Remove and replace dead or damaged trees which are determined by the tree surgeon to be incapable of restoration to normal growth status. Provide new trees of same size and species as those removed at no cost to METRO.

C. The replacement of dead or damaged trees shall be performed in full compliance with the requirements specified in PLANTING WORK - SECTION 02980 of these Specifications at no cost to METRO.

3.08 DAMAGES

A. Contractor shall be assessed damages by METRO in the amounts indicated below for non-compliance of this spec. Assessed damages do not release the contractor from repairing damage to trees. METRO will notify Contractor of non-compliance and if not remedied within 24 hours, the damages will be assessed.
1. Category I Damages: The infractions such as damaged or missing Protection Barrier and/or missing signage, foreign debris within protection zone as indicated in this specification under section 3.01 GENERAL A, and unprotected roots for more than 24 hours as indicated in this specification under section 3.06 GRADING AROUND TREES result in Category I damages. The assessed damage will be $100.00 per tree per calendar day starting 24 hours after notification.

2. Category II Damages: Violations of these specifications by wounding trees or altering their appearance by either physical root, trunk or limb damage; chemical damage or neglect result in Category II damages. These damages will be will be assessed at a dollar value based upon the severity of wounds. For minor damage an assessed damage of $10.00 per caliper inch shall be assessed. If damage is major, but not life threatening the damages will be assessed at $50.00 per linear inch.

3. Category III Damages: Violations of these specifications that result in mortally wounding trees by either physical root, trunk or limb damage; chemical damage; neglect. Category III damages will be assessed at a dollar value of $200.00 per caliper inch or in-kind tree replacement which ever is greater. The dollar value will be assessed if site conditions do not permit an in-kind tree to be planted.

END OF SECTION 01533
SECTION 01541

MAINTENANCE AND PROTECTION OF UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing protection, support, removal of existing supports, and maintenance of existing utilities within, adjacent to, or affected by the Work under this Contract.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. ANSI: American National Standards Institute
   a. A 10: Safety Requirements Series.

2. AWWA: American Water Works Association
   a. Standards and Manuals.

3. City of Houston

4. NECA: National Electrical Contractors Association

B. Work Standards

Utilities shown on the Contract Drawings and encountered in the limits of the Work area shall remain in service and be maintained in-place and protected in their locations, unless otherwise specified or indicated. Methods of temporary support and protection of various facilities, if shown on the Contract Drawings, are suggestions only, and the requirements specified herein shall apply. Such suggestions shall not be construed as dictating the Contractor's methods, means, techniques, sequences, and procedures.

C. Locating Utilities

Within the limits of and adjacent to the Work, there are known to exist public and private utilities, storm and sanitary sewers, underground and aerial power lines, telephone lines, TV cable and communication lines, gas and water service lines, street lighting, traffic signalization, and petroleum product lines.

1. The Contract Drawings indicate known existing utilities, and proposed utilities by others, in their approximate locations from information shown on record drawings, furnished by others as of the date of the contract drawings.

2. METRO does not warrant the accuracy of these locations, nor that all existing utilities within the limits of the Work have been shown on the Drawings.

3. Before commencing the Work, coordinate with utility owners to determine actual location of existing and proposed utilities. Location of utilities, as indicated, shall not relieve the Contractor of his contractual obligations of contacting utility owners. Municipally owned utility lines such as water, sanitary sewer, storm sewer, and traffic signalization may not be located by their owners and in such case determine the location of each affected line, structure, or apparatus. Coordinate all Work affecting the utilities with appropriate utility owners and the Engineer.

4. Before commencing the Work, contact the owner and verify by field investigation the locations of all utility facilities within and adjacent to the construction limits that may be affected by Work operations. Conflicts which result due to failure to locate, existing utilities which are shown on the Construction Drawings or which the Contractor has been given notice or has knowledge of, shall be the sole responsibility of the Contractor. The cost of remedial work, removal of portions of the work or extensive design changes

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occasioned by the failure of the Contractor to verify the location of existing utilities as described above, shall be borne by the Contractor.

5. If a utility line, structure, or apparatus which was not located and was not shown on the plans is encountered, notify the Engineer and determine ownership of that utility. If ownership cannot be determined through reasonable inquiry to utility owners, the utility line, structure, or apparatus shall be treated as an active utility. As appropriate, either provide support of the utility across or adjacent to the excavation as required to proceed with the work or make a more in-depth investigation of the utility line, structure, or apparatus if the location impacts the work and proceed as directed by the Engineer.

D. Notices

1. Provide written notice to all public and private utility owners at least 14 days prior to scheduled commencement of work.

2. Notify the Utility Coordinating Committee's (UCC) one-call center at (713) 223-4567, and other necessary one-call centers at least 48 hours before commencing excavation. Weekends and holidays shall not be included in the 48 hour notice period. Locate requests to one-call centers shall be made only for work that is scheduled to be performed within the next ten working days and shall not exceed a fourteen calendar day period.

3. The notification to the one-call center shall not relieve the Contractor of his responsibility to notify all public and private utilities, municipalities and agencies having jurisdiction.

4. Maintain a log of all locate requests at all times and it shall be made available to the Engineer upon request. The log shall contain an accurate description of the instructions to the municipalities, utility companies, the name of the one-call center, date of the contact, the notification number provided by the one-call center if applicable.

5. If a locate request is not fulfilled by a member of the appropriate one-call center, contact the one-call notification center and request a status on the "locate" requested for the non-responsive utility company and notify Engineer. If during the status investigation the utility has indicated either they have no facilities in the vicinity of the work and the contract documents depict a utility line, structure, or apparatus or that they did not respond, the appropriate one-call center will re-notify the utility that a "locate" is required. If a "locate" of the utility line, structure or apparatus is still not made and the plans indicates a utility line, structure, or apparatus exists in the vicinity of the
excavation, contact the appropriate one-call center for a direct contact with the non-responsive utility company. The utility company contact provided by the one-call center shall be used only for the specific non-response for that locate request. All subsequent utility locate requests shall be in accordance with the provisions of these contract documents.

6. Notify in writing all utility owners not belonging to a one-call center at least 72 hours in advance of his intent to excavate any segment of the Site, so each utility owner may mark utility locations to ensure safety of utilities as required by law. Weekends and holidays shall not be included in the 72 hour notice period.

7. Notify the Engineer immediately and notify in writing within 24 hours the affected utility owners and METRO of damage to or loss of any utility. Repairs will be made by the utility owner, or by Contractor when directed by the Utility owner, at the Contractor's expense, for damage or loss caused by the Contractor's or his subcontractor's operations.

8. The City of Houston, other cities in the area, municipal utility districts, water control and improvement districts, and Harris County are not members of a one-call system. Determine the exact location of these utilities prior to excavating. The Engineer will supply the name, address and phone number of each municipal utility owner representative.

1.03 OTHER CONTRACTS

A. Contracts may be let for utility relocation. The Contractor shall be cognizant of these relocations, and protect and support in-place as necessary the relocated utilities. When an underground facility, according to the plans, will be excavated beneath, or the soil support undermined, develop and submit to the utility owner for approval, a design of the proposed support system. Support system designs shall be submitted to the utility owner a minimum of 14 calendar days prior to the proposed excavation around the utility line, structure, or apparatus. Supports and protection shall be removed when no longer needed by the Contractor or utility owner, and as directed by the Engineer.

1.04 SAFETY

1.05 REARRANGEMENT OF UTILITY FACILITIES

A. Rearrangement of existing utility will be performed by their owners, or others as deemed appropriate by utility owners, in close coordination with the Work of this Contract. For rearrangement of utilities by owners, give the owners advance written notice of the Work schedule. Written notice to utility owners shall be at least 14 working days prior to the Contractor's scheduled commencement of Work. However, rearrangements by owners may or may not be started or completed at the end of the minimum notice period. The Engineer may direct the Contractor to schedule and participate in meetings with utility owners as deemed necessary by the Engineer to coordinate both Contractor's and utility owner's work schedules.

B. Where utilities or their appurtenances conflict with permanent construction, work involved in permanently relocating or otherwise altering such utilities and their appurtenances will be done by utility owners or others.

C. If the Contractor wishes to have any utilities temporarily or permanently relocated, braced, or otherwise supported for his own convenience, he shall make necessary arrangements with utility owners and compensate them at his own expense for the cost of such work as mutually agreed upon. Compensation shall be by certified check in advance of the contemplated work.

D. In accordance with OSHA Section 1926.651 General Requirements, utilities exposed in the excavation shall be protected, supported or removed as necessary to safeguard employees.

1.06 COOPERATION AND ACCESS

A. Provide access to utility owners, and others as designated, to the Work Site at all times to relocate, service, and inspect their facilities. Cooperate with utility owners and others in facilitating such work so as not to delay the Work of this Contract.

1.07 CONTINUITY OF SERVICE

A. Ensure continuity of utility service and maintain, in a safe and satisfactory operating condition, all overhead, surface, and subsurface utilities. This Article shall apply equally to utilities owned or operated by METRO, public utilities, and private owners.

B. Existing service connections to buildings are not necessarily shown on the Drawings, but protect, support, and maintain such connections to ensure continuous service.
1.08 PRESERVATION OR ABANDONMENT OF PROPERTY

A. Rearranged facilities and existing utilities not indicated as abandoned or to be abandoned shall be protected. When a utility has been placed in-service, the utility owner will verify that those facilities to be abandoned are out-of-service before the Contractor starts work in that area. Abandoned utilities shall be verified by the utility owner and Contractor before removal of the utility. Verification shall be confirmed in writing by the Contractor to both the utility owner and the Engineer.

1.09 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, prepare and submit Shop Drawings to the Engineer and utility owners for review and approval of all utilities which conflict with construction of the Work.

B. Work Plan

Shop Drawings shall identify the plan and schedule for performing the Work. The plan for performing the Work shall include, but not necessarily be limited to, the horizontal and vertical locations of existing and rearranged utility services, conflicts which such utilities and facilities present to the Work, details of proposed temporary support and protection systems for facilities designated on the Contract Drawings, or where required to be protected and supported, and how the Contractor proposes to proceed with the Work. Work shall not be started until the Engineer and the utility owner have approved the plan in writing. Approval shall not relieve the Contractor of his obligation to comply with the Contract Documents.

C. Notices

Submit to the Engineer a copy of all notices and correspondence with utility companies and public agencies including locate requests.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise specified or indicated, all materials for Work hereunder shall conform to the requirements of the respective Sections of these Specifications for each system to which such materials pertain.

B. Existing manhole frames and covers, grates, valve boxes, indicator posts, curb cocks, meter boxes, and similar items shall be adjusted, supported in place,
replaced in kind, or repaired to governing standards for which such materials pertain.

C. Existing utility poles indicated on the drawings may or may not be relocated by their owners. Unless indicated otherwise on the drawings, assume utility poles are to remain in place.

PART 3 - EXECUTION

3.01 INSPECTION

A. Locate and identify subsurface existing structures indicated to remain before beginning the Work in the vicinity of such structures. Work shall be performed so as not to damage existing subsurface structures.

3.02 EXCAVATION, BACKFILLING, AND COMPACTION

A. All excavation shall be in accordance with Section 02161 - Trench Safety Systems, of these Specifications.

B. Perform backfilling and compaction as specified in Section 02200 - Earthwork of these Specifications.

3.03 REMOVAL AND REPLACEMENT OF PAVEMENTS, SIDEWALKS, CURBS, AND GUTTERS

A. Remove and replace pavements, sidewalks, curbs and gutters as required to perform excavation work. Each utility owner will perform removal and restoration work as required for their appropriate portion of the Work, unless otherwise indicated or directed by the Engineer.

3.04 UNSAFE AND UNSUITABLE FACILITIES

A. If condition or location of a facility is unsafe or unsuitable for maintenance and support, and if an unsafe or unsuitable condition is a result of work performed by utility owners, the Contractor shall immediately notify the Engineer and the utility owner, with written follow-up within 24 hours, of the conditions requiring remedial action. Do not proceed further without written direction from the Engineer.
3.05 SANITARY, STORM AND COMBINED SEWERS

A. Maintain active sewers, house connections and laterals in operating condition and a closed system at all times. Adequate precautions and safety measures shall be taken to avoid flooding of the job during storms and to avert dangers from sudden increases in flows, for any reason, that might clog, damage, or interfere with normal operations. Discharge of storm water and construction-generated sediment into the sanitary and combined sewer systems, and flow of waste water contaminants across surfaces of streets, property, into open excavations or other natural or man-made systems shall not be permitted. Work hereunder shall be coordinated with that of Section 01560 - Environmental Impact Controls of these Specifications.

B. Temporary sewer facilities and supports of design and capacity necessitated by construction shall be provided where indicated or required. Plan and design temporary sewer facilities and supports and construct same in accordance with approved Shop Drawings. Furnish, install, maintain and ultimately remove temporary sewer facilities and supports. Furnish and install new sewer facilities at proper line and grade, as indicated or required.

C. Maintain minimum requirements for backfilling and compacting exposed existing sewer facilities and for new installations in accordance with City of Houston Standard Specifications listed in Section 1.02-A-3, above.

3.06 WATER MAINS

A. Maintain continuity of all existing water mains, and shall provide for temporary support and protection of these facilities at the Site.

B. Details for supporting water mains during construction shall be submitted in writing a minimum of 14 calendar days prior to excavation for review and approval by the City of Houston Water Department.

C. Perform work in connection with relocation, removal, replacement, and construction of new, permanent and temporary water mains and service connections as indicated. Where water mains are to be abandoned or taken out of service, City of Houston Water Department will disconnect lines and services and cap water mains prior to any removal work except as indicated or provided for in the contract documents. City of Houston Water Department will supervise removal of temporary supports from its lines, and placement and compaction of backfill around and over its water lines.
D. City of Houston Water Department will disinfect the water main and perform one bacteriological test on Contractor-installed mains. Retests will be done at the Contractor's expense and with no increase in Contract time.

E. Conformance to the Specifications of the City of Houston Water Department, as listed in Section 1.02-A-3 above and applicable AWWA Standards and Manuals shall be required.

F. Perform hydrostatic or pressure tests.

3.07 ELECTRICAL DISTRIBUTION AND SERVICE

A. Maintain continuity of existing electrical facilities and provide protection of Houston Lighting & Power Company facilities on the Site.

B. When excavating within five feet (5-feet) and beneath a depth of three feet (3-feet) below existing grade of a utility pole or anchor to which HL&P Company facilities are attached, HL&P Company or its contractor will secure or otherwise brace these poles and anchors prior to excavation. The cost of Houston Lighting and Power's work shall be included in the contract bid price and no additional compensation will be made.

C. HL&P will perform all work in connection with relocation, removal, replacement, and construction of new permanent building service connections, duct banks, and manhole adjustments, at no cost to the Contractor, unless otherwise indicated. Where electric lines are to be abandoned or taken out of service, HL&P will disconnect lines and services prior to any removal work by the Contractor. HL&P will oversee removal of temporary supports from its underground facilities, and also oversee placement and compaction of backfill around and over its underground facilities.

D. Details for electrical ducts and manholes to be supported in-place during construction shall be submitted in writing a minimum of 14 calendar days prior to excavation for review and approval by HL&P.

3.08 GAS MAINS AND SERVICES AND PETROLEUM PRODUCT LINES

A. Maintain continuity of existing gas facilities and protection of Entex facilities during construction operations.

B. Entex or its designated contractor, will perform all work in connection with relocation, removal, replacement, support, and construction of permanent and temporary gas mains and service connections identified in the Contract. Where gas mains are to be taken out of service or abandoned, Entex will disconnect mains
and services and cap mains to remain, prior to any removal work by the Contractor. Entex will oversee removal of temporary supports from its line, and placement and compaction of backfill around and over gas mains.

C. Entex will provide details for supporting in-place, its gas facilities during construction. A minimum of 14 calendar days prior to excavation submit in writing to Entex details for any alternative system for supporting in-place, the Entex gas facilities during construction. Entex is under no obligation to approve the Contractor’s proposed system for supporting in-place, the Entex gas facilities.

D. Articles 3.08 A thru C hereinabove shall apply as appropriate to petroleum product or other natural gas facilities, with the owners thereof substituted in lieu of Entex.

3.09 TELEPHONE FACILITIES

A. Maintain continuity of existing telephone facilities and temporary support and protection of these facilities on the Site.

B. Southwestern Bell Telephone Company, or its designated contractor, will perform all work in connection with relocation, removal, and replacement of telephone service identified in the Contract. Where telephone lines are to be abandoned or taken out of service, Southwestern Bell Telephone Company, or its designated contractor, will disconnect lines and services prior to any removal work by the Contractor. Southwestern Bell Telephone Company will supervise removal of temporary supports from its lines, and also supervise placement and compaction of backfill around and over its underground facilities.

C. Details for telephone ducts and manholes to be supported in-place during construction shall be submitted by the contractor in writing a minimum of 14 calendar days prior to excavation for review and approval by Southwestern Bell Telephone Company.

D. Provide support and otherwise brace utility poles and anchors on which there are no Houston Lighting and Power facilities as required. Maintain the facility in a safe condition. Prevent any movement of utility poles and anchors during or as a result of the excavation.

3.10 TRAFFIC SIGNALS

A. Maintain continuity of existing and rearranged facilities, and temporary support and protection of these facilities on the Site as directed by the City of Houston and the engineer.
3.11 STREET LIGHTS

A. Maintain existing intensity and adequacy of illumination along all pedestrian walkways, grade separations, and streets where existing lighting has been removed or disconnected for construction, as directed by HL&P and the Engineer.

3.12 CABLEVISION, WESTERN UNION AND OTHER COMMUNICATION FACILITIES

A. Maintain continuity of existing and rearranged facilities, by providing adequate temporary support and protection of facilities on the Site, as directed by the facility owner and the Engineer.

3.13 OTHER FACILITIES

A. Maintain continuity of any and all facilities, adequate temporary support and protection of these utilities at the Site as directed by the Engineer.

END OF SECTION 01541
SECTION 01560

ENVIRONMENTAL IMPACT CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the controls required to control and minimize environmental impact caused by construction activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

Contractor shall provide facilities, establish procedures, and conduct construction activities in a manner which will ensure compliance with those regulations controlling construction activities at Project Site. Contractor shall designate one person, the General Superintendent or other, to enforce strict discipline on activities related to generation of wastes, pollution of air/water/soil, generation of noise, and similar harmful or deleterious effects which might violate regulations or reasonably irritate persons at or in vicinity of Project Site.

3.02 NOISE CONTROL

A. General

1. Noise caused by construction activities shall be minimized. Construction equipment and machinery shall be equipped with efficient noise suppression devices for the protection of both employees and the public.

3.03 TEMPORARY IMPROVEMENTS FOR WATER QUALITY/FLOODING/ DRAINAGE

A. Work hereunder shall be coordinated with the work of Section 01505 - Temporary Facilities of these Specifications. The City of Houston and Harris County Flood Control District and Water Pollution ordinances of the City, State and Federal Governments and the Texas Natural Resource Conservation Commission (TNRCC) regulations shall govern.
B. Temporary improvements shall be demolished when no longer required. Debris shall be removed and Site shall be restored to its original condition or as directed by METRO.

3.04 AIR POLLUTION

A. Motor Emissions

1. Emission control devices shall be used on gasoline and diesel construction equipment. Idling and unnecessary operation of equipment shall be prohibited to prevent and control air pollution in accordance with applicable City of Houston ordinances and Environmental Protection Agency criteria.

2. Contractor shall use low-sulfur (500 ppm or less) diesel fuel in all diesel operating vehicles and motorized equipment used by the contractor and its subcontractors in the performance of this work. No diesel operating vehicle or motorized equipment used in the performance of this work shall utilize a high-sulfur diesel fuel in excess of the required 500 ppm sulfur content. If the contractor or its subcontractors are found to be using high-sulfur diesel fuel during the performance of this work, METRO may, at its discretion, order the contractor to cease operation of all such vehicles and motorized equipment until this requirement has been complied with. The contractor shall not be entitled to any claims for compensation therefor. Either off-road sulfur "red-eye" diesel fuel or on-road low-sulfur diesel containing 500 ppm or less sulfur content may be used to comply with this requirement. Contractors and subcontractors using this type of fuel must have invoices/receipts available upon demand by METRO’s Contract Administrator to ensure compliance with this low-sulfur fuel use requirement.

B. Dust Control

Work and access areas shall be maintained free of dust. Loaded trucks shall be covered and dust-generating surfaces shall be sprinkled with water or receive a light application of bitumen. Trucks and equipment shall be washed down prior to leaving the construction Site. Adjacent streets shall be swept as directed by METRO to remove all spilled material. Sediments and construction materials reaching a public or private road shall be removed by street cleaning, not flushing before the end of each working day.
C. Burning

Burning of trees, shrubs, rubbish and other materials is prohibited. Burning of waste materials on METRO-controlled property will not be permitted. All materials shall be disposed of off-site in a legal manner.

3.05 EROSION AND SEDIMENT CONTROLS

A. General

Erosion and sediment controls shall:

1. Divert upslope water around disturbed areas of the Site.

2. Limit the exposure of disturbed areas of the Site.

3. Remove sediment from storm water before it leaves the Site.

B. Seeding, mulching, netting and watering shall be provided on sloped surfaces, berms at the top of the slopes, interceptor ditches at end of berms and at locations to ensure that erosion during construction will be minimized.

C. Sediment Controls

1. Silt dams, traps, dikes, barriers, fences, and related control appurtenances shall be provided as required to prevent sedimentation of existing drainage systems.

2. Temporary improvements for sedimentation control shall be removed upon completion of the Work for which the controls were provided.

D. Stabilization Practices

1. Undertake stabilization practices to cover or maintain existing cover over site soils. Minimize the amount of existing vegetated area that is disturbed or denuded, especially those areas outside the immediate zone of construction activity.

2. Stabilization practices shall include temporary and permanent seeding, mulching (or combinations of seeding and mulching applied by hydraulic planting or hydro-mulch seeding), sodding, the use of vegetative buffer strips, protection of trees and other mature vegetation, the use of woven geotextile fabrics, riprap, gabions; erosion mats, blankets or netting made of certain
fibrous materials; and other appropriate measures, such as specialized soil retaining systems, or other practices specified or approved by METRO.

E. Implementation of Stabilization Practices

1. Stabilization practices shall be undertaken within 14 days after construction activity on any portion of the construction site has temporarily or permanently ceased.

2. If construction activities on a portion of the site are scheduled to resume within 21 days of being suspended, METRO may allow the Contractor to delay implementing temporary stabilization on that portion of the site if its storm water runoff is discharged through an appropriate sediment trapping device.

3. METRO will determine the definition of Portion of the Construction Site based on construction sequencing, the Contractor's submitted construction schedule, or the type and scope of the project.

F. Construction and Maintenance of Stabilization Practices

1. Stabilization practices shall be in accordance with HC/COH Storm Water Management Handbook for Construction Activities, Appendix C; as specified in Sections 01533 - Tree Protection and Trimming of these Specifications, 02933 - Seeding of these Specifications, and 02935 - Sodding of these Specifications; as shown on the drawings; and in accordance with the project Storm Water Pollution Prevention Plan (SWPPP) specified in Section 01566 - Storm Water Pollution Prevention of these Specifications.

2. Stabilization practices shall be inspected after each storm event of record for erosion or other storm related damage. Repair any storm damage within 24 hours of said inspection and promptly repair any other degradation to the effectiveness of a specific stabilization practice.

G. Structural Practices

1. Structural practices specified in the project SWPPP shall be designed to prevent water from crossing disturbed areas of the site or to remove sediment from site runoff before it is discharged or both.

2. Approved structural practices shall include earth dikes and drainage swales (when combined, commonly called diversions), silt fences, sediment traps, check dams, level spreaders, subsurface drains, pipe slope drains,
temporary storm drain diversions, storm drain inlet protection, rock outlet protection, sump pits, temporary or permanent sediment basins, temporary waterway crossings, wind breaks, construction entrance/exit stabilization measures, and other practices specified or approved by METRO.

3. Structural practices that are not approved for implementation on METRO projects include the use of brush barriers and the use of straw bales as sediment fences, traps, barriers, dikes, or check dams - inclusive of whether or not said brush barriers or straw bales are proposed to be covered with filter fabric.

H. Construction and Maintenance of Structural Practices

1. Structural practices shall be in accordance with HC/CH Storm Water Management Handbook for Construction Activities, Appendix C, and in accordance with the dimensions shown on drawings or specified in the project SWPPP or both.

2. Structural practices shall be inspected after each storm event of record for damage or sediment accumulation. Repair any storm related damage within 24 hours of said inspection and otherwise perform routine maintenance of structural practices as stated in the project SWPPP, or as directed by METRO.

3.06 STORM WATER MANAGEMENT MEASURES (SWMMs)

A. Specified Management Measures

SWMMs include the use of on-site infiltration devices, storm water flow attenuation by the use of vegetative swales or natural depressions, storm water outfall velocity dissipation devices, storm water retention structures including those with artificial wetlands, storm water quality detention structures, combinations of these management measures, and other approved measures.

B. Construction and Maintenance of SWMMs

1. SWMMs shall be constructed in accordance with the project plans and/or as specified in the project SWPPP.

2. SWMMs that are constructed to function during construction shall be inspected after each storm event of record for damage or sediment accumulation. Repair any such storm related damage within 24 hours of said inspection and shall otherwise perform routine maintenance of SWMMs as stated in the project SWPPP, or as directed by METRO.
3. Responsibility for the maintenance of permanent SWMMs constructed as part of the project shall revert to METRO or another designated party at the completion and close-out of the project.

3.07 CONSTRUCTION SITE HOUSEKEEPING BEST MANAGEMENT PRACTICES

A. General

Appropriate construction site housekeeping Best Management Practices (BMPs) shall be instituted to minimize the opportunities for toxic and hazardous substances to enter storm water discharges from construction activities.

3.08 CLEANING

A. Safety Requirements

1. The Site shall be maintained in a neat, orderly and hazard-free condition in accordance with local ordinances and anti-pollution regulations until final acceptance of the Work.

2. Volatile wastes shall be stored in covered metal containers and removed from the Site daily.

3. Accumulation of wastes which create hazardous conditions shall be prevented.

4. Adequate ventilation shall be provided during the use of volatile or noxious substances.

B. Interim Cleaning

1. Cleaning shall be performed daily to ensure that the Site facilities, shelters, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.

2. Loose materials on exposed surfaces shall be removed or secured at end of each day’s work or more often to maintain the Site in hazard-free condition. Dislodgement of materials due to wind and other forces shall be prevented.

3. Dry materials and rubbish shall be wet down to prevent blowing dust.
4. On-site containers shall be provided for collection of waste materials, debris and rubbish. Containers shall be regularly emptied and contents disposed of legally off-site.

5. Interiors of shelters shall be vacuum cleaned when ready to receive finish painting or special coatings. Vacuum cleaning shall continue as required, until shelters are ready for final acceptance.

6. Dropping or throwing of materials from heights will be prohibited.

7. Cleaning operations shall be scheduled so that dust and other contaminants resulting from cleaning processes will not fall on wet, newly painted surfaces.

8. Waste materials shall not be buried in site excavations.

C. Final Cleaning

1. Refer to Section 01700 - Project Closeout of these Specifications. A final inspection shall be conducted, in the company of METRO, of exposed interior and exterior surfaces in preparation for Substantial Completion. The cognizant METRO Division Directors and Assistant General Managers may be in attendance.

2. Grease, dust, dirt, stains, spilled paint and concrete, labels (except UL and FM labels), fingerprints and other materials shall be removed from exposed finished surfaces.

3. Marred surfaces shall be repaired and refinished to specified finish to match adjacent surfaces at no additional cost to METRO. Paved surfaces shall be broom cleaned.

4. Thoroughly sweep and washdown pavement surfaces on or along the site and adjacent streets or properties subject to off-site tracking of sediments or fugitive dust as specified in this Section and the project's SWPPP specified in Section 01566 - Storm Water Pollution Prevention of these specifications.

5. Cleaning operations shall continue until Work has been finally accepted by METRO in writing.

3.09 SITE SPECIFIC COMMITMENTS

A. Where specific mitigation measures or more rigorous criteria and specifications are identified in such documents, the more stringent requirements shall take precedence over these Specifications.
SECTION 01566

STORM WATER POLLUTION PREVENTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. General

This Section specifies the requirements to control and minimize the levels of pollutants in storm water runoff from construction activities.

B. Storm Water Pollution Prevention Plan (SWPPP)

The narrative portion of the SWPPP is attached to and made a part of this section.

1.02 QUALITY ASSURANCE

A. Reference standards applicable to this Section.

1. ASTM: American Society for Testing and Materials


2. FR: Federal Register / Vol. 57, No. 175 / Wednesday, September 9, 1992 / Notices

   a. Final NPDES General Permits for Storm Water Discharges from Construction Sites.

3. HC/COH: Harris County, the Harris County Flood Control District and the City of Houston

4. USDA: U.S. Department of Agriculture, Soil Conservation Service; Temple, Texas; 1976

   a. Erosion and Sediment Control Guidelines for Developing Areas in Texas.

1.03 SUBMITTALS

In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

A. A copy of the Contractor's Notice of Intent (NOI) form filed with the U.S. Environmental Protection Agency (EPA).

B. A copy of the Contractor's Notice of Termination (NOT) form filed with the U.S. EPA.

C. Manufacturer literature and specifications on geotextile filter fabric, and reinforcement and support posts for silt fences and barriers.

D. Manufacturer literature such as catalog sheets and other pertinent information on materials used for temporary or permanent seeding, mulching, sodding, or other site stabilization measures.

E. Coverage Under the National Pollutant Discharge Elimination System (NPDES) General Permit

   1. General

   To obtain coverage under the NPDES General Permit for Storm Water Discharges from Construction Activities, both METRO and the Contractor have to file a completed Notice of Intent (NOI) form (EPA Form 3510-6) with EPA. The Contractor may file his NOI form anytime during the contract pre-construction stage of the contracting process once the final SWPPP has been prepared and signed, but not later than the date he receives his Notice-to-Proceed (NTP) from METRO. No construction related activities shall be started on the project site until at least 48 hours have elapsed since the Contractor's NOI form original was postmarked and mailed to EPA.

   2. Distribution of the Notice of Intent

   The Contractor shall distribute copies of his NOI form as follows:

   a. Two copies to METRO.
b. One copy to the local Municipal Separate Storm Sewer System (MS4) Operator-the City of Houston/Harris County/Harris County Flood Control District, jointly, addressed to:

Storm Water Management Joint Task Force
P. O. Box 131066
Houston, Texas 77219

c. One copy to be posted on the jobsite bulletin board.

d. One copy to be included as an attachment to the SWPPP maintained on-site.

F. Termination of NPDES General Permit Coverage

The Contractor shall file a Notice of Termination (NOT) form (EPA Form 3510-7) with EPA once the project has been completed and accepted by METRO. Copies of this form shall be distributed as follows:

METRO - Two copies
Local MS4 Operator - One copy

1.04 DEFINITIONS

A. Best Management Practices (BMPs): Management practices, operating procedures, or schedules of activities to control, reduce or prevent the discharge of pollutants from construction related activities into the waters of the U.S., including pollutants related to site housekeeping practices.

B. Erodibility Factor: A soil loss factor used to estimate the potential for erosion by water (rainfall) or wind; varies depending on soil classification and soil horizon; also known as the K factor.

C. Erosion and Sediment Controls (E&SCs): Temporary or permanent controls or practices used to minimize the opportunities for soil erosion to occur and lead to the presence of sediments in storm water runoff from construction sites, and to remove those sediments which do enter storm water before it is discharged from the site.

D. Final Stabilization: A condition where all soil disturbing activities at the site have been completed, and that a uniform perennial vegetative cover with a density of 70% of the cover for unpaved areas and areas not covered by permanent structures has been established or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.
E. General Permit for Storm Water Discharges from Construction Activities: A permit granted for storm water discharges associated with construction activities (clearing, grading, excavation, backfilling, etc.) disturbing five acres or more of land area; coverage is gained by submittal of a Notice of Intent form and maintained by following a project specific Storm Water Pollution Prevention Plan; may be administered by a state (if general permitting authority is authorized) or reserved to the U.S. EPA.

F. Municipal Separate Storm Sewer System (MS4): The system of local streets, storm sewers, drainage ditches and bayous used to collect, convey, and discharge storm water runoff into the waters of the U.S.; the Operator of the local system is Harris County, the Harris County Flood Control District, and the City of Houston under a joint Municipal Permit for Storm Water Discharges.

G. National Pollutant Discharge Elimination System (NPDES): The program established under the Clean Water Act to control and reduce the discharge of pollutants from point sources into the waters of the United States through the issuance of discharge permits; the program was expanded from the coverage of wastewater treatment plant and process water treatment plant discharges to storm water related discharges by the Water Quality Act of 1987; administered by the U.S. EPA.

H. Non-Structural Controls or Practices: See Stabilization Practices; also called vegetative practices.

I. Notice of Intent (NOI): The application form and format to request coverage under the General Permit for Storm Water Discharges from Construction Activities; must be submitted to the U.S. EPA.

J. Notice of Termination (NOT): The form which must be completed and filed with the EPA to terminate coverage under the NPDES General Permit for Storm Water Discharges from Construction Activities.

K. Pollution Prevention Plan (PPP): See Storm Water Pollution Prevention Plan.

L. Protected Storm Sewer Inlet: A storm sewer inlet containing a sediment basket or other sediment trapping device or an inlet surrounded by sediment fence or if a curb inlet, with its entry point covered with filter fabric and other sediment trapping materials.

M. Runoff Coefficient: The ratio or fraction of the total rainfall on a site that will appear at the discharge point or points as runoff; also known as the c factor.
N. Spill Prevention and Response Procedures: Procedures and actions to be undertaken to prevent, control and clean-up spills of fuels, lubricants, solvents and other chemicals according to manufacturer recommendations and local, state and federal regulations; includes a discussion of storage and handling practices, absorbent materials and supplies to be used in spill clean-up, disposal of spill residues, and the naming of a responsible individual to ensure that the Spill Prevention and Response Procedures are followed.

O. Stabilization Practices: Erosion and Sediment Controls or Practices involving the use of mainly vegetative measures such as seeding, mulching, sodding, or buffer strips to provide temporary or permanent erosion control or prevention.

P. Storm Water Management Measures (SWMMs): Temporary or permanent measures used to minimize the volume and velocity of storm water runoff entering and leaving a site, thereby reducing the potential for erosion and the discharge of sediments and other pollutants; could include the use of structural measures, such as a detention basin.

Q. Storm Water Pollution Prevention Plan (SWPPP): A Plan of action to minimize the discharge of pollutants in storm water runoff; Plan development is part of the process for gaining coverage under the General Permit for Storm Water Discharges from Construction Activities.

R. Structural Controls or Practices: Erosion and Sediment Controls or Practices involving the use or construction of temporary or permanent dikes, berms, ridges, diversions, traps, sump pits, or other erosion control or sediment trapping devices; could also include the construction of permanent storm water detention or retention structures and outfall velocity dissipation devices as part of the Storm Water Management Measures for a specific project or site.

PART 2 - PRODUCTS

2.01 FILTER FABRIC

A. Filter fabric shall be woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene or polyamide material. Geotextile fabric shall have a grab strength of 100 psi in any principal direction conforming to ASTM D4632, Mullen burst strength exceeding 200 psi conforming to ASTM D3786, and the equivalent opening size as shown on drawings. Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 F to 120 F. Source: Mirafi Inc. or approved equal.
B. Do not use filter fabric as a separation geotextile, fabric wrap or other specified applications.

2.02 GEOTEXTILE FABRIC WRAP AND SEPARATION GEOTEXTILE

A. Geotextile fabric wrap and separation geotextile shall be woven or nonwoven geotextile fabric made of either polypropylene, polyethylene, ethylene, or polyamide material. Geotextile fabric shall have a grab strength exceeding 270 psi in conformance with ASTM D4632 and with equivalent opening size as shown on drawings. Geotextile fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 F to 120 F. Both the geotextile and threads shall be resistant to chemical attack, mildew and rot. Source: Mirafi Inc. or approved equal.

2.03 RAIN GAUGE

A. Rain gauge shall be either calibrated cylindrical or with a tipping bucket.

2.04 MISCELLANEOUS PRODUCTS

A. Other products used in the performance of the Work include, but are not limited to, galvanized metal pipe, riprap, sands, metal products, seeding, sodding, wood products, concrete, and PVC piping. These products shall be as specified in other Sections of these Specifications.

PART 3 - EXECUTION

3.01 STORM WATER POLLUTION PREVENTION PLAN

A. Site clearing shall be as specified in Section 02110 - Site Clearing of these Specifications.

B. Ensure that Subcontractors comply with the provisions of the SWPPP.

C. Provide qualified personnel to perform the required site inspections for compliance to the SWPPP, and complete, certify and maintain the reports of said inspections at the project site.

D. Repair any storm related damage to temporary or permanent erosion and sediment control measures or storm water management devices specified in the SWPPP within 24 hours of the storm of record event which caused said damage.

E. Immediately correct, as directed by METRO, conditions that prevent compliance with the SWPPP.
F. The Contractor and Subcontractors that are required to implement provisions of the SWPPP, shall be identified in the SWPPP Plan.

G. Inspections for Compliance with the SWPPP

1. Perform, document and certify the required inspections of compliance with the FR Vol. 57, No. 175. Install and maintain at the project site a rain gauge. Inspection personnel shall rely on this rain gauge when complying with the mandated storm of record inspection frequency of performing a site inspection within 24 hours of the end of a rainfall event totaling 1/2 inch or greater in a 24-hour period.

2. The site inspection shall include all disturbed areas for evidence of erosion, locations used to store raw materials exposed to storm water, structural and non-structural erosion and sediment control measures for their effectiveness, construction site entrances and exits for sediment tracking problems, and storm water discharge locations for evidence of sediment discharge and erosive velocities. Inspections that are non-storm related shall be undertaken at seven day intervals except where areas of the site have undergone final stabilization, inspection intervals shall not exceed 30 days.

H. Revisions to the SWPPP

Where revisions to the SWPPP are necessary due to changing conditions, they shall be identified and performed not later than seven days after notification by METRO.

3.02 EROSION AND SEDIMENT CONTROLS

A. Erosion and sediment controls shall be as specified in Section 01560 - Environmental Impact Control of these Specifications.

B. Stabilization Practices

Stabilization practices shall be as specified in Section 01560 - Environmental Impact Control.

3.03 STORM WATER MANAGEMENT MEASURES

A. Management Measures

SWMMs include the use of on-site infiltration devices, storm water flow attenuation by the use of vegetative swales or natural depressions, storm water outfall velocity
dissipation devices, storm water retention structures including those with artificial wetlands, storm water quality detention structures, combinations of these management measures, and other measures approved by METRO.

B. Construction and Maintenance of SWMMs

1. SWMMs shall be constructed in accordance with the project plans, as specified in the project SWPPP or both.

2. SWMMs that are constructed to function during construction shall be inspected after each storm event of record for damage or sediment accumulation. Repair any such storm related damage within 24 hours of said inspection and perform routine maintenance of SWMMs as stated in the project SWPPP, or as directed by METRO.

3. Responsibility for the maintenance of permanent SWMMs constructed as part of the project shall revert to METRO or another designated party by METRO at the completion and close-out of the project.

3.04 CONSTRUCTION SITE HOUSEKEEPING BEST MANAGEMENT PRACTICES

A. General

Appropriate construction site housekeeping Best Management Practices (BMPs) shall be instituted to minimize the opportunities for toxic and hazardous substances to enter storm water discharges from construction activities. Construction site housekeeping shall be as specified in Section 01560 - Environmental Impact Controls.

B. Off-site Tracking Controls

Off-site tracking of construction site sediments or other substances shall not be allowed. Construction site entrance/exit stabilization measures, along with frequent adjacent street sweeping or cleaning or equipment wash rack areas, shall be employed to prevent off-site tracking and to control the generation of fugitive dust.

C. Fugitive Dust and Sediment Tracking Controls

Jobsite office trailer and Contractor staging areas, vehicle or equipment parking or maintenance areas, and project site haul roads that are subject to more than 25 vehicle trips per day or are the source of fugitive dust or sediment tracking, shall be graveled as well as monitored for dust generation and sediment tracking.

D. Concrete Truck Mixer Discharge Controls
Concrete truck mixer and chute washwater shall be discharged on-site, but only to a sump pit or other sediment trapping device.

E. Other Special Practices

In addition to those construction site housekeeping BMPs specified and listed under Item 4811, General Source Controls, in Appendix C of the HC/COH Storm Water Management Handbook for Construction Activities, other Special Practices may be shown on the drawings and required for construction projects which are adjacent to waterways, wetlands, or other environmentally sensitive areas.

3.05 NON-STORM WATER DISCHARGES

A. General

Non-storm water discharges from the project site are not allowed except as stated below. Discharges of water from waterline or fire hydrant flushing shall be onto an impervious or non-erosive surface with the resulting runoff directed into protected storm sewer inlets or sediment traps if it flows across any non-stabilized areas. Similarly, runoff from pavement washdown or excess irrigation or drainage from watering vegetation or landscaping shall be directed to protected storm sewer inlets, sump pits, or sediment traps.

B. Authorized Discharges

Authorized non-storm water discharges include:

1. Discharge from fire fighting activities.
2. Fire hydrant flushing.
3. Waterline flushing, including sprinkler system flushing.
4. Water for washing vehicles or dust control undertaken per the construction site housekeeping BMP practices.
5. Irrigation or sprinkler system drainage from watering vegetation.
6. External building washdown containing no detergents or solvents.
7. Pavement washwater, but not from areas where spills of fuels and toxic or hazardous materials have occurred unless such spills have been thoroughly eradicated.
8. Air conditioning condensate.

9. Springs or other sources of uncontaminated ground water.

10. Uncontaminated flows from foundation or footing drains.

C. Site Dewatering

Dewatering shall be as specified in Section 02200 - Earthwork of these Specifications.

D. Pavement Sawing, Cutting or Grinding

Water used by equipment performing pavement sawing, cutting or grinding shall be considered as water being used for dust control. Runoff or other excess discharge from these activities shall be directed only to protected storm sewer inlets or to sump pits or sediment traps. Excess dust or residual particles produced by these activities shall be promptly swept up or otherwise removed from pavement surfaces so as to not become a source of fugitive dust or storm water pollution.

3.06 PROJECT CLOSE-OUT

A. General

Project close-out shall be as specified in Section 01700 - Project Close-Out of these Specifications.

B. Project Area Clean-Up

Project area clean-up shall be as specified in Section 01560 - Environmental Impact Controls of these Specifications.

END OF SECTION 01566
SECTION 01590

FIELD OFFICE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for a field office for the exclusive use of METRO and METRO representatives at the Site of the Work. The actual field office shall be provided by the Contractor.

B. Field office provided by the Contractor and equipped with furnishings, fittings, equipment and utility connections, will remain the property of the Contractor and shall be removed from the Site of the Work upon written acceptance of the Work by METRO.

C. The Contractor shall retain responsibility for risk of loss or damage to the field office during performance of the Contract.

D. Field office provided by the Contractor shall be separate from any building used by the Contractor.

1.02 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Location and Layout

   a. Drawings showing the proposed location of the field office, including access from public streets, parking provisions and utility connections.

   b. Drawings showing the internal space arrangement, windows and accesses for the field office provided by the Contractor.

   c. Location, utility and layout drawings within 5 working days of the effective date specified in the Notice to Proceed.
2. Manufacturer's Data

Manufacturer's complete technical data shall be submitted for new equipment and furnishings. Photographs, with technical data noted thereon, shall be submitted for used furnishings.

PART 2 - PRODUCTS

2.01 FIELD OFFICE, CONTRACTOR-PROVIDED

A. Field office shall be a factory-manufactured, mobile unit at least 10 ft. wide by 30 ft. long having a minimum of 250 sq. ft. of useable floor space. Unit shall be weather tight, resist heat transmission and have a structurally sound foundation and superstructure.

B. Field office shall be free of damage and defects which would impair its suitability to perform the intended function. Field office will be inspected by METRO for suitability, prior to installation at the Site. Field offices found unsuitable will not be approved for use and shall not be transported to the Site.

C. Field office floor space shall be divided into a private office at one end, a restroom, a storage closet, and a general open office space.

D. Field office shall include the following finishes and fittings:

1. Exterior walls, floors and ceilings: Insulated for the climate indigenous to the Houston, Texas area.

2. Floors: Resilient flooring.

3. Restroom fittings: Water closet, lavatory with hot and cold water supply, mirror, soap holder, toilet tissue dispenser and paper towel dispenser.

4. Lighting: General lighting shall be not less than 100 footcandles at desk height. Restroom lighting shall be adequate.

5. Electrical receptacles: Duplex receptacles on 10 ft. centers on all walls, except in restroom.

6. Water cooler: Electric water cooler with refrigerator compartment, drinking cup dispenser, cups and cup disposal.

7. Water heater: Not less than 20 gallon capacity.
8. Heating and air conditioning: Thermostatically controlled system capable of maintaining office spaces at an ambient temperature of between 68 and 78°F in the climate indigenous to the Houston, Texas area.

9. Doors and locks: Restroom door shall have privacy lock. Exterior doors shall have cylinder lock keyed alike and two keys shall be furnished for each lock.

10. Telephone: One (1) telephone with extra long cord and Two (2) service lines, one (1) line with call waiting feature and answering service or answering machine, the second line shall be used for the fax machine.

11. Burglar alarm: Burglar alarm system with a central control box and audible alarm. Alarm system shall be connected to all windows and exterior doors.

12. Tie-downs: Field office shall be secured in place using tie-downs and methods capable of withstanding winds up to hurricane force and meeting local codes.

13. Outside stairs and landing.

E. Unless otherwise directed by METRO, field office shall include the following furnishings and equipment. Furnishings and equipment may be either new or used. Used furnishings and proposed substitutions of equal furnishings, shall be subject to review and approval by METRO.

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Double pedestal desk, Jasper Office Furniture, Model F 2660.</td>
</tr>
<tr>
<td>1</td>
<td>Hi-Lo Thermometer.</td>
</tr>
<tr>
<td>2</td>
<td>Executive posture chair: Jasper Office Furniture, Model 1750.</td>
</tr>
<tr>
<td>1</td>
<td>Conference Table: 30&quot; x 72&quot;</td>
</tr>
<tr>
<td>8</td>
<td>Stack chairs: GF Business Equipment, Model 40/4.</td>
</tr>
<tr>
<td>1</td>
<td>Built-in plan table, in general office open space.</td>
</tr>
<tr>
<td>1</td>
<td>Desk lamp: Art Specialty, Model K4-2241.</td>
</tr>
<tr>
<td>1</td>
<td>Plan rack, 12 stick.</td>
</tr>
<tr>
<td>1</td>
<td>Rain Gauge.</td>
</tr>
<tr>
<td>1</td>
<td>Fire extinguisher, 8-1/2 lb., Class ABC.</td>
</tr>
<tr>
<td>1</td>
<td>First Aid Kit: Zee Medical Products Co., Model 150.</td>
</tr>
<tr>
<td>1</td>
<td>Printing calculator: Sharp, Model EL-2168S, including maintenance and supplies.</td>
</tr>
<tr>
<td>QUANTITY</td>
<td>ITEM</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Coat Rack: Vogel Peterson, Model E4-S-48cDTN.</td>
</tr>
<tr>
<td>1</td>
<td>Fireproof file, 4 drawer: Hon, Model HN-94CP.</td>
</tr>
<tr>
<td>1</td>
<td>Copy machine, with multiple paper trays (3) and enlarge/reduce functions. Canon, NP 2020 (or approved equal), including maintenance and supplies.</td>
</tr>
<tr>
<td>1</td>
<td>Plain paper fax machine, 14.4 kbps fax modum, with 10 page incoming memory, including maintenance and supplies.</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 GENERAL

A. Field office, including utility connections, tie-downs, access and parking therefor shall be installed prior to beginning construction activities at the Site.

3.02 ACCESS AND PARKING

A. Field office shall be located as indicated on the approved location Drawings with clear access from public streets.

B. Parking space shall be provided for not less than three vehicles adjacent to the field office. Signs shall be posted indicating that the parking is reserved for METRO personnel.

C. Access road and parking space shall be graded for drainage and surfaced with gravel, asphalt or concrete so as to provide an all-weather surface.

3.03 SEWER CONNECTION

A. The restroom shall be connected either to an existing sanitary sewer line or to a chemical holding tank. The holding tank shall be serviced as often as necessary to prevent an accumulation of wastes and an unsanitary condition.

3.04 TELEPHONE AND UTILITY SERVICES

A. Telephones and utilities shall be connected and all connection and service charges paid by the Contractor.
3.05 MAINTENANCE

A. Field office shall be maintained and serviced daily, by the Contractor’s forces, during normal working hours. Servicing shall include complete janitorial services including supplies such as soap, toilet tissue, paper towels and cups.

3.06 REMOVAL

A. The utilities shall be disconnected and field office shall be removed from the Site upon written acceptance of the Work by METRO.

B. All evidence of parking, access and utility connections shall be removed and the field office site shall be restored to a satisfactory condition as directed by METRO. Disconnection charges shall be paid and accounts closed out.

END OF SECTION 01590
SS SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for transportation, delivery, handling, and storage of materials and equipment.

1.02 PRODUCTS

B. Products: Means material, equipment, or systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components designated for reuse.

C. Do not reuse materials and equipment, designated to be removed, except as specified by the Contract Documents.

D. Provide equipment and components from the fewest number of manufacturers as is practical, in order to simplify spare parts inventory and to allow for maximum interchangeability of components. For multiple components of the same size, type or application, use the same make and model of component throughout the project.

1.03 TRANSPORTATION

E. Make arrangements for transportation, delivery, and handling of equipment and materials required for timely completion of the Work.

F. Transport and handle products in accordance with manufacturer's instructions.

G. Consign and address shipping documents to the proper party giving name of Project, street number, and City. Shipments shall be delivered to the Contractor.

1.04 DELIVERY

A. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation. Avoid deliveries that cause lengthy storage or overburden of limited storage space.
B. Coordinate deliveries to avoid conflict with Work and conditions at the site and to accommodate the following:

1. Work of other contractors or the Owner.
2. Limitations of storage space.
3. Availability of equipment and personnel for handling products.
4. Owner's use of premises.

C. Have products delivered to the project site only after related Shop Drawings have been reviewed by the Engineer.

D. Have products delivered to the site when adequate storage facilities have been provided.

E. Have products delivered to the site in manufacturer's original, unopened, labeled containers. Keep the Engineer informed of delivery schedules for equipment to be incorporated in the Work.

F. Clearly mark partial deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate assembly.

G. Immediately upon delivery, inspect shipment to assure:

1. Product complies with requirements of Contract Documents and reviewed submittals.
2. Quantities are correct.
3. Containers and packages are intact; labels are legible.
4. Products are properly protected and undamaged.

1.05 PRODUCT HANDLING

A. Coordinate the off-loading of materials and equipment delivered to the job site. If necessary to move stored materials and equipment during construction, Contractor shall relocate materials and equipment at no additional cost to the Owner.

B. Provide equipment and personnel necessary to handle products, including those provided by the Owner, by methods to prevent soiling or damage to products or packaging.

C. Provide additional protection during handling as necessary to prevent scraping, marring, or otherwise damaging products or surrounding surfaces.
D. Handle products by methods to prevent bending or over stressing.

E. Lift heavy components only at designated lifting points.

F. Handle materials and equipment in accordance with Manufacturer's recommendations.

G. Do not drop, roll, or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

1.06 STORAGE OF MATERIAL

A. Store and protect materials in accordance with manufacturer's recommendations and requirements of these Specifications.

B. Make necessary provisions for safe storage of materials and equipment. Place excavated materials, construction equipment, and materials and equipment to be incorporated into the Work to prevent damage to any part of the Work or existing facilities and to maintain free access at all times to all parts of the Work and to utility service company installations in the vicinity of the Work. Keep materials and equipment neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants. Arrange storage in a manner to provide easy access for inspection.

C. Restrict storage to areas available on the construction site for storage of material and equipment as shown on Drawings or approved by the Engineer.

D. Provide off-site storage and protection when on-site storage is not adequate.

E. Do not use lawns, grass plots, or other private property for storage purposes without written permission of the owner or other person in possession or control of such premises.

F. Protect stored materials and equipment against loss or damage.

G. Store in manufacturers' unopened containers.

H. Materials delivered and stored shall be neatly, safely, and compactly stacked along the work site in such manner as to cause the least inconvenience and damage to property owners and the general public, and shall be not closer than 3 feet to any fire hydrant. Public and private drives and street crossings shall be kept open.

I. Damage to lawns, sidewalks, streets or other improvements shall be repaired or replaced to the satisfaction of the Engineer.
PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not used)

END OF SECTION
SECTION 01630

PRODUCTS AND SUBSTITUTIONS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for preparing and submitting requests for substitution for specified products and methods.

1.02 LIST OF PRODUCTS PROPOSED FOR USE
A. General

The Contractor's options in selecting products are limited by requirements of the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects.

B. Standards

Where products are specified in the Contract Documents by reference standards or code only, any product meeting or exceeding those standards may be proposed. Listing shall indicate the name and address of manufacturer, model number or catalog designation, manufacturer's reference standards and pertinent test data indicating compliance with the referenced standard, code, or regulation.

C. Approved Equal

Where products are specified by naming one or more products and "approved equal", the intent shall be to establish a quality standard, a performance standard and an appearance standard for the product and any other product equaling or exceeding those standards, for the application intended, may be proposed. A formal request for substitution shall be submitted for consideration of any product not specifically named in the Contract Documents. Contractor shall comply with the Contract Documents provisions for substitutions to obtain METRO approval of an unnamed product.

D. Proprietary

Where products are specified by naming only one product, or manufacturer, the intent is to establish not only a quality standard, but continuity to ensure form, fit,
function, and compatibility on all METRO projects and facilities, and not to restrict competition. Other products may not be accepted, unless the Specification indicates possible consideration of other products. Advise METRO before proceeding, when it is discovered that the named product is not a feasible solution.

E. Response

METRO will respond to the Contractor in writing within 10 working days of receipt of the product-listing submitted. No response by METRO within the 10 working day time period constitutes no objection to the listed products or manufacturers, but does not constitute a waiver of the requirement that products comply with the requirements of the Contract Documents. METRO's response will include the following:

1. Listing of unacceptable product selections, if any, containing an explanation of the reasons for this action.

2. A request for additional data necessary for the review and possible acceptance of the products and manufacturer's listed.

1.03 SUBSTITUTIONS FOR PRODUCTS AND METHODS

A. General

Three copies of written requests for substitutions for products or methods, to replace those items specified or indicated, shall be submitted to METRO in sufficient time for METRO's review and comment so as not to delay the Work.

B. Limited Approval

1. Approval of substitutions by METRO shall be only for the characteristics and use specifically indicated in the approval. Approved substitutions shall neither be interpreted as a modification to the Contract Document requirements nor as an acceptance of the product or method for any use other than that specifically indicated in the approval for the substitution.

2. All Shop Drawings, product data and samples submitted by the Contractor shall illustrate details of work, equipment, materials, products, systems, designs or workmanship that the Contractor proposes to use in order to comply with the design concept established in Contract Documents. METRO's review of these submittals is only for the limited purpose of checking the same for conformity with the design concept of the Work as established in the Contract Documents. This review is not intended to be for the purpose of determining the accuracy of other matters that may be
contained in such submittals, including but not limited to such matters as
dimensions, quantities, performance of equipment and systems designed by
the Contractor, Contractor-furnished engineering and design, construction
means, methods, techniques, sequences, procedures or safety precautions,
the correctness of which as set forth in the submittal shall be the sole
responsibility of the Contractor. METRO will undertake its review with
reasonable promptness so as to cause no delay. METRO's review of a
specific item shall not indicate approval of an assembly of which the item is a
component or in which it functions.

C. Suitability Evaluation

Where a request for use of a substitute product or method requires redesign or
rework of another portion of the Work, the time and cost required to effect such
redesign or rework shall be considered in evaluating the suitability of the requested
substitution. The costs of all such redesign or rework as required to incorporate the
substitution shall be considered a part of the Work.

D. Written Requests

In each request, identify the product or fabrication or installation method to be
replaced by the substitution; include related Specification section and Drawing
numbers, and complete documentation showing compliance with the requirements
for substitutions. Include the following information, as appropriate, with each written
request:

1. Complete product data, drawings, descriptions, and procedures
substantiating compliance with the Contract Documents requirements.

2. Detailed comparison of the proposed substitution with the product or method
specified or indicated. Comparison shall include estimated service life in the
application intended, estimated preventive maintenance, spare parts
availability, repair service availability, energy consumption, performance,
operating characteristics and requirements, warranties and other significant
qualities and differences.

3. Product identification including manufacturer's name, address, local
representative and complete literature relative to the proposed substitution.

4. Detailed description of construction methods, means, techniques,
sequences, and procedures, including drawings or photographs illustrating
such items, where necessary for clarification.
5. Provide complete coordination information. Include all changes required in other elements of the Work to accommodate the substitution, including work performed by METRO and other Contractors.

6. Provide a statement indicating the effect the substitution will have on the Work schedule in comparison to the schedule without approval of the proposed substitution. Include information regarding the effect of the proposed substitution on the Contract Period of Performance.

7. Provide complete cost information, including a proposal of the net change, if any in the Contract Sum.

8. Provide certification by the Contractor to the effect that, in the Contractor's opinion, after thorough evaluation, the proposed substitution will result in work that in every significant respect is equal-to or better than the work required by the Contract Documents, and that it will perform adequately in the application indicated. Include in this certification, the Contractor's waiver of rights to additional payment or time due to failure of the substitution to perform adequately.

E. Certification

In making a request for substitution, Contractor shall certify in writing that he will:

1. Provide at least the same guarantee for the substitution as may be required for the product specified or indicated.

2. Coordinate the installation of the substitution and make or have made all necessary adjustments and changes to interfacing work.

3. Replace substitutions which fail to meet the Contract Documents requirements, including substitutions in kind which have not yet failed, if so directed, at no additional cost to METRO.

F. Conditions

The Contractor's request for a substitution will be considered when extensive revisions to the Contract Documents are not required, when the proposed changes are in keeping with the general intent of the Contract Documents, when the requests are timely, fully documented and properly submitted. Substitutions will not be considered if indicated or implied on Shop Drawings or product data submittals for which no written request for substitution has been submitted. The Contractor's submittal of and METRO's acceptance of Shop Drawings, product data or samples which relate to work not complying with requirements of the Contract Documents,
does not constitute an acceptable or valid request for a substitution, nor approval thereof.

G. Notification

Within 7 working days of receipt of the Contractor's request for substitution, METRO will request additional information or documentation as may be needed for evaluation of the request. Within 10 working days of receipt of the request, or within 7 working days of receipt of the requested additional information or documentation, whichever is later, METRO will notify the Contractor of either the acceptance or rejection of the proposed substitution. Acceptance will be in the form of a Change Order. Rejection will include a statement giving reasons for the rejection. METRO's approval of substitutions shall not be construed as approval of the Contractor's methods, means, techniques, sequences, and procedures submitted for clarification purposes at METRO's request.

H. Visual Matching

Where matching an established sample is required, the final judgment of whether a product substitution proposed by the Contractor matches the sample satisfactorily will be determined by METRO. Where there is no product available within the specified product category that matches the sample satisfactorily and also complies with other specified requirements, Contractor shall comply with the provisions of this Section 01630 and the Contract Documents concerning "substitutions" for selection of a matching product.

I. Visual Selection

Except as otherwise indicated, where specified product requirements include the phrase "as selected from the manufacturer's standard colors, patterns, textures. . . ." or similar phrases, the Contractor may select the proposed product and manufacturer, provided the selection complies with other specified requirements. METRO will select the color, pattern and texture from the product line proposed by the Contractor.

J. Producer's Statement of Applicability

Where directed by METRO, the Contractor shall submit a written certified statement from the producer stating that the producer has reviewed the proposed application of the product. This statement shall state that the producer agrees with or does not object to METRO's specification and the Contractor's selection of the product for use in the Work. The statement shall also state that the proposed application of the product on the Work is suitable and proper.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01630
SECTION 01700

PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for completing, documenting, and closing out the Project.

1.02 DEFINITIONS

A. Project Closeout

Project closeout is the term used to describe certain collective requirements, indicating completion of the Project, that are to be fulfilled near the end of the Contract Period of Performance in preparation for final acceptance of the Project by METRO, as well as final payment to the Contractor and the normal termination of the Contract.

B. Other Requirements

Specific requirements for individual units of work shall be as included in the appropriate Sections in Divisions 2 through 16 of the Contract Documents.

C. Time

Time of closeout is directly related to "Substantial Completion"; therefore, the time of closeout may be either a single time period for the entire Project or a series of time periods for individual elements of the Project that have been certified as substantially complete at different dates. This time variation, if any, shall be applicable to the other provisions of this Section.

D. Substantial Completion

This milestone shall be the stage of the Project at which when solely determined by METRO, the Project is ready for intended service to the extent required by METRO.
1.03 PREREQUISITES TO SUBSTANTIAL COMPLETION

A. General

Contractor shall complete the following, as applicable, before requesting METRO's inspection for certification of Substantial Completion, either for the entire Project or for portions of the Project. List known exceptions in the request.

1. In the progress payment request that coincides with, or is the first request following, the date Substantial Completion is claimed, show either 100% completion for the portion of the Project claimed as "substantially complete", or list incomplete items, the value of incomplete work, and reasons for the work being incomplete. Include supporting documentation for completion as indicated in the Contract Documents.

2. Submit a statement showing an accounting of Change Orders to the Contract Sum.

3. Advise METRO of all pending insurance change-over requirements.

4. Submit specific warranties, workmanship/maintenance bonds, maintenance agreements, final certifications and similar documents.

5. Obtain and submit releases enabling METRO's full, unrestricted use of the Project and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.

6. Assemble Record Drawings, maintenance manuals, final photographs, damage or settlement survey, property survey, and similar final record information for turnover after final acceptance.

7. Assemble special tools, spare parts, extra stock of material and similar physical items for turnover after final acceptance.

8. Make the final change-over of locks and transmit the keys to METRO. Advise METRO personnel of the change-over in security provisions.

9. Complete start-up testing of systems, and instruction of METRO operating and maintenance personnel. Discontinue or change over and remove temporary facilities and services from the Project Site, along with construction tools and facilities, mock-ups, and similar elements.
10. Complete final cleaning up requirements, including touch-up painting of marred surfaces. Touch-up and otherwise repair and restore marred exposed finishes.

B. Inspection Procedures

Upon receipt of the Contractor's request for inspection, METRO will either proceed with inspection or advise the Contractor in writing of unfilled prerequisites. Following the initial inspection, METRO will either prepare the Certificate of Substantial Completion, or will advise the Contractor in writing of work which must be performed before the certificate will be issued. METRO will repeat, or have repeated, the inspection when requested and when assured that the Project has been Substantially Completed. Results of the completed inspection shall form the initial "punch-list" for final acceptance.

1.04 PREREQUISITES TO FINAL ACCEPTANCE

A. General

Contractor shall complete the following, as applicable, before requesting METRO's final inspection for certification of final acceptance, and final payment as required by the Contract Documents. List known exceptions in request.

1. Submit the 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.

2. Submit an updated final cost statement, accounting for final additional Change Orders to the Contract Sum.

3. Submit a certified copy of the final punch-list of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and has been endorsed and dated by METRO.

4. After receipt of Substantial Completion, Contractor shall transfer potable and irrigation water, sanitary, electrical and phone services over to METRO. Utilities shall address their invoices to:

   Director of Accounting
   Metropolitan Transit Authority
   1201 Louisiana, 18th Floor
   P. O. Box 61429
   Houston, Texas 77208-1429
Upon transfer of utilities to METRO, Contractor shall provide documentation on date of utility transfer along with meter readings for potable and irrigation water and electric services.

5. Submit consent of surety.

6. Submit a final liquidated damages or incentive settlement statement, acceptable to METRO.

7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Reinspection Procedure

1. METRO will reinspect the Project upon receipt of the Contractor’s notice that the punch-list items resulting from earlier inspections, have been completed, except for those items whose completion has been delayed because of circumstances that are known to and acceptable by METRO.

2. Upon completion of reinspection, METRO will either prepare a Certificate of Final Acceptance, or will advise the Contractor in writing of work that is incomplete or of obligations that have not been fulfilled, but are required for final acceptance. If necessary, the reinspection procedure shall be repeated until final acceptance.

1.05 RECORD DOCUMENTS REQUIRED AT CLOSEOUT

A. General

1. Requirements for Record Documents shall be as indicated herein. General submittal requirements are indicated in the various "Submittals" Articles and in Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications.

2. Do not use Record Documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to Record Documents for METRO’s reference during normal working hours.

B. Record Drawings

1. Maintain a Record Drawings set of blue or black line white-prints of Contract Drawings and Shop Drawings in a clean, undamaged condition. Mark-up the set of Record Drawings to show the actual installation where the installed
work varies from the work as originally shown. Mark whichever Drawing is most capable of showing the actual "field" condition fully and accurately; however, where Shop Drawings are used for mark-up, record a cross-reference at the corresponding location on the working drawings. Give particular attention to concealed work that would be difficult to measure and record at a later date.

2. Mark Record Drawing sets with red erasable pencil and where feasible, use other colors to distinguish between variations in separate categories of work.

3. Mark-up new information which is known to be important to METRO, but for some reason was not shown on either Contract Drawings or Shop Drawings.

4. Note related Change Order numbers where applicable.

5. Organize Record Drawing sets into manageable sets, bind with durable paper or cardboard cover sheets, and print suitable titles, dates and other identification on the cover of each set.

C. Record Specifications

Maintain one complete copy of the Contract Documents, including Specifications and Addenda, and one copy of other written documents such as Change Orders and similar modifications issued during construction. Mark these documents to show variations in the actual work performed in comparison with the text of the Specifications and modifications as issued. Give particular attention to substitutions, selection of options and similar information on work where it is concealed or cannot otherwise be readily discerned at a later date by direct observation. Note related Record Drawing information and Record Product Data, where applicable. Upon completion of the Project, submit Record Specifications to METRO for retention.

D. Record Storm Water Pollution Prevention

Maintain inspection reports on storm water pollution prevention, one copy of each revision to the SWPPP and one signed copy of the Notice of Termination, all as specified in Section 01566 - Storm Water Pollution Prevention.

E. Record Product Data

Maintain one copy of each Product Data submittal. Mark these Record Documents to show variations in the actual work performed in comparison with the submitted information. Include both variations in the products as delivered to the Site, and variations from the manufacturer's instructions and recommendations for installation.
Give particular attention to concealed products and portions of the Project which cannot otherwise be readily discerned at a later date by direct observation. Note related Change Orders and mark-up of Record Drawings and Specifications. Upon completion of mark-up, submit complete set of Record Product Data to METRO for retention.

F. Record Sample Submittals

Immediately prior to the date of Substantial Completion, the Contractor shall meet at the Site with METRO personnel who so desire, to determine which, if any, of the submitted samples that have been maintained by the Contractor during progress of the Work, are to be transmitted to METRO for retention.

G. Miscellaneous Record Submittals

Refer to other Sections of these Specifications for requirements of miscellaneous record-keeping and submittals in connection with the actual performance of the Work. Immediately prior to the date of Substantial Completion, Contractor shall complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference and submit to METRO for retention.

H. Maintenance Manuals

Contractor shall organize operating and maintenance data into sets of manageable size. Bind data into individual binders, properly identified and indexed. Bind each set of data in a heavy-duty 2-inch, 3-ring vinyl-covered binder, with pocket folders for folded sheet information. Mark the appropriate identification on both front and spine of each binder in accordance with Section 01730 - Operating and Maintenance Data.

1.06 MEASUREMENT AND PAYMENT

No separate measurement or payment will be made for project closeout. This cost will be considered incidental to the total contract bid amount.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 OPERATING AND MAINTENANCE INSTRUCTIONS AT CLOSEOUT

A. General
1. Contractor shall comply with Section 01730 - Operating and Maintenance Data of these Specifications.

2. Arrange for each Installer of operating equipment and other work that requires regular or continuing maintenance, to meet at the Site with METRO personnel to provide necessary basic instruction in the proper operation and maintenance of the entire Work. Where Installers are not experienced in the required procedures, arrange for instruction by the manufacturer's representatives.

3. As part of this instruction, provide a detailed review of the following items, as appropriate:

   Maintenance manuals
   Record Documents
   Spare parts and materials
   Tools
   Lubricants
   Fuels
   Identification systems
   Control sequences
   Hazards
   Cleaning
   Warranties, bonds, maintenance agreements and similar continuing commitments.

4. As part of this instruction, for operating equipment demonstrate the following procedures:

   Start-up
   Shut-down
   Emergency operations
   Noise, vibration, control, and flow adjustments
   Safety procedures
   Economy and efficiency adjustments
   Effective energy utilization

3.02 FINAL CLEANING

A. General

1. Contractor shall comply with Section 01560 - Environmental Impact Controls of these Specifications. Provide final cleaning of the Project at the time so directed by METRO in writing. Employ experienced workers or professional
cleaners for final cleaning. Clean each surface or unit of work to the condition expected from a normal, commercial cleaning and maintenance program. Comply with the manufacturer's instructions for cleaning and make ready operations.

2. Complete the following cleaning operations before requesting METRO inspection for certification of Substantial Completion:
   a. Remove labels which are not required as permanent UL or FM labels.
   b. Clean transparent materials, including mirrors and glass, to a polished condition. Remove putty and other substances which are noticeable. Replace chipped or broken glass and other damaged transparent materials.
   c. Clean exposed exterior and interim hard-surfac ed finishes to a dust-free condition, free of dirt, dust, stains, films and similar noticeable distracting substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors and pavers broom clean. Vacuum interior surfaces.
   d. Wipe and clean surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
   e. Clean the Project Site, including landscape areas, of rubbish, litter and other foreign substances. Sweep paved areas to a broom clean condition; remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth even-textured surface.

B. Pest Control

When so directed in writing by METRO, Contractor shall engage an exterminator to make a final inspection of the Project, and to rid the Project of rodents, insects and other pests.

C. Removal of Temporary Protection

Contractor shall comply with Section 01510 - Temporary Facilities of these Specifications. Except as otherwise indicated or directed in writing by METRO, remove temporary protection devices and facilities which were installed during the course of the Project to protect previously completed work during the remainder of the construction period.
D. Compliance

Contractor shall coordinate his efforts hereunder with Section 01560 - Environmental Impact Controls of these Specifications. Comply with safety standards and governing regulations for cleaning operations. Do not burn waste materials at the Site. Do not bury debris or excess materials on METRO property. Do not discharge volatile or other harmful or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of in a lawful manner. Where extra materials of value, which remain after completion of associated work, have become METRO property, dispose of these materials as directed in writing by METRO.

END OF SECTION 01700
SECTION 01730

OPERATING AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for preparing operating and maintenance data for products, equipment, and systems and for instructing METRO personnel in the operation and maintenance of products, equipment and systems at the Project Site.

1.02 SUBMITTALS
A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Two copies of a preliminary draft of proposed data formats and outlines of contents to METRO for review, not less than 90 calendar days prior to final inspection and acceptance of the Work.

2. Two copies of the completed data in final form to METRO for approval, not less than 30 calendar days prior to final inspection and acceptance of the Work.

3. Six copies of the approved data to METRO for record and retention, within 10 working days after written acceptance of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 OPERATING AND MAINTENANCE MANUALS
A. General

1. Contractor shall comply with Section 01700 - Project Closeout of these Specifications. Operating and maintenance data shall be assembled using the appropriate manufacturer's latest applicable standard commercial data.

2. Data shall be prepared in form of an instructional and operations manual.
B. Format

1. General Title on Cover and Title Page: Operating and Maintenance Instructions.

2. METRO Contract No. and Title.

3. Subject: Mechanical or Electrical Equipment or Systems Identification.

4. Table of Contents and Index.

5. Text: Manufacturer's printed data.

6. Name, address and telephone numbers of manufacturer's local service representative and stock point, subcontractor or installer, and maintenance contractor, as appropriate.

C. Contents

1. Physical and Functional Description of System and Components
   a. System and equipment functions, normal operating characteristics and limiting conditions.
   b. Performance curves, engineering data and tests.

2. Operating Procedures
   a. Safety precautions and pre-operation warnings or cautions.
   b. Start-up, break-in, routine and normal operating instructions.
   c. Control, stopping, shut-down and emergency instructions.
   d. Special operating instructions.

3. Maintenance Procedures
   a. Routine maintenance operations and preventive maintenance schedule.
   c. Adjustment and repair instructions to the level of effort commensurate with METRO operating personnel.
4. Servicing and lubricating schedule, operating hours checklist and log.

5. Manufacturer's printed operating and maintenance instructions.

6. Manufacturer's parts list, illustrations, assembly drawings, diagrams and illustrated parts breakdown.

7. Control and wiring diagrams and one-line schematics.

8. List of original manufacturer's spare parts, manufacturer's current prices, recommended stockage quantities, and name and address of nearest parts vendor or stock point.

D. Manual Updating

Contract technical data shall be maintained current. Updating of operating and maintenance manuals shall be accomplished by the manufacturer, by service bulletins, and other printed notices as revisions occur throughout the life of the equipment.

3.02 OPERATING AND MAINTENANCE INSTRUCTION

A. Prior to acceptance of the completed Project by METRO, METRO personnel shall be instructed in hands-on operation and maintenance of products, equipment and systems. METRO may require others to be in attendance at such demonstrations.

B. The operating and maintenance manual, as specified in Article 1.02 C of this Section, shall constitute the basis of instruction.

C. Start-up, shut-down, emergency operations, lubrication, cleaning, adjustments, safety, and similar operations shall be demonstrated and all procedures pertaining thereto shall be validated.

D. Additional data shall be included to supplement the operating and maintenance manual when the need for such data becomes apparent during instruction.

END OF SECTION 01730
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Demolishing and removing existing structures, equipment and materials.
B. Disposing of demolished materials and equipment.

1.02 SUBMITTALS

A. Submittals shall conform to requirements of Section 01340 – Shop Drawings, Product Data, Samples and Record Documents.
B. Submit proposed methods, equipment, materials and sequence of operations for demolition of structures. Describe coordination for shutting off, capping, and removing temporary utilities. Plan operations to minimize temporary disruption of utilities to existing facilities or adjacent property.
C. Submit proposed demolition and removal schedule for approval. Notify OWNER in writing at least 48 hours before starting demolition.
D. Submit an approved copy of demolition schedule to Fire Department prior to commencement of demolition operations, as required.
E. Obtain a permit for building demolition, as required.

1.03 OWNERSHIP OF MATERIAL AND EQUIPMENT

A. Materials and equipment designated for reuse or salvage are listed in Section 01010 - Summary of Work. Protect items designated for reuse or salvage from damage during demolition, handling and storage. Restore damaged items to satisfactory condition.
B. Materials and equipment not designated for reuse or salvage become the property of the Contractor.

1.04 STORAGE AND HANDLING

A. Store and protect materials and equipment designated for reuse until time of installation.
B. Deliver items to be salvaged to OWNER property storage areas indicated on Drawings.

C. Remove equipment and materials not designated for reuse or salvage and all waste and debris resulting from demolition from site. Remove material as work progresses to avoid clutter.

1.05 ENVIRONMENTAL CONTROLS

A. Minimize spread of dust and flying particles. If required by governing regulations, use temporary enclosures and other suitable methods to prevent the spread of dust, dirt and debris.

B. Use appropriate controls to limit noise from demolition to levels designated in City ordinances.

C. Do not use water where it can create dangerous or objectionable conditions, such as localized flooding, erosion, or sedimentation of nearby ditches or streams.

D. Stop demolition and notify Owner if underground fuel storage tanks, asbestos, PCB’s, contaminated soils, or other hazardous materials are encountered.

E. Dispose of removed equipment, materials, waste and debris in a manner conforming to applicable laws and regulations.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS FOR DEMOLITION

A. Use equipment and materials approved under Paragraph 1.03, Submittals.

B. Fires are not permitted.

C. Do not use a "drop hammer" where the potential exists for damage to underground utilities, structures, or adjacent improvements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to demolition, make an inspection with OWNER’s representative to determine the condition of existing structures and features adjacent to
items designated for demolition.

B. OWNER’s representative will mark or list existing equipment to remain the property of the OWNER.

C. Do not proceed with demolition or removal operations until after the joint inspection and subsequent authorization by OWNER’s representative.

3.02 PROTECTION OF PERSONS AND PROPERTY

A. Provide safe working conditions for employees throughout demolition and removal operations. Observe safety requirements for work below grade.

B. Maintain safe access to adjacent property and buildings. Do not obstruct roadways, sidewalks or passageways adjacent to the work.

C. Perform demolition in a manner to prevent damage to adjacent property. Repair damage to City property or adjacent property and facilities.

D. The Contractor shall be responsible for safety and integrity of adjacent structures and shall be liable for any damage due to movement or settlement. Provide proper framing and shoring necessary for support. Cease operations if an adjacent structure appears to be endangered. Resume demolition only after proper protective measures have been taken.

E. Erect and maintain enclosures, barriers, warning lights, and other required protective devices.

3.03 UTILITY SERVICES

A. Follow rules and regulations of authorities or companies having jurisdiction over communications, pipelines, and electrical distribution services.

B. Notify and coordinate with utility company and adjacent building occupants when temporary interruption of utility service is necessary.

3.04 DEMOLITION

A. Demolish structure to the lines and grades shown on Drawings. Where no limits are shown, the limits shall be 4 inches outside new items to be installed. Removals beyond these limits shall be at the Contractor's expense; satisfactorily reconstruct excess removals.
B. Demolish structures to a minimum of 3 feet below finished grade, unless otherwise indicated on Drawings.

3.05 DISPOSAL

A. Remove from the site all items contained in or upon the structure not designated for reuse or salvage.

B. Follow method of disposal as required by regulatory agencies.

3.06 BACKFILL

A. Backfill holes in accordance with specification sections governing materials indicated on Drawings. Where no material is indicated, backfill with approved borrow and compact to a density of 90 percent standard Proctor.

B. Do not backfill with material from demolition unless approved by OWNER’s representative.

3.07 MECHANICAL WORK ITEMS

A. Mechanical removals consist of dismantling and removing existing piping, pumps, motors, water tanks, equipment and other appurtenances. It includes cutting, capping, and plugging required to restore use of existing utilities.

B. Remove existing process, water, and other piping indicated to be removed on Drawings. Take out piping to the limits shown. Piping not indicated on Drawings shall be removed to the nearest solid support, capped, and the remainder left in place even though it does not interfere with new work. Purge process lines and tanks. Verify that such lines are safe prior to removal or capping.

C. When underground piping is to be altered or removed, cap the remaining piping. Abandoned underground piping may be left in place unless it interferes with new work or is shown or specified to be removed. Piping less than 15 inches in diameter may be plugged and abandoned in place. For piping 15 inches in diameter and greater to be abandoned, fill with sand, pressure grout or other approved method and plug with concrete or brick masonry bulkhead.

3.08 ELECTRICAL WORK ITEMS
A. Shall comply with SS16095 – Selective Demolition for Electrical Systems.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. DEMOLITION shall be measured per Lump Sum for all work indicated on the drawings and the measurement shall include all equipment, labor and materials required to complete the work.

4.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for removal and disposal of all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
SS SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 PROTECTION

A. Provide temporary fencing, barricades, barriers, and guards to protect utilities, structures, and facilities to remain undisturbed.

B. Establish paths of traffic and material storage areas and conduct construction operations of moving mechanical equipment to maintain adequate clearance to prevent damage to items to remain undisturbed.

C. Maintain drainage sewers, drainage swales, and ditches or establish temporary drainage system to prevent flooding, sedimentation, or erosion damage to project site, adjacent properties, and receiving drainage ways and waters.

D. Maintain public roadway used during site preparation operations as haul roads, sweep roadways free of spillage, and restore to previous condition.

E. Maintain and protect existing utilities to remain which pass through project area.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 INSPECTION

A. Verify existing site conditions.

B. Beginning work means acceptance of existing site conditions.

C. Notify Engineer of differing or irregular existing site conditions.

D. Identify established lines, levels, and datum.

E. Delineate construction areas from areas to remain undisturbed.

F. Mark location of underground utilities.

3.02 PRESERVATION OF STAKING
A. Site preparation operations shall preserve survey staking.

B. Employ surveyor to check staking and reset any missing, disturbed, or damaged staking upon completion of site preparation at no additional cost to Owner.

C. Use staking to ensure obstructions have been removed within designated construction area, rights-of-way, or easements.

D. Barricade bench marks to protect from damage or displacement.

3.03 FILLING AND ROUGH GRADING

A. Depressions and areas below grade in site area shall be filled to rough grade elevations shown using material from high areas.

B. Fill to indicated rough grade elevations with material specified, when fill obtained from high areas is exhausted.

C. Compact fill to preclude further consolidation.

D. Rough Grading:
   1. Site shall be rough-graded to eliminate holes and sharp breaks in grade and to fit into area drainage pattern.
   2. Site shall drain readily.

3.04 DISPOSAL OF WASTE MATERIALS

A. Trash, debris, cleared and grubbed materials, and unsuitable, unusable, and undesirable materials necessary and designated by Owner shall be removed from construction area.

B. Burning on Owner's Property:
   1. Burning of combustible cleared and grubbed and other combustible materials is not permitted.

3.05 EXCESS MATERIAL

A. Excess material designated by Owner to be removed shall become property of Contractor and removed from Owner's controlled property and legally disposed of.
PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. SITE PREPARATION shall be measured Lump Sum for all work indicated on the drawings and the measurement shall include all equipment, labor and materials required.

B. DISPOSAL OF EXCESS EXCAVATED SOIL shall be measured per Cubic Yard and the measurement shall include all equipment, labor and materials required.

4.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid for each item as presented in the bid form for “Sitework”. The unit price bid for each item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
SECTION 02110

SITE CLEARING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for Site clearing which may consist of:

1. Protection of trees indicated to be preserved.
2. Protection of above-ground and below-ground existing improvements indicated to be preserved.
3. Clearing, grubbing, removal and disposal of trees, stumps, brush, roots, vegetation, logs and rubbish.
4. Removal and disposal of above-ground and below-ground materials and existing improvements, including building demolition if any, as indicated.
5. Stripping and stockpiling of topsoil.

1.02 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples and Record Documents of these Specifications, the following shall be submitted:

1. A detailed sequence of demolition and removal work to METRO for review prior to start of Work.

1.03 JOB CONDITIONS

A. Conduct demolition operations and removal of debris in accordance with governing regulations and Section 02050 - Demolition of these Specifications.
B. Ensure minimum interference with adjacent occupied or used facilities.
C. Exercise care to protect adjacent building, structures, and persons.
D. Tree Protection

1. Trees to be preserved shall be protected by barricades to avoid any confusion and damage prior to site clearing operations.

2. Contractor shall install barricades 3 ft. beyond drip line of trees to be protected. Construction equipment or storage activities shall not be permitted within the fenced area.

E. Above-ground and below-ground existing improvements, indicated to remain, shall be protected from damage prior to and during construction operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 CLEARING

A. Trees to be removed, stumps, brush, roots and vegetation shall be removed to a depth of not less than 2 feet below original or finish ground level, whichever is lower.

Within tree barriers clear herbaceous understory and woody understory less than 2 inches in caliper (diameter - measured 12 inches above grade) and less than 4 feet in height, unless otherwise directed by METRO. For multi-trunk trees such as Yaupons, etc., calculate diameter by one-half of sum of all trunks.

B. Miscellaneous vegetation, logs and rubbish shall be removed in their entirety, within the limits of improvements.

C. Rake pinestraw and leaf mulch and stockpile on site for use as natural leaf mulch after grading operations are completed.

D. Topsoil shall be stripped to underlying subsoil. Topsoil shall be defined as friable organic clay loam surface soil, reasonably free of clay lumps, stones, weeds, roots and other objectionable material. Topsoil shall be safely stockpiled on the Site. Stockpiles shall be constructed to freely drain surface water.

E. Depressions caused by clearing, grubbing and stripping operations shall be filled with approved backfill material, unless further excavation is required by the construction operations. Backfill shall be placed in accordance with Section 02200 - Earthwork of these Specifications.
3.02 REMOVAL OF IMPROVEMENTS

A. Above-ground and below-ground existing improvements shall be removed in their entirety, except for utilities which shall be removed only to the extent indicated. Where utilities are indicated to be removed in part, the ends of the remaining utilities shall be permanently plugged with Class 3000 concrete, as specified in Section 03310 - Portland Cement Concrete of these Specifications.

3.03 DISPOSAL OF MATERIALS

A. Contractor shall comply with Section 01560 - Environmental Impact Controls of these Specifications. Materials not scheduled to be salvaged shall become the property of the Contractor and shall be removed from the Site and legally disposed of. Burning or burying cleared, grubbed and demolition waste materials on the Site shall not be permitted.

B. Remove items, without damaging, scheduled to be salvaged as directed by METRO and placed in designated storage area.

END OF SECTION 02110
SECTION 02161

TRENCH SAFETY SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work specified in this section consists of furnishing, installation, maintenance and removal of all necessary shoring, bracing, sheeting, shields, piling, deterring equipment and incidentals for all trench excavation, five feet or more in depth. The systems shall be in accordance with Occupational Safety and Health Administration (OSHA) Standards, 29CFR Part 1926 (Amended) October 31, 1989, Subpart P, Excavations.

B. This section applies to all required trenching, including but not limited to, excavation for storm sewers, water lines, sanitary sewer lines, and other underground improvements.

1.02 SUBMITTALS

A. The Contractor shall be responsible for selecting the excavation safety system as approved by OSSA 29CFR Part 1926 (amended October 31, 1989) and shall provide written notification of the protective system selected for project reference. The written notification shall include any tables, charts, diagrams, drawings or tabulated data applicable to the manufacturer's equipment.

1.03 PAYMENT

A. A line item shall be added for this section in the schedule of values. The Contract Total Bid Price shall include this item.

PART 2 - PRODUCTS

2.01 SHORING MATERIALS

A. Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Trench Safety System shall be installed in accordance with the OSSA requirements.

B. In trenches four (4) feet deep or deeper, the Contractor shall provide adequate means of trench egress using ladders or steps. Ladders must extend three (3) feet above original ground level. Ladders shall be positioned in accordance with the following:

<table>
<thead>
<tr>
<th>TRENCH LENGTH</th>
<th>POSITION OF LADDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 25 Feet</td>
<td>At third points</td>
</tr>
<tr>
<td>Less than 50 Feet</td>
<td>Each end and center</td>
</tr>
<tr>
<td>Greater than 50 Feet</td>
<td>At 25 feet intervals</td>
</tr>
</tbody>
</table>

3.02 REMOVAL

A. Temporary trench shoring shall be removed concurrently with backfill operations.

END OF SECTION 02161
SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for earthwork, including excavation, utility protection, filling, backfilling, compaction, grading and disposal of unacceptable and excess excavated material.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. ASTM: American Society for Testing and Materials
   b. D 1785: Specification for Poly (Vinyl Chloride) (PVC) Pipe, Schedules 40, 80, and 120.

2. AASHTO: American Association of State Highway and Transportation Officials

1.03 JOB CONDITIONS

A. Protection of Existing Utilities

1. Contractor shall comply with Section 01541 - Maintenance and Protection of Utilities of these Specifications.
2. Locate existing underground utilities and provide adequate protection and support during earthwork operations if such utilities are to remain in place.

3. Prepare a Record Drawing of uncharted or incorrectly charted piping and other utilities encountered during excavation. Inform METRO in writing when such utilities are encountered. Do not relocate utilities without written direction from METRO and utility owner.

B. Protection of Existing Trees

1. Existing trees to remain as indicated within the construction drawings shall be protected from damage during the entire duration of the construction project earthwork stripping, excavation compaction and construction as noted in more detail within Specification 01533 - TREE PROTECTION AND TRIMMING.

C. Artifacts

When excavation operations encounter artifacts of historical or archeological significance, METRO shall be notified and the excavation operations shall be temporarily discontinued at the Site. METRO will contact archaeology authorities to determine the disposition of artifacts. When directed in writing by METRO, excavation shall be resumed.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Classification

Acceptable material shall be as classified in ASTM D 2487, Groups GW, GP, GM, SM, SW, and SP.

B. Minimum Requirements

Material for fill shall be low in plasticity, free of rocks larger than 2 inches in any dimensions and free of debris, waste material, vegetation, roots and any other nonusable matter.

C. Borrow Fill

1. Borrow fill is material for embankment obtained from sources other than excavation at the Site. Tests shall be performed on borrow material to determine its acceptability.
2. Borrow material shall comply with the requirements for Soil Classification Groups A-1, A-2-4, A-2-5 or A-3 of AASHTO M 145.

2.02 IRRIGATION SYSTEM CORE SLEEVES

A. Control Wires

ASTM D 1785, Schedule 80, PVC pipe, size as indicated on the Drawings.

B. Mains and Laterals

ASTM D 1785, Schedule 80, PVC pipe, size as indicated on the Drawings.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Section 02161 - Trench Safety Systems shall apply where required.

B. General

1. Contractor shall inspect the Site and confirm actual grades and levels, and existing conditions under which the Work is to be performed.

2. Existing base material, sub-base material, and existing ground shall be excavated to the subgrade shown on the Drawings so as to comply with typical sections, elevations and grades as required.

3. Surfaces exposed after stripping shall be proof-rolled with a minimum of 3 passes of 30-ton pneumatic-tired roller utilizing tire pressure of approximately 90 psi. If rutting develops, tire pressure shall be reduced, proof-rolling operations continued until proper compaction is achieved to the satisfaction of the Engineer.

4. If unsuitable material or soft spots are encountered at the required subgrade elevations at the time of excavation or when compacting the subgrade, remove the unacceptable material to a depth of at least 2 ft. below subgrade.

5. The following materials shall be classified as unsuitable when found in the subgrade zone:
a. Abandoned structures such as pipes or conduits, underground equipment, vaults, septic tanks, floor slabs or other similar constructions.

b. Tree and shrubbery roots.

c. Deposits of refuse and debris.

d. Soils having an organic content exceeding 5 percent by weight, or having a plasticity index (PI) greater than 20, as determined in accordance with ASTM D 4318, shall not be used as fill unless such soils are treated as directed by METRO.

e. Soils that cannot be compacted to specified density after repeated compactive effort due to such causes as the inherent nature of the soil, high moisture content, ground-water conditions or other causes.

6. Embankments or fills shall be constructed in successive horizontal layers, not exceeding 8 inches in thickness, loose measure. Each layer shall extend across the entire fill and shall be compacted to the required dry density as specified in Article 3.02 of this Section.

7. Backfilling of pipe or conduit trenches shall be constructed in successive horizontal layers, not exceeding 6 inches in thickness, loose measure. Backfill shall be compacted to the required dry density as specified in Article 3.02 of this Section.

C. Unauthorized Excavation

1. Unauthorized excavation shall consist of removal of materials beyond indicated subgrade elevations, limits or dimensions.

2. Remedial work shall be equal to that specified for normal earthwork in this Section.

D. Dewatering

1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding the Site and surrounding area.

2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other
dewatering system components necessary to convey water away from excavations.

3. Convey water removed from excavations and rain water to collecting or run-off areas. Establish and maintain temporary drainage ditches and other diversions outside excavation limits. Do not use trench excavations as temporary drainage ditches.

4. Notify METRO in writing of work delays due to water or water-affected conditions.

5. Prior to discharge, route to a pump pit or sediment trap, storm water or run-off from authorized non-storm water required to be removed from the site.

6. Do not perform direct off-site discharge from dewatering activities.

E. Stockpiling

Stockpile satisfactory excavated material and borrow fill material at locations convenient for re-handling of the material during fill or backfilling operations.

F. Excavation for Structures

1. Conform to elevations and dimensions within a tolerance of plus or minus 0.10 ft. and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

2. In excavating for footings and foundations, take care not to disturb bottom of excavation. Perform all excavations other than drilled shafts by hand to final grade just before concrete reinforcement is placed. Tamp bottoms to required lines and grades to provide a solid base to receive concrete.

3. Excavate a minimum of 1 foot below base of passenger shelter slab.

G. Excavation for Pavements

1. Cut surface under pavements to comply with typical sections, elevations, and grades as indicated on the Drawings.

2. Stripping shall extend a minimum of 2 feet beyond the proposed edge of pavement.

H. Excavation for Utilities (Trenching)
1. Contractor shall comply with Section 02161 - Trench Safety Systems of these Specifications.

2. Dig trenches to the uniform width required for the item to be installed, sufficiently wide to provide ample working room.

3. Excavate trenches to the depth required. Carry the depth of trenches for piping to establish the indicated flow lines and invert elevations.

4. Grade bottoms of trenches to provide solid bearing for the entire body of the pipe when special bedding is not required.

3.02 COMPACTION

A. General

Control soil compaction during construction and attain the minimum percentage of density specified in this Section.

B. Required Density and Moisture

1. Compact fill material to ninety-eight percent (98%) of the maximum dry density as determined in accordance with ASTM D 698, Method C (Standard Proctor).

2. Obtain the specified compaction for fill material at a moisture content within a range of optimum moisture to optimum moisture plus two percentage points. Determine optimum moisture in accordance with ASTM D 698, Method C.

3. Material which cannot be compacted to the required density shall be removed and replaced with acceptable material that will meet the specified requirements.

C. Moisture Control

1. Where subgrade or a layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material. Prevent free water from appearing on surface during or subsequent to compaction operations.

2. Remove and replace, or scarify and air dry soil material that is too wet to permit compaction to the specified density. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or
spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3. Earthwork materials shall not be placed, spread, rolled or compacted during inclement weather. If such operations are interrupted by rain, operations shall not resume until the Contractor has determined that the moisture content and density of the previously placed material are within the specified limits. If previously placed material is not within the specified limits the Contractor shall remove, replace and compact new suitable material as directed by the Engineer at no cost to METRO.

3.03 BACKFILL AND FILL

A. General

Place acceptable soil material in the specified layers to required subgrade elevations, for each area classification as follows:

1. In excavations, use satisfactory excavated or borrow material that has been sampled, tested and approved.

2. Under grassed areas, use satisfactory excavated or borrow material.

3. Under walks and pavements, use sub-base material, or satisfactory excavated or borrow material, or a combination of both as required.

B. Backfill of Excavation

Backfill excavation as promptly as work permits, but not until completion of the following:

1. Completion of construction below finish grade including waterproofing, inspection testing and recording locations of underground utilities.


4. Removal of trash and debris.

C. Ground Surface Preparation
1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than one vertical to four horizontal so that fill material will bond with existing surface.

2. When existing ground surface has a density less than that specified under Article 3.02 herein for the particular area classification, break up the ground surface, pulverize, moisture condition to the required moisture content, and compact to required depth and percentage of maximum density.

D. Placement and Compaction

1. Place backfill and fill materials in layers not more than 8 in. in loose depth for material compacted by heavy compaction equipment, and no more than 4 in. in loose depth for material compacted by hand-operated tampers.

2. Before compaction, moisten or aerate each layer as necessary to provide the required moisture content. Compact each layer to the required percentage of maximum dry density. Do not place backfill or fill material on surfaces that are muddy or frozen.

3. Place backfill and fill materials in uniform layers adjacent to structures, to required elevations. Take care to prevent wedging action (unbalanced horizontal force on one side of a structure) of backfill against structures by carrying the same elevation in each lift.

3.04 GRADING

A. General

Uniformly grade each area within limits of grading under this Section, including adjacent transition areas. Smooth finished surface within the specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Lawn or Unpaved Areas

See Sections 02933 - Seeding, and 02935 - Sodding of these Specifications.

C. Walks

Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10 ft. above or below the required subgrade elevation.
D. Pavements

Shape the surface of areas under pavement to line, grade and cross-section, with the finish surface not more than zero in. above or 1/2 in. below the required subgrade elevation.

E. Compaction

After grading, compact subgrade surfaces to the depth and percentage of the specified maximum density.

3.05 IRRIGATION SLEEVES

A. Install Schedule 80 PVC irrigation sleeves as indicated on Drawings. Extend sleeve 24 inches, minimum, beyond curb, sidewalk, or pavement edge and plug ends until ready for use. Mark location of both ends of sleeve.

B. Extend 6 inch PVC sleeves (one sleeve for irrigation lines, and when indicated on the Drawings, another sleeve for electrical control wires) under any parking areas that separate planting islands. Sleeves shall run straight from one side of pavement to the other side with no bends.

C. Trench depth for sleeves under pavement shall be 30 inches below finished grade of pavement. Trench depth for sleeves under walks shall be 14 inches below finished grade of walk.

3.06 MAINTENANCE

A. Protection of Graded Areas

Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas

Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

3.07 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Waste materials, including unacceptable excavated material, trash and debris, shall be removed from the Site and disposed of legally.
3.08 STABILIZATION PRACTICES

A. Stabilization practices shall be as specified in Section 01560 - Environmental Impact Controls of these specifications.

END OF SECTION 02200
SECTION 02215
LANDSCAPE GRADING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Work Included.

1. Machinery Restrictions.
2. Excavation, filling and backfilling of onsite material.
3. Subgrade preparation and spreading of topsoil.
4. Finished grading.

1.02 GENERAL PROVISIONS

A. Finished grading shall be defined as placing and grading of additional soil that will be required to bring the grade to the required grades for lawns, shrub and groundcover beds.

B. Additional fill materials shall generally be defined as topsoil as specified herein unless otherwise specified.

C. Where practicable and as directed, the use of heavy machinery shall be kept to a minimum.

PART 2 - MATERIALS

2.01 TOPSOIL

A. Topsoil material that will be required for finish grading operations shall conform to the requirements included within this section.

B. General Qualifications: Topsoil shall be considered as imported material conforming to the following minimum criteria.

1. Natural, friable, loamy soil, typical of local topsoil which produces heavy vegetative growth, free from subsoil, weeds, sods, stiff clay, stones larger
than one (1) inch, toxic substances, debris, or other substances which may be harmful to plant growth. Do not deliver in muddy condition.

2. Acidity/Alkalinity: pH 6.0 to pH 7.5.

C. Grading Analysis: Two (2) inch sieve, 100% minimum passing. Number 4 sieve, 90 percent minimum passing. Number 10 sieve, 80 percent minimum passing.

1. Sand, silt, and clay content (from ASSHTO M146):
   a) Sand 20 to 75 percent
   b) Silt 10 to 60 percent
   c) Clay 5 to 30 percent

2. All topsoil shall be free from all herbicides and insecticides which might adversely affect subsequent growth of turf or plantings or which might otherwise contain materials toxic to humans and pets.

D. Non-conforming Material: The Contractor shall not be permitted to use on-site material which does not conform to the above minimum criteria for fine grade operations. At the discretion of the owner, such material can either be amended to meet the minimum requirements or shall be removed from the site and replaced with suitable material as specified herein.

E. It shall be the Contractor's responsibility to verify that the existing topsoil conforms to these specifications. Topsoil determined to be non-conforming subsequent to the award of a contract shall not be means for extra compensation unless otherwise provided for herein.

F. Soil Analysis: At the discretion of the Engineer, obtain soil analysis of topsoil from an accredited soils laboratory at METRO's cost. Submit results of soil analysis to the Engineer for review.

2.02 Sand shall be "Sharp Sand" to A.S.T.M. C-33. Sample shall be submitted for approval. Sand shall not be permitted for fill purposes if the depth exceeds two (2) inches to achieve the finished grade.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Work shall be performed by personnel trained and experienced in this work and shall be done under the direction of a superintendent on the Contractor's staff.
3.02 PREPARATION OF SUBGRADE AND SPREADING OF TOPSOIL

A. The subgrade soil shall be loosened to a depth of four (4) inches and graded to remove all ridges and depressions so that it will be everywhere paralleled to proposed finished grade. All stones over one and one-half (1-1/2) inches in any dimensions, stick, rubbish and other extraneous matter shall be removed during this operation. No heavy objects except rollers shall be moved over lawn areas after the subgrade soil has been prepared before topsoil is spread.

B. After the subgrade soil has been prepared, topsoil shall be spread evenly therein to depth of two (2) inches by an approved method and the area then rolled with a 200 pound roller. No topsoil shall be spread in a frozen or muddy condition.

C. On all grass areas, the finished surface of the topsoil shall conform to the finished grade and shall be free from hollows or other inequalities, stones, stocks and other extraneous matter.

3.03 FINISH GRADING

A. In areas to receive lawns, this Contractor shall till, disc, or otherwise scarify the soil, removing all clods, stones, and related material one (1) inch or larger. Place and spread any additional material that may be required. Roll completely.

B. This Contractor shall be responsible for minor adjustments to the finished subgrade if such treatment is required in the opinion of the Engineer.

C. The Contractor may use machinery acceptable to the Engineer to complete most of the work to re-establishing finished grade.

D. Hand-rake the surface, removing all clods and undesirable material greater than one-half (1/2) inch from ground surface. Fill all low spots and cut irregularities to the acceptance of the Engineer. Roll the entire surface evenly with a 200 pound water ballast roller or other means acceptable.

E. During the finished grading operations, all swales and additional swales that may be required to drain areas where there are existing plant materials, shall be finished. In general, all grade adjustments shall be made so there are no areas that will have standing water.

F. To prevent excessive weed growth in the lawn areas, the Contractor should be prepared to immediately install the sod or hydroseed upon the completed and acceptable finished grade.
END OF SECTION 02215
SS SECTION 02222

STRUCTURAL EXCAVATION AND BACKFILL

PART 1 GENERAL

1.01 This section covers structural excavation and BACKFILL and area fill. Roadway excavation and excavation and trenching for pipe and utilities are specified elsewhere.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 Excavation work shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case other than for drilled shaft or caissoned foundations, shall excavation faces be undercut for extended footings.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

A. Blasting: No blasting or other use of explosives for excavation will be permitted.

B. Preservation of Trees: No trees shall be removed unless their removal is authorized by the Engineer. Trees left standing shall be adequately protected from permanent damage by construction operations. Trimming or pruning of standing trees, where required, shall be as directed by the Engineer.

3.02 STRUCTURAL EXCAVATION: Bottom of excavations shall be accurately finished to the grades and slopes shown on the drawings. Excavations shall extend a sufficient distance from walls and footings to allow for forms, installation of services and for inspection, except where concrete for walls and footings is authorized to be deposited directly against excavated surfaces.

A. Unsuitable Material: All footings shall be carried to firm undisturbed earth unless otherwise indicated. If suitable bearing for foundations is not encountered at the depth indicated on the drawings, the Contractor will immediately notify the Engineer, and shall not proceed until further instructions are given by the Engineer.
B. Sheet ing and Shoring: Except where banks are cut back on a stable slope, excavation for structures shall be properly and substantially sheeted, braced, and shored, as necessary, to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheet ing, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining shape and position under all circumstances. Design of sheeting and shoring is the responsibility of the Contractor.

C. Over-Excavation: Placing of concrete walls, footings, slabs on grade, and foundations on earth fill shall not be permitted unless otherwise indicated. Excavation below the required grades shall be replaced by and at the expense of the Contractor, with the concrete placed at the same time and monolithic with the concrete above.

D. Mechanical Excavation: The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

E. Storage of Excavated Material: Excavated material required to be used for backfill may be deposited by the Contractor in storage piles at points convenient for rehandling the material during the backfill operations. The location of storage piles shall be subject to the approval of the Engineer. Excavated material shall not be deposited in a manner that may endanger a partly finished structure or that may be detrimental to any completed work in any way. Excess excavated materials shall be stored on the job site as directed by the Engineer. Topsoil (free from deleterious materials) shall be stored separately.

3.03 STABILIZATION: Subgrades for concrete structures shall be firm, dense, and thoroughly compacted and consolidated, shall be free from mud and muck, and shall be sufficiently stable to remain firm and intact under the feet of the workmen. At the contractors option, unless required by the contract drawings, a layer of unreinforced concrete may be used below the structure subgrade to maintain stable subgrade.

Subgrades for concrete structures which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with one or more layers of crushed rock or gravel. The finished elevation of stabilized subgrades for concrete structures shall not be above subgrade elevations shown on the drawings.
All stabilization work shall be performed by and at the expense of the Contractor.

3.04 BACKFILL AROUND STRUCTURES: Backfill around and outside of structures shall be deposited in layers not to exceed 8 inches in uncompacted thickness and mechanically compacted, using platform type tampers, to at least 90% of maximum density at optimum moisture content as determined by ASTM D698. Compaction of structural backfill by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Heavy rolling compaction equipment shall not operate closer to the wall than a distance equal to 2/3 the height of the fill above the base of the structure at any elevation. Compaction of structural backfill by inundation with water will not be permitted.

Material for structural backfill shall be composed of earth only and shall not contain any deleterious materials such as wood, grass, roots, broken concrete, stones, trash, or debris of any kind.

No tamped, rolled or otherwise mechanically compacted backfill shall be deposited or compacted in water.

All backfill material shall consist of loose, damp (not wet) earth having a moisture content such that maximum density of the compacted soil will be obtained. Moisture content shall be distributed uniformly and water for correction of moisture content shall be added sufficiently in advance that proper moisture distribution and compaction will be obtained.

3.05 BACKFILL BENEATH STRUCTURES: Backfill beneath structures or backfill that in any way carries structural loads shall be placed in layers not to exceed 6 inches in uncompacted thickness and compacted to at least 98% of maximum density at optimum moisture content as determined by ASTM D698.

Backfill material for placement beneath structures or for carrying structural loads shall be sandy clay with a plasticity index of 15 to 20% obtained from on-site excavations unless another material is called for by the Drawings. Backfill material judged unsuitable by the Engineer shall not be used. Backfill shall be completely free from deleterious materials and shall be placed and compacted with the actual moisture content within ±1% of optimum moisture content as determined by ASTM D698.
All backfill beneath structures or backfill that carries structural loads shall be subject to continuous field testing to insure adequate compaction. Each lift shall be tested once for each 500 square feet of compacted area. If any test indicates inadequate compaction, additional tests shall be performed to identify the extent of the undercompaction, and the undercompacted area shall be recompacted and retested. Records of the compaction testing shall be kept and made available to the Engineer for review.

3.06 AREA FILL: Areas that are required to be filled and that do not support structural loads shall have backfill material placed in 8 inch uncompacted lifts and compacted to at least 90% of maximum density at optimum moisture content as determined by ASTM D698.

Area fill material shall be sandy clay soil obtained from on-site excavations except the upper 4 inches which shall be topsoil reserved from site excavations. Topsoil layer shall not be compacted except as specified in Section 2100.

3.07 SETTLEMENT: The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within one year after final completion of the Contract under which the work was performed.

The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from the Engineer or Owner.

3.08 TESTING: All work performed under this Section shall be subject to testing by the Owner. Work that fails testing shall be removed and replaced.

END OF SECTION
PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Laboratory Quality Control by Contractor:

1. Establish optimum moisture-maximum density curve for bedding and backfill material, ASTM D 698; for those soils which will not exhibit a well defined moisture-density relationship, determine optimum relative density, ASTM D 4253 and D 4254.

2. Establish optimum moisture-maximum density curve, ASTM D 698; Atterberg Limits, ASTM D 4318; and sieve analysis, ASTM D 422 for following:
   a. Borrow bedding and backfill material to be used.
   b. Excavated material of questionable suitability for use as bedding and backfill material.

3. One optimum moisture-maximum density curve, ASTM D 698, shall be established for each significant change in materials.

4. Bedding and backfill materials which do not meet specified requirements shall be replaced with suitable materials.

B. Field Quality Control by Owner:

1. Laboratory density testing of trench backfill:
   a. One field in-place density test per 500 lin. ft. of trench.
   b. One field in-place density test per 150 lin. ft. of trench for each fill layer under existing or proposed paved areas and at least one test per fill layer at each road crossing.

2. Laboratory density testing of general fill: One field in-place density test per 100 cu. yd. of fill placed.

3. Field in-place density tests shall be in compliance with ASTM D 1556, ASTM D 2922, or ASTM D 2167.
C. If, during progress of work, tests indicate that compacted materials do not pass specified requirements, work shall be removed, replaced, and retested at no cost to Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Suitable bedding and Backfill Materials:

1. Sand for pipe bedding:
   a. Plasticity index: 7 maximum, ASTM D 4318.
   b. 100 percent passing 1/2 in. standard sieve and 15 percent maximum passing No. 200 sieve, ASTM C 136 and C 117.
   c. Free of clay lumps, organic material, salt, or other deleterious substances.

2. Material for trench backfill:
   a. Select sandy soil or other granular material.
   b. Plasticity index: 11 maximum, ASTM D 4318.
   c. 100 percent passing 1 in. standard sieve and 30 percent maximum passing No. 200 sieve, ASTM C 136 and C 117.
   d. Free of clay lumps, organic material, salt, or other deleterious substances.

B. Cement Stabilized Sand:


2. Use two sacks of portland cement per cu. yd. sand for sanitary sewer pipe embedment 9 ft. each side of crossing under water line when sanitary sewer pipe material is ABS truss pipe, clay or concrete pipe with gasketed joints.

3. Sand:
   a. Clean durable sand, free of lumps of clay, organic material, salt or other deleterious substances.
   b. Plasticity index: 6 maximum (of materials passing No. 200 sieve), ASTM D 4318.
   c. 100 percent passing 3/8 in. sieve, ASTM C 136.
   d. 5 percent to 25 percent passing No. 50 sieve, ASTM C 136.
PART 3 EXECUTION

3.01 PREPARATION

Refer to Section 02000.

3.02 GENERAL

A. Work includes excavating, trenching, and backfilling for pipe.

B. Work includes as incidental to construction, clearing of trenching areas, salvaging of topsoil and stockpiling, and construction required in crossing continued utilities, such as support of lines while trenching through, and capping and sealing, and removal of discontinued utilities within excavated areas and restoration.

C. Make open cut excavations to required lines and grades.

D. No extra compensation will be made because of subsurface soil conditions requiring removal of rock, boulders, hard-pan or other classes of excavation; materials shall be excavated as required by construction without claim for extra compensation because of subsurface soil conditions.

E. Excavate adequate but not excessive working space and clearances for installation of work and form removal.

F. Allow not less than 6 in. clearance in horizontal dimensions of excavations for outside plastering of manholes and similar structures constructed of masonry units.

G. Do not undercut excavation faces for extended footings of structures.

H. Clear subgrade surfaces of loose material before placing concrete or bedding materials.

I. Backfill with specified suitable materials unless otherwise shown on Drawings, specified, or authorized.
J. Remove from site and legally dispose of excavated materials not suitable for backfill.

K. Do not damage pipe or disturb jointing or alignment during backfilling operations.

L. Excavate by hand within 2 ft. of existing utilities to remain.

3.03 CLASSIFICATION OF EXCAVATED MATERIALS

A. Excavated materials will be unclassified.

B. Excavate materials encountered without exception.

3.04 BLASTING

A. Use of explosives will not be permitted.

3.05 REMOVAL OF WATER

A. Provide and maintain adequate pumping system in trenches and excavations to collect, remove, and dispose of surface and ground water entering excavations and trenches.

B. Keep excavations dry continually during preparation of subgrade and until structure or piping is completed to extend that no damage from hydrostatic pressure, floatation, or other water related causes will result.

C. Divert surface water away from excavated areas and prevent water from entering excavations.

D. Where excavations for trenches or concrete structures extend down below static ground water elevations, prevent ground water boiling up through trench bottom, loosening up, and flooding trench subgrade; lower and maintain ground water surface to depth not less than 12 in. below bottom of excavation by installing series of well points, pumping and collecting system, and approved discharge and disposal system.

E. Maintain sewers used for drainage purposes in usable conditions; leave clean and free from sediment and obstacles at completion of work.

3.06 SHEETING AND SHORING

A. Except where banks are cut back on stable slope, sheet, brace, and shore excavations for trenches and structures.
B. When sheeting, bracing and shoring are necessary, construct sheeting, bracing, and shoring to withstand loads caused by earth movement and construction operations.

1. Maintain shape and position of sheeting, bracing, and shoring for duration necessary.

2. Remove sheeting, bracing, and shoring when not needed.

3.07 SUBGRADE PREPARATION

A. Trench bottoms and subgrade surfaces for concrete structures shall be free from mud and muck, and shall be firm, dense, and compacted and consolidated to degree of remaining firm and intact under feet of workmen.

B. Remove peat, muck, quicksand, or other unstable material encountered at and below subgrade to depth 1 ft. below subgrade or depth equal to diameter of pipe for pipe larger than 1 ft.; backfill with sand or gravel compacted to maximum density or concrete.

C. Where rock or other incompressible material is encountered, remove material to depth 6 in. below subgrade and backfill with tamped sand, gravel, or concrete.

D. Reinforce trench bottoms or subgrade surfaces for concrete structures which are solid, but which become mucky on top due to construction operations with specified sand.

E. Use only sand or gravel compacted to maximum density, or concrete to bring fills to lines and grades indicated and for replacing unsatisfactory materials.

F. Special Trench Bottom Reinforcement: If foundation on which pipe is to be laid is excessively wet, excavate trench to minimum of 6 in. below outside bottom surface of pipe and fill with washed gravel or crushed stone.

3.08 EXCAVATION

A. Do not keep open more than 100 ft. of trench on any line under construction.

B. Open cut excavation from surfaces unless tunneling or boring and jacking operations are indicated.

C. Alignment and Grade:

1. Fix and determine alignment and grade or elevation of each pipe line by using offset stakes.
2. Vertical and horizontal alignment of pipes and maximum joint deflection used shall be in conformity with requirements of pipe being laid.

3. Laser equipment may be used to set line and grade provided manufacturer’s procedures are followed and accuracy is maintained.

4. Employ surveyor to periodically check and document correct grade and alignment of pipe laid with laser equipment.

D. Trenching:

1. Where trenches for sanitary sewers have been excavated below 10 ft. depth, pipe shall be on 6 in. minimum bed of cement stabilized sand with cradle of cement stabilized sand carried up to springline of pipe.

2. Make vertical sides in bedding zone; slope sides at stable slope above top of pipe.

3. Where trench hoe is used, do not use excavated material composed of large chucks and clods for backfill.

4. Dispose of large chunks and clods as waste materials and provide suitable backfill material.

5. Excavated trench material to be replaced in trench as backfill, shall be well broken up and moisture content shall not exceed 3 percent above optimum moisture content as determined by ASTM D 698.

E. Trench Widths:

1. Trenches for pipe sewers smaller than 30 in. pipe shall have width below top of pipe not less than outside diameter plus 12 in. and not more than outside diameter of pipe plus 18 in.

2. Trench widths for special jointing shall meet requirements of pipe materials manufacturer.

3. Trench widths below tops of pipe bells may be increased by an amount to permit sheathing and bracing timbers and to permit installation of well points and pumps in trench where sump pumping is uneconomical.

4. Provide space between cross braces to permit handling of forms, pipe, and other materials.

F. Do no obstruct drainage during handling of excavated material.
G. Unauthorized Trench Widths: Where trench width below top of pipe exceeds maximum permitted, provide pipe of adequate strength, arch concrete encasement, or special pipe embedment designed with safety factor of 2 and selected to satisfy loading conditions.

H. Joint Holes:
1. Provide adequate clearance for tools and jointing operations.
2. Do not allow part of joint or coupling to contact trench bottom or trench wall when pipe is jointed.

3.09 PIPE ENVELOPE
A. Pipe shall be bedded as shown in pipe envelope details on Drawings.
B. Use specified sand for pipe envelope where sand envelope is shown.
C. Use specified cement stabilized sand for pipe envelope and backfill where shown.

3.10 TRENCH BACKFILL
A. Do not backfill with wet, mucky, or unsuitable materials or with large rocks or clods of material.
B. Trench backfill above pipe embedment shall conform to requirements for type and location of pipe.

3.11 BACKFILL AT MANHOLES, JUNCTION BOXES
A. Place backfill in 8 in. maximum layers around structures and compact to density of adjacent undisturbed materials.
B. Backfill material shall not contain wood, grass, roots, broken concrete, stones, trash, or debris.
C. Do not deposit or compact backfill by flooding.

3.12 DRAINAGE MAINTENANCE
A. Start backfilling operations upstream for trenches crossing highways, streets, driveways adjacent to drainage ditches, and water courses; proceed downstream to prevent impounding of water.
B. Do not allow water to accumulate in uncompleted trenches.
C. Remove material deposited in ditch or water course crossed by trench excavation immediately after completion of backfill.
D. Restore section, grades, and contours of ditches or water courses to original condition.

3.13 UNSUITABLE AND EXCESS MATERIALS
A. Dispose of unsuitable excavated materials off-site in legal manner.
B. Suitable excess excavated material shall remain property of Owner to be stockpiled or spread at locations as directed.

3.14 FINISHING AND GRADING
A. Uniformly grade disturbed areas smooth so areas match adjacent undisturbed natural ground and fit into drainage pattern of surrounding areas.
B. For areas previously finished to proposed established grade and cross section, finish surface within 0.10 ft. above or below required grade and cross section.
C. Finish ditches and gutters to drain.

3.15 RESTORATION
A. Unless disturbed areas and excavation areas are scheduled for subsequent construction, restore as follows, as incidental to construction:
   1. Replace 4 in. depth of topsoil from stockpiles of topsoil formed during preparation operations.
   2. Provide hauled-in topsoil as necessary.
   3. For excavation and disturbed areas sodded prior to construction, resod to match pre-existing conditions.

END OF SECTION
SS SECTION 02227

WASTE MATERIAL DISPOSAL

PART 1  GENERAL

1.01  DESCRIPTION

A. Dispose of waste material and salvageable material off the Owner’s site. All materials become property of the contractor unless noted otherwise.

B. Obtain and submit disposal permits for proposed sites if required by local ordinances.

C. Submit a copy of written permission from property owner, along with description of property, prior to disposal of excess material adjacent to the Project. Submit a written and signed release from property owner upon completion of disposal work.

PART 2  PRODUCTS (Not Used)

PART 3  EXECUTION

3.01  EXCESS MATERIAL

A. Vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, unused piping & valves, process equipment, and other materials shall become the property of Contractor and shall be removed from the job site and legally disposed of.

B. Excess soil may be deposited on private property adjacent to the Project when written permission is obtained from property owner.

C. Verify the flood plain status of any proposed disposal site. Do not dispose of excavated materials in an area designated as within the 100-year Flood Hazard Area unless any required permit has been obtained. Excess material placed in a “100-year Flood Hazard Area” shall be removed by Contractor at no additional cost to the Owner.

D. Waste materials shall be removed from the site on a daily basis, such that the site is maintained in a neat and orderly condition.

END OF SECTION
SECTION 02510

CONCRETE WALKS AND RAMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing, placing, curing and protecting Portland cement concrete walks, wheelchair and driveway ramps, constructed on a prepared subgrade.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute
    a. 301: Specifications for Structural Concrete for Buildings.
    b. 316R: Recommendations for Construction of Concrete Pavements and Concrete Bases.

2. ASTM: American Society for Testing and Materials
    a. C 150: Specification for Portland Cement Type I or Type II.
    e. D 1752: Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
3. TxDOT: Texas Department of Transportation


1) Item 531: SIDEWALKS

b. The above referenced standard may be obtained from:

Texas Department of Transportation
11th and Brazos Streets
Austin, Texas  78701
Telephone: (512) 475-2081

c. Special Provisions to the above mentioned TxDOT Standard Specification as follows:

1) For this project Item 531, SIDEWALKS, of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this item are waived or changed hereby.

ARTICLE 531.2, the second paragraph, is voided and replaced by the following: Concrete for sidewalks shall be Class 3000.

ARTICLE 531.4 Measurement is voided and not replaced.

ARTICLE 531.5 Payment is voided and not replaced.

B. Finishing Tolerance

Finished surfaces shall have a Class B tolerance as specified in ACI 316R, Chapter 12.5 and ACI 301, Chapter 11.9.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:
1. Reinforcement Materials
   a. As required in Section 03200 - Concrete Reinforcement of these Specifications.

2. Concrete Materials
   a. As required in Sections 03300 - Cast-in-Place Concrete, and 03310 - Portland Cement Concrete of these Specifications.

3. Coloring Agents (pigments and stains)
   a. Submittals shall be made for all coloring agents to confirm product and color acceptability.

1.05 EXTENDED WARRANTY

A. Manufacturer of joint sealant shall provide at least a 1 year written warranty against material degradation or failure and water and foreign matter infiltration through the joint from the time of written acceptance of the Work. This warranty shall not limit METRO's rights or remedies as may otherwise be afforded under law or statute.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Forms

   Either wood or metal, straight and free of warp.

B. Reinforcing Steel Bars

   As specified in Section 03200 - Concrete Reinforcement of these Specifications.

C. Welded Steel Wire Fabric

   Plain wire fabric, as specified in Section 03200 - Concrete Reinforcement of these Specifications.

D. Concrete

   Class 3000, as specified in Section 03310 - Portland Cement Concrete of these Specifications.
E. Membrane Forming Curing Compound

ASTM C 309, Type 2, unless otherwise directed.

F. Joint Materials


2. Joint Sealing Material: See Section 07900 - Joint Sealers of these Specifications.

G. Form Coating

Commercial formulation form-coating compound that will neither bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces.

H. Stain (Handicap Ramps)

Stain used for surface coating of Handicap Ramps to produce a contrasting color as designated on the plans shall be EXI-GUARD ® CSX₂O STAIN, Color designation No. 418 - Medium Gray, or approved equal.


2. The coating shall be water based, membrane forming polysiloxane/penetrating sealer. The system shall be non-flammable, non-hazardous, and non-toxic.

3. Maximum VOC content: 0.27 lbs./gal., and shall comply with all applicable regulations regarding VOC's.

4. Warranty: Provide Manufacturer's limited five (5) year warranty. Failure of the product is indicated by water, oils, or solvents soaking into the substrate, when placed on surface.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION
A. Prepared subgrade shall be inspected for unstable or unsuitable areas and need for additional compaction. Do not begin walk or ramp construction until all such deficiencies have been corrected.

B. Loose and foreign material shall be removed from the compacted subgrade immediately prior to placing concrete, and subgrade shall be uniformly dampened.

3.02 SETTING FORMS

A. Forms shall be set to the line and grade indicated and shall be securely staked to maintain set position during depositing and curing of concrete.

B. Forms shall be set in sufficient quantity to allow continuous progress of concrete placement, and to ensure that forms shall remain in place not less than 24 hours.

C. Forms shall be cleaned after each use and coated with an approved form release agent prior to each use.

3.03 INSTALLATION OF JOINTS, REINFORCEMENT, AND SEALANT

A. Reinforcement shall be installed as indicated on the Drawings and as specified in Section 03200 - Concrete Reinforcement of these Specifications.

B. Walks shall be constructed in sections, of the length indicated on the Drawings, with sections a minimum of 8 ft. long and a maximum of 20 ft. long. Sections shall be separated by joint fillers placed vertically and at right angles to the longitudinal axis of the walk. Transverse scored control joints shall be spaced at a dimension no greater than the width of the sidewalk.

C. Expansion joint fillers shall be installed for the full length and depth of joints, where walks or ramps abut rigid construction, and where obstructions protrude through walks or ramps.

D. Sealant manufacturer’s instructions and procedures shall be followed so as not to invalidate the warranty.

3.04 PLACING AND FINISHING CONCRETE

A. Concrete shall be placed and finished as specified in Section 03300 - Cast-in-Place Concrete of these Specifications, and ACI 301, Chapter 11.9 and ACI 316R, Chapters 10 and 12.5.

B. Concrete shall be consolidated in accordance with Section 03300 - Cast-In-Place Concrete of these Specifications.
3. The top surface shall be wood floated to a uniform gritty texture. The edges and joints shall be rounded using an edging tool having a radius of 1/8 in. Scored joints shall be placed in a regular pattern, as indicated on the Drawings.

3.05 WALKS AND RAMPS

A. Thickness

1. Walk and ramp thickness shall be as indicated on Drawings.

B. Deficient Thickness

1. Thickness may be determined in accordance with Item 360, Paragraph 360.13 of the TxDOT Standard Specifications.

2. Price adjustments for thickness deficiencies will be determined in accordance with Item 360, ARTICLE 360.13, SUBARTICLE b of the TxDOT Standard Specifications.

3.06 CURING AND PROTECTING

A. Concrete shall be cured in accordance with the recommendations of ACI 316 R, Chapter 11, using the membrane curing method and materials.

B. Protection as recommended in ACI 316 R, Chapter 11, shall be provided until written acceptance by METRO.

3.07 APPLICATION OF CONCRETE STAIN

1. Applicator: Must be a specialist in applying coating, waterproofing/repellents with five (5) years minimum experience and approved by product manufacturer.

2. Concrete to cure fourteen (14) days prior to treatment.

3. Remove dirt, oil, wax, curing compounds, efflorescence, gum, paint, and other coatings. Use cleaning methods acceptable to manufacturer for preparation of surface to receive treatment.

4. Deliver products to site with containers unopened and with manufacturer's seal intact.
5. A field test sample shall be applied to a concrete surface at a location selected by METRO (less than 100 sq. ft.) to determine visual or physical effect of product prior to general execution of work. Test area may remain as part of general work.

6. Apply stain in accordance to manufacturer's published instructions and guidelines. A copy of such shall be provided to the Resident Engineer.

7. Apply stain only to those surfaces identified in details provided by METRO.

8. Do not dilute EXI-GUARD product, use as supplied by manufacturer. Coverage rate 175 sq. ft. per gallon (minimum) to 200 sq. ft. per gallon (maximum).

9. Remove excess after fifteen (15) minutes from initial application (use clean mop or cotton cloth).

10. Finished surfaces shall be fully and uniformly coated without pinholes, bubbles, sag, runs, lumps, brush marks, abraded areas, scratches, or discoloration.

11. Protect areas from moisture for 8 hours (minimum) after application of stain.

12. Mask, shield, and protect all surfaces not designated for treatment against over spray. Contractor is fully responsible for removing over spray and returning non-designated surfaces to original condition.

13. Protect treated surfaces against oil/grease/fuel drips caused by cleaning equipment and other contamination.

14. Do not permit traffic including pedestrian on treated surfaces until stain has completely penetrated and the substrate is fully dry.

END OF SECTION 02510
SECTION 02528

CONCRETE CURBS AND CURB AND GUTTER

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing, placing, curing, and protecting Portland cement concrete curbs, and combination curbs and gutters, constructed on a prepared subgrade.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute

   a. 316R: Recommendations for Construction of Concrete Pavements and Concrete Bases.

2. ASTM: American Society for Testing and Materials

   a. A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (with Supplement + S1).

   b. C 150: Specification for Portland Cement Type I or Type II.


   e. D 1751: Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient bituminous Types).

   f. D 1752: Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
g. D 3405: Specification for Joint Sealants, Hot-Poured, for Portland Cement Concrete Pavement.

3. FS: Federal Specifications and Standards

B. Finishing Tolerance

The top surface of curbs and combination curbs and gutters shall have a Class A tolerance as specified in ACI 316 R, Chapter 12.5.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Reinforcement Materials
   a. As required in Section 03200 - Concrete Reinforcement of these Specifications.

2. Concrete Materials
   a. As required in Sections 03300 - Cast-in-Place Concrete, and 03310 - Portland Cement Concrete of these Specifications.

1.05 EXTENDED WARRANTY

A. Manufacturer of joint sealant shall provide at least a 1-year written warranty against material degradation and failure and water and foreign matter infiltration through the joint from the time of written acceptance of the Work. This warranty shall not limit METRO's rights or remedies as may otherwise be afforded under law or statute.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Forms

Either wood or metal, of the size and shape necessary for forming the item, straight and free of warp.

B. Reinforcing Steel Bars
As specified in Section 03200 - Concrete Reinforcement of these Specifications.

C. Dowel Bars

Smooth, ASTM A 615 + S1, Grade 60, new billet steel, unbonded ends painted with red-lead-base paint, FS TT-P-86, Type I and coated with a water-resistant lubricant immediately prior to placement of concrete in which unbonded ends of bars are to be embedded.

D. Dowel Bar Expansion Caps

PVC or plastic cap, slightly larger than dowel bar, closed end, a minimum of 6 in. long, with 1-1/2 in. long compressible insert.

E. Concrete

Class 3000, as specified in Section 03310 - Portland Cement Concrete of these Specifications.

F. Membrane Forming Curing Compound

ASTM C 309, Type 2, unless otherwise directed.

G. Joint Materials


2. Joint Sealing Material: See Section 07900 of these Specifications.

H. Form Coating

Commercial formulation form-coating compound that will not bond with, stain nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Prepared subgrade shall be inspected for unstable or unsuitable areas and need for additional compaction. Notify METRO in writing of such deficiencies. Do not begin curb construction until all such deficiencies have been corrected.
B. Loose and foreign material shall be removed from the compacted subgrade immediately prior to placing concrete, and subgrade shall be uniformly dampened.

3.02 SETTING FORMS

A. Forms shall be set to the line and grade indicated, and shall be securely staked to maintain set position during depositing and curing of concrete. The inside form shall be rigidly attached to the outside form.

B. Forms shall be set in sufficient quantity to allow continuous progress of concrete placement and to ensure that forms shall remain in place not less than 24 hours.

C. Forms shall be cleaned after each use and coated with an approved form release agent prior to each use.

3.03 INSTALLATION OF JOINTS, REINFORCEMENT, AND SEALANT

A. Reinforcement shall be installed as indicated on the Drawings and as specified in Section 03200 - Concrete Reinforcement of these Specifications. Joints shall be installed where indicated on the Drawings and in accordance with Section 07900 - Joint Sealers of these Specifications.

B. Sealant manufacturer’s instructions and procedures shall be followed so as not to invalidate the warranty.

3.04 PLACING AND FINISHING CONCRETE

A. Concrete shall be placed and finished as specified in Section 03300 - Cast-in-Place Concrete of these Specifications, and ACI 316 R, Chapters 10 and 12.5.

B. After concrete has been struck off and has sufficiently set, the exposed surfaces shall be worked with a wood float. The exposed edges shall be rounded using an edging tool.

C. After form removal, the surfaces of the curb or combination curb and gutter shall be plastered with a mortar consisting of one part Portland Cement and two parts fine aggregate. Mortar shall be applied with a template constructed to the shape and dimensions of the item to be plastered. All exposed surfaces shall be brushed to a uniform smooth texture.

3.05 CURING AND PROTECTING CONCRETE
A. Concrete shall be cured in accordance with the recommendations of ACI 316 R, Chapter 11, using the membrane curing method and materials.

B. Protection as recommended in ACI 316 R, Chapter 11 shall be provided until written acceptance by METRO.

END OF SECTION 02528
SS SECTION 02620
POLYVINYL CHLORIDE PIPE

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Polyvinyl chloride (PVC) pressure pipe for water distribution in nominal diameters 1-inch through 60-inches.

1.02  REFERENCES – The latest published versions of the referenced standards shall apply.

A. ANSI A21.5 (AWWA C105) - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.

B. ANSI A21.10 (AWWA C110) - Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. for Water and Other Liquids.


E. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC Plastic Pipe (SDR-PR), cell classification 12545-B or 12454-C, SDR 21 or smaller, and pressure class of 200 psi or greater.


G. AWWA C900- Polyvinyl Chloride (PVC) Pressure Pipe, 1 in. Through 60 in. for Water Distribution.


1.03  SUBMITTALS

A. Submittals shall conform to requirements of Section 01300 - Submittals.
B. Submit shop drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

1.04 QUALITY CONTROL

A. Submit manufacturer's affidavit that PVC pipe meets requirements of AWWA C900 for pressure pipe applications.

B. Submit manufacturer's certification that PVC pipe have been hydrostatically tested at factory in accordance with AWWA C900 and this Section.

PART 2 PRODUCTS

2.01 MATERIAL

A. All products and material that come into contact with potable water must conform to ANSI/NSF Standard 61 and must bear the National Sanitation Foundation Seal of Approval (NSF-pw).

B. PVC compounds used to manufacture pipe shall contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.

C. For PVC pressure pipe, manufacture PVC pipe from Class 12454-A or Class 12454-B virgin compounds as defined in ASTM D1784. Compounds shall qualify for a rating of 4000 psi for water at 73.4 degrees F per requirements of PPITR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions and other defects, uniform as commercially practical in color, density and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.

D. For PVC pressure pipe used for water mains, PVC pipe shall be self-extinguishing and bear Underwriters’ Laboratories mark of approval that is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.

E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, have no deteriorating effect on PVC or rubber gaskets.
F. Lead Ban: The use of pipes, pipe fittings, plumbing fittings and fixtures that contain more than 0.25 percent lead is prohibited:

2.02 WATER SERVICE PIPE

A. Pipe 1-inch through 3-inch: ASTM D2241, Cell Classification 12454-B or 12454-C, SDR 21 or smaller, and pressure class of 200 psi or greater; nominal 20-foot lengths.

B. Pipe 4-inch through 12-inch: AWWA C900, Class 200, DR 18; nominal 21-foot lengths.

C. Pipe 14-inch through 60-inch: AWWA C900; Class 235; DR 18; nominal 20-foot lengths.

D. Joints: ASTM D3139; push-on type joints in integral bell or separate sleeve couplings. Gaskets and seals: ASTM F477; elastomeric; factory installed and glued in place; sole element depended upon to make joints flexible and watertight. Do not use socket type or solvent weld type joints.

E. Make curves and bends by deflecting the joints. Do not exceed maximum deflection recommended by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by Engineer.

F. Hydrostatic Test: AWWA C900, AWWA C110; at point of manufacture; submit manufacturer's written certification.

2.03 PVC PRESSURE PIPE FOR BENDS AND FITTINGS

A. Bends and Fittings: ANSI A21.10; ductile iron; ANSI A21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.

B. ANSI A21.5; provide minimum 8-mil thickness polyethylene wrapping.

C. Line fittings with epoxy coating, 24-mil minimum dry film thickness applied in three applications.

PART 3 EXECUTION

3.01 PROTECTION

A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with the manufacturer's recommendations.
3.02 INSTALLATION

A. Install PVC pipe in accordance with ASTM D2321 and manufacturer's recommendations.

B. Water service pipe 12 inches in diameter and smaller: Installed to clear utility lines and have minimum 4 feet of cover below lowest property line grade of street, unless otherwise required by Drawings.

C. Avoid imposing strains that will overstress or buckle the pipe when lowering pipe into trench.

D. Hand shovel slice bedding under the pipe haunches and along the sides of the pipe barrel to eliminate voids and ensure side support.

3.03 HYDROSTATIC LEAKAGE RATE

A. The hydrostatic leakage rate for polyvinyl chloride (PVC) pipe and appurtenances shall not exceed the amount allowed or recommended by formulas in AWWA Standard C-605 as required in 30 TAC §290.44(a)(5);

\[ Q = \frac{LDF}{144000} \]

Where:
- \( Q \) = the quantity of makeup water in gallons per hour,
- \( L \) = the length of the pipe section being tested, in feet,
- \( D \) = the nominal diameter of the pipe in inches, and
- \( P \) = the average test pressure during the hydrostatic test in pounds per square inch (psi).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. PVC PIPING shall be measured by linear feet of each diameter as indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

B. 6-INCH TAP ON EXISTING 12-INCH OUTFALL shall be measured by each as indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

4.02 PAYMENT
A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
SECTION 02660
WATER MAINS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for providing water mains and appurtenant structures.

1.02 QUALITY ASSURANCE
A. Reference Standards Applicable to this Section
   1. ASTM: American Society for Testing and Materials
   2. AWWA: American Water Works Association
      b. C151: Ductile Iron Pipe for Water or Other Liquids.
      c. C200: Standard for Steel Water Pipe, 6 in. and larger.
      e. C207: Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.
      g. C500: Standard for Gate Valves 3 in. through 48 in. NPS, for Water and Sewage Systems.
      i. C601: Standard for Disinfecting Water Mains.
j. C900: Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water.

3. City of Houston, Public Works Department:

B. Tests

1. Pressure and Leakage Tests

2. Lining Toxicity Tests

   Conforming to FDA "Method of Testing for Toxicity of Coating Material Intended for Use in Transporting or Holding Food or Potable Water." Certified test results of pipe manufacturer shall be submitted.

3. Chlorine Residual Test

   AWWA C 601

4. Bacteriologic Tests

   AWWA C 601; certified test results shall be approved by public health authority having jurisdiction.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Certificates
   a. Manufacturer's certificates stating that materials meet specified requirements.

2. Shop Drawings and Data
   a. Shop Drawings (including Record Drawings) and manufacturer's data showing details of valves, boxes, fire hydrants, and various types of pipe, fittings, appurtenances, and connections, as actually installed.
PART 2 - PRODUCTS

2.01 GENERAL

A. Products for use within public right-of-way shall meet the applicable requirements of the government agency having jurisdiction over the area.

2.02 MATERIALS

A. Steel Pipe and Fittings

1. Pipe conforming to AWWA C 200,

2. Coating conforming to AWWA C 203.

3. Flanges conforming to AWWA C 207, Class D with Grade A and Grade B bolts as required.

4. Fittings conforming to AWWA C 208.

B. Ductile Iron Pipe and Fittings

Conforming to AWWA C 115 or C 151 as appropriate and indicated.

C. Gate Valves

Conforming to AWWA C 500, with iron body, double disc, non-rising stem, 2-in. square nut operated, and push-on type joints.

D. Valve Boxes

Conforming to ASTM A 48, 30 B minimum, screw-type adjustable length, stay-put type removable cover with the word WATER or FIRE as applicable.

E. Tapping Valves and Tapping Sleeves

Conforming to governmental agency having jurisdiction over the area.

F. Fire Hydrant

Conforming to AWWA C 502, compression type, minimum 7 in. size barrel, with two hose nozzles and one pumper nozzle, with chain and cap for each nozzle.
G. PVC Materials

Conforming to AWWA C 900.

PART 3 - EXECUTION

3.01 GENERAL

A. All water work performed and materials installed within public right-of-way shall meet the applicable requirements of the government agency having jurisdiction over the area and applicable AWWA Standards.

3.02 EXCAVATION

A. All excavation shall be in accordance with Section 02161 - Trench Safety Systems of these Specifications.

B. Perform excavation for water main to line and grade required as shown on the Drawings and as specified herein.

C. Excavate to a minimum of 6 in. outside pipe barrel. Maintain sides of trench substantially vertical. Shore and support as necessary.

D. If the excavation exceeds the permissible dimensions, extend the encasement or install pipe of higher strength, as directed.

E. Prevent surface or ground water from flowing into excavation. Install, operate, and maintain dewatering system to convey water away from excavation.

F. Where it is necessary to place backfill or embankments so that the trench can be excavated, extend the backfill or embankment full depth laterally a distance of at least 2-1/2 times the diameter of the pipe on each side measured from the centerline of the pipe.

3.03 PIPE ENCASEMENT

A. Provide 6 in. of cement-stabilized sand bedding, shaped to fully support the pipe, fulfill all requirements of 1.02-A-3-a of this section, with the exception that no water tamping shall be permitted.
3.04 INSTALLATION OF VALVES AND FIRE HYDRANTS

A. Install valves, valve boxes and fire hydrants in accordance with the manufacturer’s instructions and at locations shown on the Drawings. Annotate Record Drawings to show actual "as-built" locations.

3.05 BACKFILL

A. Backfill and compact the excavation after successful completion of laying, jointing, and testing of pipe, and after obtaining written approval of METRO to do so. Comply with Section 02200 - Earthwork of these Specifications.

3.06 TESTING AND DISINFECTING

A. Conduct leakage and pressure tests by the open trench method. Allowable hydrostatic pressure and leakage shall be as specified in 1.02-A-3-a of this section.

B. Repair all leaks and defects and retest lines to ensure elimination of leaks and defects at no additional cost to METRO.

C. Disinfect and test water lines in accordance with AWWA C 601. Disinfection shall be done before final backfill around hydrants and valves.

D. Following METRO written approval of the disinfection test results, conduct operating tests to verify that each valve and hydrant is in proper working condition. Whenever practical, operating tests shall be performed during flushing of chlorine from the line. METRO shall be informed so as to witness the tests.

E. Do not connect newly constructed water mains to existing water mains until mains have been successfully cleaned, tested, disinfected and approved by the government agency or municipal utility district having jurisdiction over the area.

3.07 CLEANUP

A. Remove temporary structures, rubbish, waste materials, and excess excavated materials from the Site and dispose of legally.
SECTION 02720

STORM SEWAGE SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing storm sewers and appurtenant structures.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. AASHTO: American Association of State Highway and Transportation Officials
   b. M 190: Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   d. M 294: Specification for Corrugated Polyethylene Pipe 12 inch to 36 inch diameter.

2. ASTM: American Society for Testing and Materials
   d. C 76: Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
f. C 443: Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.
i. D 1248: Polyethylene Plastics Molding and Extrusion Material.
j. D 1693: Environmental Stress Cracking of Ethylene Plastics.
k. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
m. D 2241: Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
o. D 2412: Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
p. D 2444: Test for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
q. D 2447: Specifications for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
s. D 2467: Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
z. D 3034: Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
aa. D 3035: Specifications for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
ii. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.


mm. F 913: Standard Specification for Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

nn. F 667: Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.

3. Federal Specification


4. AWPA: American Wood Preservers' Association

a. Book of Standards.

5. City of Houston


6. TxDOT: Texas Department of Transportation


b. The above referenced TxDOT standard may be obtained from:

   Texas Department of Transportation
   Highway Building
   11th and Brazos Streets
   Austin, Texas 78701
   Telephone: (512) 475-2081

c. Special provisions to the above mentioned TxDOT Standard Specifications as follows:
1) For this project Item 556, PIPE UNDERDRAINS, of the Standard Specifications is amended with respect to the clauses cited below, and no other clauses or requirements of this item are waived or changed hereby.

ARTICLE 556.4 Measurement is voided and not replaced. ARTICLE 556.5 Payment is voided and not replaced.

7. Harris County Flood Control District (HCFCD)
   a. Standard Specifications

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Certificates
   a. Manufacturer’s certificates and load tickets stating that materials meet specified requirements.

2. Shop Drawings
   a. Shop Drawings and details of all storm sewers and drains, including relationship to other systems and true position and details of all interfaces, connections, inlets, cleanouts, manholes, alignment and grade, changes of direction, offsets, bedding and protection, materials, manufacturer's installation and connection instructions and recommendations, and all other pertinent data.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products for use within City of Houston right-of-way shall meet the applicable requirements.

2.02 PIPES AND FITTINGS

A. Reinforced Concrete Pipe (RCP)

1. ASTM C 76, bell-and-spigot, Class III, Wall B.
B. Corrugated Galvanized Metal Pipe (CGMP)
   1. AASHTO M 36, coated and paved in accordance with AASHTO M 190, Type C coating for pipe and Type A coating for coupling bands.

C. PVC Pipe in accordance with the following:
   1. ASTM D 1785.
   2. ASTM D 2241.
   3. ASTM D 2466.
   4. ASTM D 2467.

D. PE Pipe
   1. ASTM D 2447.
   2. ASTM D 3035.
   3. ASTM D 3350 Type PE 3408.
   4. ASTM F 714 Type PE 3408.

2.03 JOINTS

A. Gaskets for RCP in accordance with the following:
   1. Federal Specification SS-S-210A.
   2. ASTM C 443.

B. All joints in PVC plastic pipe shall be solvent-cemented in accordance with the following:
   1. ASTM D 2564.
   2. ASTM D 2672.
   3. ASTM D 2855.
   4. ASTM F 402.
5. ASTM F 656.

C. All joints in PE plastic pipe shall be fusion butt-welded in accordance with ASTM 3261.

2.04 DRAINAGE STRUCTURES

A. Manhole

Type as indicated on the Drawings and conforming to applicable Standards for City of Houston Right-of-Way or METRO Property. Frame and Cover ASTM A 48 Class 35 B.

B. Inlet

Type as indicated on the Drawings and conforming to applicable Standards in City of Houston Right-of-Way or METRO Property. Frame and Grate ASTM A 48 Class 35 B.

C. Reinforcing Steel

As specified in Section 03200 - Concrete Reinforcement of these Specifications.

D. Cast-in-Place Concrete (Class 3000)

As specified in Section 03300 - Cast-in-Place Concrete of these Specifications.

E. Mortar (Type M)

As specified in Section 04100 - Masonry Mortar and Grout of these Specifications.

2.05 CEMENT-STABILIZED SAND BACKFILL

A. Aggregate

Use clean sand; deleterious materials in the sand shall not exceed the following limitations, by weight:

| Material removed by denatation | 5.0 percent |
| Clay lumps                     | 0.5 percent |
| Other deleterious substances   | 2.0 percent |
Gradation Requirements:

<table>
<thead>
<tr>
<th>Gradation Requirements</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 3/8-in. sieve</td>
<td>0 percent</td>
</tr>
<tr>
<td>Retained on 1/4-in. sieve</td>
<td>0 - 5 percent</td>
</tr>
<tr>
<td>Retained on 20-mesh sieve</td>
<td>15 - 50 percent</td>
</tr>
<tr>
<td>Retained on 100-mesh sieve</td>
<td>80 - 100 percent</td>
</tr>
</tbody>
</table>

Color test per ASTM C 40, color not darker than standard color.

B. Cement

ASTM C 150, Type I or II.

C. Water

Potable, from municipal supplies approved by the State or City Health Department.

D. Mixture

Use at least 1-1/2 sacks of cement per cubic yard of mixture. Use amount of water required to provide mix suitable for mechanical hand tamping and mix in approved mixer. Stamp load tickets at plant with time of loading. Material not in place within 1-1/2 hours after loading or that has obtained an initial set will be rejected and shall be removed from the Site and replaced with new acceptable mixtures at no additional cost to METRO.

2.06 TIMBER POSTS

A. Southern Pine or Douglas Fir, pressure-treated in accordance with American Wood Preservers’ Association (AWPA) Standards, and meeting requirements of HCFCD Standard Specification 02365.

PART 3 - EXECUTION

3.01 GENERAL

A. All sewer work performed within City of Houston right-of-way shall meet the applicable requirements.

3.02 EXCAVATION

A. All excavation shall be in accordance with Section 02161 - Trench Safety Systems of these Specifications.
B. Perform excavation for storm sewer and storm sewer drainage structures to line and grade required as shown on the Drawings and as specified herein.

C. If the excavation exceeds the permissible dimensions, extend the encasement or install pipe of higher strength, as directed.

D. Prevent surface or ground water from flowing into excavation. Install, operate, and maintain dewatering system to convey water away from excavation. Notify METRO in writing of delays to the Work caused by water intrusion.

E. All excavation and backfill within HCFC Standard Specification 02221.

3.03 PIPE ENCASEMENT

A. Place cement-stabilized sand bedding before laying pipe. Bedding shall be compacted and shaped to fully support the pipe.

B. After the pipe is laid, place cement-stabilized sand beside and above the pipe in 4 in. lifts to the limits shown on the construction drawings. Compact individual lifts with a hand-operated, motorized tamper; exercise care to avoid damaging the pipe.

3.04 LAYING PIPE

A. Install and joint pipe in accordance with the pipe manufacturer's instructions and as specified herein.

B. Provide a minimum of 6 in. clearance between storm sewer and sanitary sewer.

C. Seal open end of pipe with plug when pipe laying operation is temporarily halted. Plug shall remain in place until operation restarts.

3.05 FRAMED BENT

A. Construct framed bent for pipe outfall as required. Use treated timber in construction. Timber bent shall be in accordance with HCFC Standard Specification 02365.

B. Posts shall be bedded firmly and evenly to solid bearing and carefully tamped in place.

C. Place rip rap at the outfall pipe as required in accordance with HCFC Standard Specification 02273.
3.06 BACKFILL

A. On completion of construction, backfill the excavation as specified in Section 02200 - Earthwork of these Specifications and in accordance with details on the construction drawings. Backfill only when the written approval of METRO is obtained to do so.

B. Cement stabilized sand placed in HCFCD Right-of-Way or easement shall comply with HCFCD Standard Specification 02242.

3.07 CONSTRUCTION OF MANHOLES AND INLETS

A. General

1. Construct manholes and inlets as soon as practical after sewer lines into or through the manhole or inlet locations are completed.

2. Construct manholes and inlets at locations and of the type indicated. All manholes within 9 feet of existing water lines shall be watertight.

B. Manholes

1. Provide base of the shape and size required with a minimum thickness of 12 inches.

2. Place axis of manholes directly over the centerlines of the lines, unless otherwise indicated.

3. Shall be constructed of either precast or cast-in-place concrete.

C. Inlets

1. Shall be constructed of either precast or cast-in-place concrete.

3.08 TESTING

A. Perform testing of completed sewer lines in accordance with applicable Standard.

B. Repair and eliminate leaks and retest lines as required with no additional cost to METRO. Notify METRO so as to witness the tests.
3.09 CLEANUP

A. Remove temporary structures, rubbish, waste materials, and excess excavated materials from the Site and dispose of legally.

END OF SECTION 02720
SECTION 02831
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for providing chain link fences and gates, either plain galvanized steel or vinyl-clad galvanized steel, as indicated.

1.02 QUALITY ASSURANCE
A. Reference Standards Applicable to this Section
   1. ASTM: American Society for Testing and Materials
      a. A 53: Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated Welded and Seamless.
      d. A 569: Specification for Steel Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
      e. F 552: Standard Definition of Terms Relating to Chain Link Fencing.
      g. F 626: Specification for Fence Fittings.
      h. F 668: Specification for PolyVinyl Chloride (PVC) - Coated Steel Chain-Link Fence Fabric.
      i. F 669: Specification for Strength Requirements of Metal Posts and Rails for Industrial Chain-Link Fence.

k. F934: Standard Colors for Polymer Coated Chain Link Fence Materials.

2. CLFMI: Chain Link Fence Manufacturers Institute

3. FS: Federal Specifications and Standards
   a. TT-P-641: Primer Coating, Zinc Dust-Zinc Oxide (For Galvanized Surfaces).
   b. TT-P-645: Primer, Zinc Chromate.
   c. RF 191 S: Fencing, Wire and Post Metal

B. Chain link fences and gates, as complete units, shall be produced by or the manufacture controlled by one manufacturer including all erection accessories, fittings and fastenings.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Product Data
   a. Manufacturer's literature indicating product specifications, installation instructions and recommendations.

2. Samples
   a. Two PVC coating color samples (black).

3. Certificates
   a. Certified test reports giving results of tests of vinyl coatings.
   b. Certified test reports giving results of test of zinc coatings.
PART 2 - PRODUCTS

2.01 MATERIALS

A. Framework

1. Either ASTM A 53, Schedule 40, steel pipe, standard weight and hot-dipped galvanized or ASTM A 569, cold rolled, welded steel pipe having a minimum yield strength of 50,000 psi and meeting the weight and corrosion protection requirements for Type II round posts specified in the CLFMI Product Manual. All framework to be PVC coated. Pipe shall be of the following sizes, or as indicated:

   a. End, corner and pull posts: 2.375 inches Nom. O.D. (60 mm).

   b. Line posts: 1.900 inches Nom. O.D. (48.3 mm).

   c. Gate posts: 2.875 inches Nom. O.D. for gate leaf up to 6 feet wide; 4.000 inches OD for gate leaf 6 feet to 13 feet wide; 6.625 inches OD for gate leaf 13 feet to 18 feet wide; and 8.625 inches OD for gate leaf over 18 feet wide.

   d. Top rail, center rail and post brace: 1.660 inches Nom. O.D. (42 mm).

2. Data shall be submitted indicating that materials meet the strength requirements of ASTM F 669, if so directed by METRO.

B. Tension Wire

Marcelled (spiralled or crimped), No. 7 gauge wire coated with not less than 0.80 ounce of zinc per square foot of uncoated wire.

Securely fasten the tension wire to the terminal posts. The tension wire shall be taut and free of sag.

C. Fence Fittings

ASTM F 626, except the zinc coating weight shall be in accordance with ASTM A 153.

D. Swing Gates
1. Gate frame: 1.660 inches Nom. O.D. for gate leaf up to 6 feet high by 8 feet or less wide; 1.900 inches Nom. O.D. for gate leaf up to 6 feet high by over 8 feet wide.

2. Gate Hinges

Manufacturer's galvanized heavy malleable steel hinges non-lift-off type, sized to suit gate size, offset to permit 180° gate opening. Provide 1-1/2 pairs of hinges for each leaf over 6 feet nominal height.

3. Gate Latches

Manufacturer's drop rod assembly sized to match gate height to permit operation from either side of gate, designed with padlock eye as integral part of the latch.

4. Holdbacks

Provide holdbacks with provision for locking in open position for vehicle gates which automatically engage gate leaf and hold leaf locked in open position until manually unlocked and released.

5. Stops

Provide malleable iron gate center stops for double gates, consisting of mushroom type or flush plate with anchors.

E. Cantilever Sliding Gates

Aluminum cantilever sliding gates shown on Drawings shall conform to the following:

1. Gate frames shall be made of 2 inch square tubing, weighing 0.97 pounds per lineal foot, welded at all corners to form a rigid one piece unit. Fabric shall be securely stretched and welded in the center of the 2 inch square tubing by use of hook bolts and tension rods on all four sides of the gate opening frame.

2. All cantilever overhang frames shall have 3/8 inch brace rods.

3. The track and frame shall be a one-piece extrusion having a combined weight of 5.05 pounds per foot, designed to withstand a reaction load of 3,000 pounds. Two track and frames shall be welded together to make up the top rail. Provide track on each side of top rail.
4. Four (4) swivel-type trucks with two-piece zinc die castings having four lubricant-sealed ball bearing wheels, 2 inch diameter by 9/16 inch width, and having two side-rolling wheels to ensure alignment of truck in track shall be provided for each gate leaf. Trucks shall be held to post brackets by 7/8 inch diameter ball bolts with 1/2 inch shank. Truck assembly shall be designed to take the same reaction load as the track.

5. Four (4) gate posts, 4 inches OD, weighing 9.1 pounds per foot, shall be installed for each slide gate. The two sets of posts supporting the load of the gate shall be set to conform to the length of the cantilever overhang.

6. Guide wheel assemblies shall be provided for each supporting post set. Each assembly shall consist of two rubber wheels, 4 inches in diameter, with oil-impregnated bearings. Assemblies shall be attached to post so that the bottom 4 inch square horizontal member will roll between the wheels. Wheels shall be adjacent to maintain plumb gate frames and proper alignment.

7. A positive latch shall be provided with provisions for padlock.

8. All gate fittings, other than trucks, shall be galvanized malleable iron or steel, painted black.

9. There shall be no deflection at any width opening of the gate. Maximum effort required to open or close gate shall be 25 pounds.

F. Concrete

Class 3000, as specified in Section 03300 - Cast-in-Place Concrete, of these Specifications.

G. Galvanizing Repair Paint

FS TT-P-641, Type II.

H. Zinc Chromate Primer

FS TT-P-645.

I. Poly Vinyl Chloride (PVC) Clad Fencing, Posts, and Accessories.

1. Vinyl-coated chain link fence fabric shall be No. 8 finish gauge with finished O.D. of .162 (4.11 mm), core diameter of .120 (3.05 mm), PVC coating thickness of .015 - .025 (0.38 - 0.64 mm), mesh size of 2 inch square (50
mm) and fabric extrusion type class 2A. Fabric shall meet requirements of ASTM F 668, as appropriate, unless waived in writing by METRO.

2. Primed steel ASTM A 53 pipe and accessories shall be thermal fusion coated with PVC. The coating which has been bonded to the metal surfaces shall have a minimum thickness of 0.015 inch. The color shall match the color of the PVC coating of the fabric.

3. Color shall be black.

4. All steel parts shall be hot dip galvanized prior to PVC coating application. All steel parts shall be PVC coated after galvanizing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All chain link fences and gates shall be installed in accordance with the requirements of ASTM F 567, the CLFMI Product Manual, and the manufacturer's installation instructions and recommendations. ASTM F 567 shall be given precedence in case of conflict. Notify METRO in writing of such conflicts.

B. After chain link fences and gates installation is complete, all damaged galvanized surfaces shall be thoroughly wire brushed and cleaned and painted with two coats of galvanizing repair paint to like new conditions.

C. Aluminum to be embedded in concrete shall be protected from direct contact with concrete by zinc chromate primer, FS TT-P-645.

D. PVC-clad surfaces shall be touched up with a compound as recommended by the manufacturer.

END OF SECTION 02831
SECTION 02933

SEEDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for preparing ground and providing seed, top soil, water and fertilizer necessary for seeding.

1.02 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Seed Certification
   a. Certification from the supplier for each type of seed specified. Certification shall accompany the delivery of the seed and shall indicate that the seed is in accordance with the requirements of the Texas Seed Law.

2. Fertilizer Certification
   a. Certification from the fertilizer manufacturer describing the chemical analysis of the fertilizer, a listing of the elements contained therein and their percentages. Certification shall also indicate that the fertilizer complies with the requirements of the Texas Fertilizer Law.

3. Top soil and sharp sand samples.

1.03 PRODUCT HANDLING

A. Seed Delivery

   Each variety of seed shall be delivered in separate bags or containers, labeled to indicate pure live seed, name and type of seed.

B. Fertilizer Delivery
Fertilizer shall be delivered in the manufacturer's unopened containers, labeled to indicate the manufacturer's name and product identification. Containers shall be stored protected from ground contact and from the elements.

1.04 JOB CONDITIONS

A. Hydroseeding of Bermuda grass shall occur during the periods of April 15 to June 15, and August 15 to September 15 unless otherwise approved in writing by METRO.

PART 2 - PRODUCTS

2.01 SEED

A. Type

Turfgrass seed shall be Cynodon dactylon (Common Bermuda grass). The seed shall be harvested within 1 year prior to planting, pure and free of any weed seed. The seed shall not be a mixture. The seed shall be hulled, extra fancy grade, treated with fungicide, and shall have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 85%, using the formula: purity percent times (germination percent times plus hard or sound seed percent). Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

B. Amounts

<table>
<thead>
<tr>
<th>ITEM</th>
<th>RATE PER ACRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turgrass Seed</td>
<td>2 lbs/1,000 Sq. Ft.</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>20 lbs/1,000 Sq. Ft.</td>
</tr>
<tr>
<td>Water</td>
<td>As needed</td>
</tr>
<tr>
<td>Cellulose Wood Fiber Mulch</td>
<td>50 lbs/1,000 Sq. Ft.</td>
</tr>
</tbody>
</table>

2.02 TOPSOIL

A. Top soil shall be as specified in Section 02905 - Planting Work of these Specifications.

B. Top soil shall not contain toxic substances which may be harmful to plant growth, noxious weeds or the admixture of subsoil.

2.03 FERTILIZER

A. As specified in Section 02935 - Sodding of these Specifications.
2.04 WATER
A. Potable, from municipal supplies approved by the State or City Health Department.

2.05 SHARP SAND
A. As specified in Section 02905 - Planting Work of these Specifications.

PART 3 - EXECUTION

3.01 INSPECTION
A. Surfaces indicated to be seeded shall be inspected to verify that all preparatory work in the area has been completed. Seeding shall not start until all preparatory work has been completed.

3.02 PREPARATION
A. Grade existing soil to within 2 1/2 in. of top of walks and curbs. Add 2 in. of topsoil and till to a depth of 4 in. removing all extraneous material 1 in. or greater in any dimensions. Roll tilled area with a hand pushed water filled drum roller. Fill voids and low spots with additional top soil. Add a fine layer of sand and rake to a smooth surface.

B. In areas where weeds exist, treat with Roundup or approved equal, prior to hydromulching, in accordance with manufacturer’s recommendations.

C. In natural areas where top soil is not stripped, till top soil, removing all extraneous material of 1 in. or greater in any dimension. Add new top soil to bring grade to 1/2 in. below finished grade then add a fine layer of sharp sand. Rake smooth.

3.03 APPLICATION
A. Seed shall be uniformly distributed over the designated area at the rate specified.

B. Mechanical equipment shall be used. Seed and fertilizer may be distributed at the same time, provided that each component is uniformly applied at the specified rate. When seed and fertilizer are to be distributed as a water slurry, the mixture shall be applied to the seeded areas within 30 minutes after the components are placed in the equipment.
C. Upon germination of seeds, Contractor shall reseed any bare areas. Reseeding shall occur within 30 days after initial seeding. Contractor shall provide a full stand of grass at final acceptance.

3.04 WATERING

A. After installation, seeded areas shall be watered in an amount and as often as necessary to keep areas moistened to their full depth for a period of 2 weeks.

B. After initial 2 weeks of watering, seeded areas shall be watered to the extent necessary to maintain a healthy, vigorous growth for a fully established lawn.

3.05 ESTABLISHMENT

A. Contractor shall care for all seeded areas as per specifications 02971 – Establish landscape for a period of one year from date of planting work substantial completion.

B. After one year period, all seeded areas shall be fully established and in a healthy and vigorous condition without disease.

END OF SECTION 02933
PART 1  GENERAL

1.01 SCOPE: This section covers formwork materials, systems, coatings, supports, and accessories for cast-in-place concrete.

1.02 REFERENCE STANDARDS:

A. ACI 301 - Specification for Structural Concrete for Buildings.

B. ACI 347 - Recommended Practice for Concrete Formwork.

PART 2  PRODUCTS

2.01 MATERIALS


B. Plywood Product Standard PS1, waterproof, resinbonded, exterior type Douglas fir; face adjacent to concrete Grade B or better.

C. Fiberboard Fed Spec LLL-B-810, Type IX; tempered, waterproof, screenback, concrete form hardboard.

D. Lumber Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.

E. Chamfer Strips Clear white pine, surface against concrete planed.

F. Bar Supports Product Standard PS7 and CRSI, Class D or E.


2.02 GENERAL REQUIREMENTS

A. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall conform to ACI 347 and the following additional requirements.

B. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood
forms, or forms that are lined with plywood or fiberboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and concave or convex areas.

C. Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the insides of manholes, basins, and conduits. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.

2.03 DESIGN

A. The design and engineering of all concrete formwork shall be the responsibility of the Contractor. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded.

B. Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs.

C. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations forms for concrete which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls, the forms on one side shall not extend more than 2 feet above the joint.

2.04 FORM TIES

A. Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie and the permanently embedded portion shall be at least one inch back from the concrete face. Permanently embedded portions of form ties which are not provided with threaded ends shall be constructed so that the removable
ends are readily broken off without damage to the concrete. The type of form ties used shall be acceptable to the Engineer.

B. Form ties in exposed surface shall be uniformly spaced and aligned in horizontal and vertical rows.

2.05 EDGES AND CORNERS

A. Chamfer strips shall be placed in forms to bevel all salient edges and corners except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have chamfered corners unless specifically shown otherwise on the drawings. Unless otherwise noted, bevels shall be 3/4 inch wide.

PART 3 EXECUTION

3.01 NOTIFICATION

A. The Contractor shall notify the Engineer at least 48 hours in advance of the times and places he intends to place concrete.

3.02 FORM COATING

A. Use commercial formulation of form oil or form-release agent having proven satisfactory performance. Coating must not bond with, stain, or adversely effect concrete surfaces: It must not impair subsequent treatment of concrete surfaces, including bonding agents, curing compounds and membrane waterproofing.

3.03 EMBEDMENTS

A. Anchor bolts, castings, steel shapes, conduit, sleeves, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be installed on the concrete side of the form. A second nut shall be installed on the other side of the form and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

3.04 CLEANING

A. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection. Embedments shall be clean when installed.

3.05 TOLERANCES
A. Tolerances for formed surfaces shall be as specified in ACI 301 and 347 except as modified herein. In case of conflict between ACI 301 and 347, ACI 347 shall govern. The maximum deviation from a true plane shall not exceed 1/8 inch in 6 feet.

3.06 FORM REMOVAL

A. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

3.07 REMOVAL STRENGTH

A. Control Tests: Suitable strength control tests will be used as evidence that concrete has attained specified strength for removal of formwork or shoring supporting weight of concrete in beams, slabs, and other structural members.

1. Field-Cured Test Cylinders: When field-cured test cylinders reach the specified removal strength, formwork or shoring may be removed from the respective concrete placements. Strength data from field-cured test cylinders shall be furnished by the Contractor.

2. Laboratory-Cured Test Cylinders: When concrete has been cured as specified for cast-in-place concrete for the same time period required by laboratory-cured cylinders to reach specified strength, the formwork or shoring may be removed from respective concrete placements. Determine the length of time that the concrete placement has been cured by totaling the number of days or fraction of days, not necessarily consecutive, during which the air temperature surrounding the concrete is above 50°F and the concrete has been damp or thoroughly sealed against evaporation and loss of moisture.

B. Compressive Strengths: The minimum concrete compressive strengths for removal of all formwork supporting the weight of concrete shall be 75 percent of the specified minimum 28-day strength of the class of concrete involved.

3.08 FORM REUSE
A. The reuse of forms for exposed surfaces will be permitted when thoroughly cleaned and sanded or otherwise dressed so that concrete contact surfaces are restored to original conditions. Forms that are bent, dented or otherwise deformed to the extent that tight joints and tolerance cannot be maintained shall not be used.

END OF SECTION
SECTION 03200
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for providing, fabricating and placing reinforcement for concrete structures.

1.02 QUALITY ASSURANCE
A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute
   a. 301: Specifications for Structural Concrete for Buildings.
   b. 315: Details and Detailing of Reinforced Concrete.

2. ASTM: American Society for Testing and Materials
   a. A 82: Specification for Cold-Drawn Steel Wire for Concrete Reinforcement.
   b. A 185: Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
   c. A 370: Methods and Definitions for Mechanical Testing of Steel Products.
   d. A 496: Specification for Deformed Steel Wire for Concrete Reinforcement.
   e. A 497: Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
   f. A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (with Supplement + S1).
g. E 8: Methods of Tension Testing of Metallic Materials.
h. E 94: Recommended Practice for Radiographic Testing.
i. E 390: Reference Radiographs for Steel Fusion Welds.

B. Tolerances

1. Reinforcing bars shall be fabricated to meet the fabricating tolerances indicated in ACI 301, Chapter 5.

2. Reinforcing bars shall be placed to meet the placing tolerances indicated in ACI 301, Chapter 5.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Shop Drawings and Product Data

   a. Shop Drawings, prepared in accordance with ACI 315, showing details, locations, placement plans and bending diagrams for each reinforcement item.

   b. Bar lists giving the weight of each bar type (or mark), the total weight of each bar size and the total weight of all bars in the list, based on the theoretical unit weights shown in ASTM A 615.

   c. Manufacturer’s instructions for splices and couplers.

B. Certificates

Certified copy of mill tests on each heat that the reinforcing bars or welded wire fabric are from, showing chemical and physical analysis.

1.04 PRODUCT HANDLING

A. Reinforcing bars shall be delivered to the fabricator in bundles, limited to one size and length of bar per bundle, securely tied and labeled with exposed plastic tags identifying the grade and size of bars.
B. After fabrication, reinforcing bars shall be delivered to the Work Site properly identified in accordance with the approved Shop Drawings.

C. Bars shall be handled and placed so as to prevent crimping, bending or warping before and during placement.

D. Bars shall be protected from ground contact and from the elements.

E. Welded steel wire fabric shall be delivered in bundles of flat sheets only labeled to indicate the manufacturer's name and product identification.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcing Steel Bars

1. ASTM A 615 + S1, deformed, new billet steel, Grade 60.
   a. Minimum size shall be #4 bar.

B. Spiral Reinforcement and Reinforcing Wire

1. Plain: ASTM A 82, Grade 40.
2. Deformed: ASTM A 496, Grade 40.
3. Use plain wire, unless otherwise indicated.

C. Welded Steel Wire Fabric

1. Plain: ASTM A 185.
3. Use gauges, spacing and dimensions as indicated.

D. Metal Filled Sleeve Couplers

1. Capable of developing 125 percent of the yield strength of adjoining reinforcing steel bars.
2. Designed to produce 100 percent penetration of the joint.
3. Connection shall be produced by a standard exothermic process whereby molten filler metal, contained by a high-strength steel sleeve of larger inside diameter than adjoining bars, is introduced into the annular space between the bars and the sleeve as well as between the ends of the bars.

E. Mechanical Sleeve Couplers

1. Capable of developing in tension 125 percent of the yield strength of adjoining reinforcing steel bars.

2. Connection shall be produced by mechanical joining of threaded reinforcing bar ends and threaded coupler, or by metal sleeves hydraulically pressed or forged onto butt-ended reinforcing steel bars.

3. Capable of being installed in the clear spaces indicated on the Drawings.

F. Accessories

Provide accessories as recommended in ACI 318. Supports and spacers coming in contact with formwork or within 2 in. of the surface of architectural concrete shall have a Class C plastic or Class E stainless steel finish in accordance with ACI 315.

2.02 FABRICATION

A. General

After bar lists and bending diagrams have been reviewed and approved, each unit of reinforcement shall be fabricated to the type, shape, size, grade, and dimensions shown on the Drawings.

B. Cutting and Bending

1. Reinforcing bars shall be cut and bent before shipping to the Site.

2. Bending shall be performed cold and so as not to injure the material.

3. Irregularities in bending and evidence of rebending will be cause for rejection.

PART 3 - EXECUTION

3.01 GENERAL
A. Before placing concrete, reinforcing steel shall be clean and free of mortar, dirt, scale, paint, oil, grease, loose rust and other foreign matter which could destroy or reduce the bond.

B. Placement of reinforcement will be inspected by and shall have the approval of METRO before concrete is placed.

3.02 PLACING AND FASTENING

A. Reinforcement shall be arranged and placed as shown on the Drawings and the approved bending diagrams and placement plans, and in accordance with the tolerances specified herein.

B. Reinforcing steel shall be embedded in concrete in accordance with the requirements of ACI 318 for embedment, unless otherwise required or indicated.

C. Reinforcement shall be positively secured against displacement during placement of concrete.

D. Bars shall be securely wired or clipped together.

E. On formwork for as-cast finish, only spacers which will not show in the exposed finish shall be used.

F. Concrete reinforcement shall be placed to provide minimum protective coverings in accordance with ACI 318, except where greater minimum coverings are indicated on the Drawings.

3.03 SUPPORTS AND SPACERS

A. Reinforcing bars shall be supported in position by approved spacers, chairs or hangers.

B. Reinforcing steel located in the bottom of slabs on earth shall be supported on heavy-duty plastic chairs or precast concrete mortar blocks with cast-in tie wires, of the proper size and dimensions to correctly position the steel.

3.04 SPLICING

A. Reinforcing bars shall be furnished in full lengths as shown on the Drawings.

B. Where permitted, splices shall conform to the following requirements:
1. The specified concrete cover shall be maintained at lap splices. The spliced bars shall be placed in direct contact with each other and securely tied together. Column bars, in compression only, may be spliced using approved splicing devices.

2. Main bar splices in adjacent bars shall be staggered a minimum of two splice lengths.

C. Lapped splices shall be made so that both bars will be in the same plane parallel with the concrete surface.

D. Splices shall develop the full strength of the bar being spliced.

E. Splices shall be made in accordance with the requirements of ACI 318.

F. Metal-filled sleeve couplers shall be used at the locations indicated on the Drawings, and may be used in lieu of tied lap splices. Couplers shall be installed by qualified personnel in accordance with manufacturer's written instructions. Field test radiographically, not less than one of each 25 sleeve coupler installations in accordance with ASTM E 94 and E 390. Should these tests fail, additional tests shall be made at the rate of not less than one of each 10 sleeve coupler installations.

G. Mechanical sleeve couplers shall be used at locations indicated on the Drawings, and may be used in lieu of tied lap splices. Couplers shall be installed by qualified personnel in accordance with manufacturer's written instructions. Sample couplers made by each installation crew using actual reinforcing bar sizes shall be static tested in accordance with ASTM A 370 and applicable portions of ASTM E 8. The coupled reinforcing bars shall each contain at least three deformation patterns. Three splice specimens shall be tested for each installation crew and reinforcing bar size. Splice capacity shall be at least 125 percent of the yield strength of the reinforcing bars. Reinforcing bars without splices shall be similarly tested to determine their yield strength. Additional tests shall be made at the rate of one per each 25 couplers/crew. Should these latter tests fail, field splices shall be cut from actual installations, at the rate of one per each 25 couplers/crew and tested as specified herein.

END OF SECTION 03200
PART 1 GENERAL

1.01 SCOPE

A. The section covers normal weight cast-in-place portland cement concrete. Forms, concrete joints, and reinforcing are covered in other sections in Division 3. Placement, testing, finishing, grout cleaning, and other appurtenant work specified in this section shall apply to all cast-in-place concrete. **This specification allows for up to 25% fly ash replacement of cement.**

1.02 SUBMITTALS

A. Submittals of data and drawings shall be in accordance with the procedure set forth in Section 01300.

B. The source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the Engineer for review before concrete work is started. Certified reports prepared by an independent testing laboratory covering materials and mix design shall be submitted. Review of these reports shall be for general acceptability only and continued compliance with all contract provisions will be required.

1. Aggregates: Reports on aggregates shall include the following information:

   a. Fine Aggregate
      1) Source and type
      2) Gradation and soundness.
      3) Deleterious substances.

   b. Coarse Aggregate
      1) Source and type.
      2) Gradation and abrasion loss.
      3) Deleterious substances.
      4) Results of sodium or magnesium sulfate soundness test.

2. Mix Design: Using concrete materials acceptable to the Engineer, a tentative concrete mix shall be designed and tested for each class of concrete specified, and shall be designed and tested for each size and gradation of aggregates, and for each consistency
intended for use on the work. Design quantities and test results of each mix shall be submitted for review.

a. The report for each tentative concrete mix submitted shall contain the following information:
   1) Slump on which design is based.
   2) Total gallons of water per cubic yard.
   3) Brand, type, composition, and quantity of cement.
   4) Specific gravity and gradation of each aggregate.
   5) Ratio of fine to total aggregates.
   6) Weight (surface dry) of each aggregate per cubic yard.
   7) Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.
   8) Air content.
   9) Unit weight.
   10) Compressive strength based on 7 day and 28 day compression tests.
   11) Drying shrinkage bar tests for each mix design.
   12) Time of initial set.
   13) Curing Method.

1.03 STORAGE OF MATERIALS

A. Cement shall be stored in suitable moisture-proof enclosures.

B. Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

1.04 TESTING SERVICES

A. The tests required in this section shall be performed by a commercial testing laboratory selected and paid by owner in accordance with the requirements of Division 1.

1.05 SERVICE CONDITIONS

A. Concrete classes shall be defined and used as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>All concrete unless specifically allowed to be another class.</td>
</tr>
<tr>
<td>B</td>
<td>Structural and slab on grade concrete not normally in contact with liquid during plant operation.</td>
</tr>
</tbody>
</table>
C  Paving and sidewalk concrete.

D  Encasement Concrete - Pipe and electrical conduit encasement, concrete fill, and seal slabs only.

PART 2  PRODUCTS

2.01  MATERIALS

A.  Cement
   1.  Class A, B, C and D Concrete, ASTM C150, Type I.
   2.  All cement used shall be produced at the same plant.

B.  Fine Aggregate
   2.  Artificial or manufactured sand will not be acceptable.

C.  Coarse Aggregate
   1.  ASTM C33 Crushed rock.
   2.  Clay and shale particles shall not exceed one percent.

D.  Water
   1.  ASTM C94 Potable.

E.  Water Reducer
   1.  ASTM C494, Type A, containing no calcium chloride catalyst
   2.  American Admixtures "Lubircon 400"
   3.  Master Builders "Pozzolith N"
   4.  Sika chemical "Plastocrete,"
   5.  Grace "WRDA/Hycol, WRDA-79, or WRDA-82" or approved equal.

F.  Retarder
1. ASTM C494, Type D

2. American Admixtures "Lubricon R"

3. Master Builders "Pozzolith R"

4. Sika Chemical "Plastiment,"

5. Grace "Daratard 17" or approved equal.

G. Accelerator

1. ASTM C-444 Type C

2. Non-chloride type

3. Grace "Daraset" or equal.

H. High Range Water Reducer

1. ASTM C494, Type F. (Type G or F/G not approved)

2. Grade "WRDA-19"

3. Master Builder's "400 N"


I. Air-Entraining Agent

1. ASTM C260

2. Grace "Daravair-M"

3. American Admixtures "Amex 210"

4. Master Builders "MB-VR"

5. Sika Chemical "AER," or approved equal

J. Polyethylene Film

1. Product Standard PS17, 6 mil.

K. Membrane Curing Compound
1. Fed Spec TT-C-0800, Type I; minimum 18 percent solids, nonyellowing, and minimum water retention 0.039 gm/cm\(^2\); ALX-9

2. Protex "Acrychlor"


L. Bonding Agent

1. Grace "Daraweld-C," or approved equal.

M. Fly Ash

1. Maximum 25% fly ash replacement of cement in the mix design.

2.02 LIMITING REQUIREMENTS

A. For each class of concrete each concrete mix shall be designed to attain the minimum compressive strengths listed below and each component of the mix shall be controlled within the limits of Table 1. Coarse aggregate shall be limited to 1" maximum size for pumped concrete mixes.

<table>
<thead>
<tr>
<th>CONCRETE CLASS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min compressive strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 7 days, psi</td>
<td>3000</td>
<td>3000</td>
<td>2000</td>
<td>---</td>
</tr>
<tr>
<td>At 28 days, psi</td>
<td>4000</td>
<td>4000</td>
<td>3000</td>
<td>2500</td>
</tr>
<tr>
<td>Min flexural strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 7 Days, PSI</td>
<td>---</td>
<td>---</td>
<td>450</td>
<td>---</td>
</tr>
<tr>
<td>Max water/cement ratio by weight</td>
<td>1.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>Max slump, inches</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>superplasticized</td>
<td>9</td>
<td>10</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Max coarse aggregate size, inches</td>
<td>1</td>
<td>1</td>
<td>1-1/2</td>
<td>1-1/2</td>
</tr>
<tr>
<td>Water Reducer/Retarder</td>
<td>Req'd</td>
<td>Req'd</td>
<td>Req'd</td>
<td>Optnl</td>
</tr>
<tr>
<td>Air-entraining</td>
<td>Req'd</td>
<td>Req'd</td>
<td>Req'd</td>
<td>Req'd</td>
</tr>
<tr>
<td>Superplasticizer</td>
<td>Req'd</td>
<td>Optnl</td>
<td>Optnl</td>
<td>Optnl</td>
</tr>
<tr>
<td>(High Range Water Reducer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerator</td>
<td>Optnl</td>
<td>Optnl</td>
<td>Optnl</td>
<td>Optnl</td>
</tr>
</tbody>
</table>

B. Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless otherwise authorized by the Engineer, slump shall not exceed the maximum slump specified in Table.
C. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendations for minimum shrinkage for compliance with these specifications.

D. No calcium chloride shall be used.

E. The minimum acceptable compressive strengths as determined by ASTM C39 shall be as specified for each concrete class.

PART 3 EXECUTION

3.01 NOTIFICATION

A. The Contractor shall notify the Engineer at least 48 hours in advance of the times and places he intends to place concrete.

3.02 BATCHING AND MIXING

A. Concrete shall be furnished by an acceptable ready-mix concrete supplier and shall conform to ASTM C94.

B. A delivery ticket shall be prepared for each load of ready-mixed concrete. A copy of each ticket shall be handed to the Engineer by the truck operator at the time of delivery. Tickets shall show the quantity delivered, concrete class, the amount of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and numerical sequence of the delivery.

C. No water shall be added to Class A or B concrete at the job site. Any desired increase in slump shall be attained by use of high range water reducer. Adding water to Class A or B concrete at the job site shall be cause for rejection of the load in question.

3.03 PLACEMENT

A. The limits of each concrete placement shall be predetermined by the Contractor and shall be acceptable to the Engineer. All concrete within such limits shall be placed in one continuous operation.

B. Before concrete is placed, forms, reinforcements, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placement operations shall be cleaned; and the entire installation shall be acceptable to the Engineer.

1. Concrete shall be conveyed to the point of final deposit by methods which will prevent separation or loss of ingredients.
Concrete shall be placed in final position without being moved laterally in the forms more than 5 feet (except where superplasticizer is used).

2. Concrete shall be placed in approximately horizontal layers of proper depth for effective compaction; however, the depth of a layer shall not exceed 24 inches. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than 2 feet per hour. Vertical construction joints shall be provided as necessary to comply with these requirements. Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet of vertical height. Concrete in walls or columns shall settle at least 2 hours before concrete is placed in the structural systems to be supported by such walls or columns.

Concrete shall be thoroughly settled when top finished. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled the excess shall be screeded off.

3. During and immediately after placement concrete shall be thoroughly compacted and worked around all reinforcements and embedments and into the corners of the forms. Mechanical vibrators shall be used which will maintain at least 9000 cycles per minute when immersed in the concrete. Each vibrator shall be driven by not smaller than a 1-1/2 hp motor. The number and type of vibrators shall be acceptable to the Engineer.

4. Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete at the time of mixing shall be not less than that shown in the following table for corresponding outdoor temperature (in shade) existing at the time of placement:
<table>
<thead>
<tr>
<th>Outdoor Temperature</th>
<th>Concrete Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 30°F</td>
<td>70°F</td>
</tr>
<tr>
<td>Between 30°F and 45°F</td>
<td>60°F</td>
</tr>
<tr>
<td>Above 45°F</td>
<td>45°F</td>
</tr>
</tbody>
</table>

Heated concrete shall not be warmer than 80°F when placed.

When freezing temperatures may be expected during the curing period, the concrete shall be maintained at a temperature of at least 50°F for 5 days or 70°F for 3 days after placement. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

5. Except as modified herein, hot weather concreting shall comply with ACI 305. At air temperatures weather of 90°F or above, concrete shall be kept as cool as possible during placement and curing. The temperature of the concrete when placed in the work shall not exceed 90°F and ice shall be used as required to maintain the temperature at or below 90°F.

In order to prevent plastic shrinkage cracking due to rapid evaporation of moisture, no concrete shall be placed when the rate of evaporation, determined by using figure 2.1.5 in ACI 305, equals or exceeds 0.2 pound per square foot per hour.

6. Construction joints for portland cement concrete not located on the drawings shall be spaced at a maximum of 40 foot intervals for reducing to a minimum the effect of shrinkage in producing cracks. No two abutting sections shall be placed within a period of 72 hours, unless otherwise authorized by the Engineer.

7. The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, and damp. Surface mortar shall be removed to expose the aggregate. The hardened surface shall be cleaned of all foreign substances (including curing compound), washed with clean water, and
kept saturated during the 24 hour period preceding placement of fresh concrete.

Coarse aggregate shall be omitted from the first batch or batches of concrete placed on hardened concrete in wall or column forms. This mortar puddle shall cover the hardened area to a depth of at least 2 in.

3.04 REPAIRING DEFECTIVE CONCRETE

A. Defects in formed concrete surfaces shall be repaired within 24 hours of the removal of forms, to the satisfaction of the Engineer, and defective concrete shall be replaced within 48 hours after the adjacent forms have been removed. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

B. Concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured.

3.05 FINISHING UNFORMED SURFACES

A. No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

B. Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch as measured from a 10 foot straightedge.

C. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed
finish for unformed surfaces shall be the float finish produced by the second floating. Floating shall be performed with hand floats or suitable mechanical compactor-floats.

D. Surfaces of exterior slabs and exterior concrete stair treads shall be given a light broom finish providing a non-slip surface. Brooming shall be done after the second floating and at right angles to the normal traffic direction.

E. Interior floor surfaces which will be exposed after construction is completed, the exposed portion of the top of equipment bases, the top of interior curbs, and other surfaces designated on the drawings shall be steel trowel finished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

F. All surface mortar shall be removed from surfaces which are to be later covered with concrete or mortar topping. The coarse aggregate shall be exposed in all such surfaces to improve bonding.

G. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having 1/4 inch corner radius.

H. When checked with sludge collecting equipment, each clarifier or chlorine contact basin floor shall not exceed a deviation of one inch from a plane generated by the rotating arms. Basin floors shall be float finished and water cured.

3.06 CURING

A. Concrete shall be protected from loss of moisture for at least 7 days after placement; however, when concrete is being protected from low temperatures, the time period for curing by saturation shall be one day less than the duration of the low temperature protection. Curing of concrete shall be by methods which will keep the concrete surfaces adequately wet during the specified curing period. Concrete for Class A concrete as described under Service Conditions shall be water cured; membrane curing will not be acceptable.

B. Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.
C. Membrane curing compound may be used in lieu of water curing only on Class B and C concrete which will not be covered later with mortar or additional concrete and that required to be water cured above.

Membrane curing compound shall be spray applied at a coverage of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out. Curing compound shall be suitably protected against abrasion during the curing period.

3.07 FINISHING FORMED SURFACES

A. After removal of forms, fins, and other surface projections shall be removed with a power grinder to provide a smooth, flush surface. Tie holes and surfaces irregularities shall be filled with patching mortar and made to match the texture of adjacent concrete.

B. Formed surfaces that are exposed to view during normal operation of the plant shall receive a rubbed finish. Rubbing shall be performed soon after form removal with Carborundum stone. Concrete shall be wetted and rubbed to a paste, the paste shall be spread uniformly, striped with a brush and allowed to take a reset after which the surfaces shall be washed with clean water leaving a uniform appearance and texture.

C. In lieu of rubbing, the contractor may apply a textured structural coating to the concrete if approved by the Engineer. The coating shall be applied in strict conformity with the manufacturer’s recommendations. The coating shall be Preston Shield or approved equal.

3.08 CONCRETE EMBEDMENT AND ENCASEMENT

A. Concrete for embedment and encasement shall be Class D concrete and shall be installed where and as indicated on the plans and at such locations where installation conditions require such pipe reinforcement because of unforeseen conditions encountered in the work, as determined by the Engineer.

B. Embedment and encasement of pipe and electric conduit shall be preceded by the following preliminary steps:

1. All loose material shall be removed from the trench prior to placing concrete. All concrete shall have a continuous contact with undisturbed soil on sides and bottom of trench.
2. A base course of concrete shall be accurately screeded to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of such base course.

3. Each length of pipe shall be rigidly held in alignment and anchored, to prevent flotation, in a manner acceptable to the Engineer.

3.09 FIELD CONTROL TESTING

A. The responsibility for tests required for field quality control shall be as set forth in Division 1.

B. The frequency hereinafter specified for each field control test is a minimum. If additional field control tests are necessary, in the opinion of the Engineer, all such tests shall be made.

C. Each 100 tons of fine aggregate and each 200 tons of coarse aggregate shall be sampled and tested in accordance with ASTM D75 and C136.

D. A slump test shall be made for each 50 cubic yards of concrete. Slump shall be determined in accordance with ASTM C143. When pumping concrete, slump tests shall be made at both ends of the pumping system at the specified intervals and whenever the pumping system is changed.

E. Class A or B concrete is used, an air content test shall be made from one of the first three batches mixed each day, and from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231. When pumping concrete, air content tests shall be made at the discharge end of the pumping system.

F. Compression Tests

1. One set of compression test cylinders shall consist of four cylinders. Cylinders shall be made, cured, stored and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39. Two cylinders from each set shall be tested at 7 days and two at 28 days. Compression tests shall be evaluated in accordance with ACI 214 and 318.

2. Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete
represented by the cylinders was placed, the delivery truck or batch number, the air content and the slump.

3. The quantity of test cylinders shall be made according to the following schedule:

a. Class A Concrete: A minimum of two sets of test cylinders shall be made for each 50 cubic yards, or fraction thereof, placed in any twenty-four hour period. Also, at least one set of cylinders shall be made for each individual portion of a structure poured in a twenty-four hour period. An individual portion of a structure is defined as any volume of concrete placed monolithically and separated from the remainder of the structure by any joint as given in Section 03 150. Samples shall be distributed so as to indicate the true quality of all concrete represented by the sample.

b. Class B Concrete: A minimum of two sets of test cylinders shall be made for each 100 cubic yards, or fraction thereof, placed in any twenty-four hour period. Also, at least one set of cylinders shall be made for each individual portion of a structure poured in a twenty-four hour period. An individual portion of a structure is defined as any volume of concrete placed monolithically and separated from the remainder of the structure by any join. Samples shall be distributed so as to indicate the true quality of all concrete represented by the sample.

c. Class C Concrete: Two sets of test cylinders shall be made for each 500 square yards of pavement (or fraction thereof) placed in a twenty-four hour period.

d. Class D Concrete: One set of test cylinders shall be made for each pour of Class D concrete involving more than 5 cubic yards. Testing of smaller quantities shall be as directed by the Engineer.

3.10 MIX DESIGN TESTING

A. The responsibility for tests required for review of materials and mix design shall be as set forth in Division 1. Tests to be performed shall not be less than hereinafter specified.

1. Aggregates shall be sampled and tested in accordance with ASTM C33. In addition, the bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM 128.
2. Slump shall be determined in accordance with ASTM C143 and total air content shall be determined in conformity with ASTM C231.

3. Two sets of compression test cylinders, three cylinders per set, shall be made from each proposed concrete mix. One set of three cylinders shall be tested at an age of 7 days and the other set shall be tested at an age of 28 days. Concrete test specimens shall be made, cured, and stored in conformity with ASTM C192 and tested in conformity with ASTM C39.

END OF SECTION
SECTION 03310
PORTLAND CEMENT CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for Portland cement concrete, including materials, proportioning, batching, mixing, delivering and testing to be performed by the Contractor and testing by METRO.

B. Portland cement concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures, all proportioned and mixed as specified herein to achieve the intended class of concrete.

C. Classes of Concrete

1. Classes of concrete are designated by a numeral indicating the minimum 28 day compressive strength in pounds per square inch as determined by ASTM C 39.

2. Each class of concrete may consist of one or more mixes determined by the maximum size of aggregate and types of admixtures, special aggregates, or special reinforcement (i.e., fiber-reinforced concrete).

3. Each design mix within a class shall be considered as a specific type and shall require approval prior to use.

1.02 DESIGN CRITERIA

A. General Requirements

1. Design mixes and proportions shall be as recommended by ACI211.1 for normal concrete under severe exposure conditions. Design mixes shall be prepared and tested by the Contractor’s testing laboratory service for conformance to Contract requirements.

2. The design mixes for each class of concrete used shall be as determined by the Contractor’s testing laboratory service.
3. For each class of concrete there shall be as many design mixes as required for the different combinations or types of ingredients anticipated to cover the Contract requirements.

4. Length change of each concrete mix design shall be less than 0.030% when tested in accordance with ASTM C 157.

B. Design Strength

Design for concrete mixes shall be based on the required over-design factor according to ACI 318-89. The average of any three consecutive strength tests shall be equal to or greater than the specified strength. Where a class is not indicated, Class 4000 concrete shall be used.

1.03 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute
   a. 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   b. 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
   c. 318-89: Building Code Requirements for Reinforced Concrete.
   d. 224R: Control of Cracking in Concrete Structures.

2. ASTM: American Society for Testing and Materials
   a. C 31: Method of Making and Curing Concrete Test Specimens in the Field.
   b. C 33: Specification for Concrete Aggregates.

With the following exception:

1) Table 3, Class Designation 5S, Abrasion shall be reduced from 50 to 40.


e. C 138: Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.


i. C 172: Method of Sampling Freshly Mixed Concrete.


With the following exception:

1) In Paragraph 6.1.6 there shall be no length change from the reference concrete containing no ASTM C 260 Air-Entraining Admixtures when tested in accordance with ASTM C 157.

k. C 293: Test Method for Flexural Strength of Concrete using Simple Beam with Center-Point Loading.


With the following exceptions:

1) In Paragraph 17.1.4, last sentence the value 0.010 shall be replaced by 0.000.

2) In Table 1, Physical Requirements, Length Change, Percent of Control; 135 shall be replaced by 100 Increase over Control; 0.010 shall be replaced by 0.000.

m. C 618: Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.

3. CPMB: Concrete Plant Manufacturer's Bureau
a. Concrete Plant Standards.

B. Design Mix

1. Once a design mix for any class of concrete is approved, the mix shall not be varied as to source, quantity or quality. Proportioning may vary, with the exception of cementitious materials, depending upon changes in gradation of the aggregates. The variation shall be on a volumetric basis with a maximum change of 10 percent without submitting a new design mix.

2. All proposed mix changes shall be accomplished by preparing a new design mix with the written approval of METRO.

C. Sampling and Testing

Concrete ingredients shall be sampled prior to use and shall be tested by the Contractor's testing laboratory service in accordance with the methods specified.

D. Slump

The slump range at point of delivery for concrete shall be maintained within the following limits:

<table>
<thead>
<tr>
<th>Description</th>
<th>Slump Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Concrete pavement, pavement base, sidewalk and incidental construction:</td>
<td>2-3 in.</td>
</tr>
<tr>
<td>2. Non-reinforced concrete other than the above:</td>
<td>1-3 in.</td>
</tr>
<tr>
<td>4. Concrete placed by pumping and concrete for filling steel shell piles: (A separate design mix shall be supplied for concrete that will be pumped.)</td>
<td>Pumpable slump shall be obtained by the use of an approved ASTM 494 Type F admixture only.</td>
</tr>
<tr>
<td>5. Concrete placed by slip-form method.</td>
<td>1-1/2 in. maximum</td>
</tr>
<tr>
<td>6. Any increase in the above limits shall only be achieved by the addition of an approved ASTM C 494 Type F admixture to the concrete at the site in accordance with the manufacturer's recommendations with the exception of concrete placed by the slip-form method where no increase in slump shall be allowed.</td>
<td></td>
</tr>
</tbody>
</table>

E. Classes of Concrete

Class: 3,000
4,000
F. Water Cement Ratio

1. Shall be that used for severe exposure, in accordance with ACI 211.1.

G. Air-Entrainment

1. Air-Entrainment shall be used in the concrete produced for parking areas, travel ways, bus lanes and sidewalks. The total air, entrained plus entrapped, shall be no more than 3 percent plus or minus 1/2 percent.

2. Air-Entrainment shall not be used in concrete toppings, patterned concrete or structural concrete.

3. Air-Entraining Admixtures shall not contain any chlorides.

1.04 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Design Mixes

   a. At least 30 days prior to the start of placing concrete, design mix reports for each class of concrete to METRO indicating that the concrete ingredients, gradations and proportions will result in a concrete mix meeting specified requirements.

   b. Design mixes shall indicate the percentages of fine aggregate and each coarse aggregate.

   c. Design mixes shall indicate the specific gravity of each of the coarse and fine aggregates any ASTM C 618 pozzolanic admixtures.

   d. The gradations of the coarse aggregates shall indicate the percentage passing the following sieves:

      2 in., 1-1/2 in., 1 in., 3/4 in., 1/2 in., 3/8 in., No. 4, No. 8 and No. 16.

   e. The gradation of the fine aggregate shall indicate the percentage passing the following sieves:

      3/8 in., Nos. 4, 8, 16, 30, 50, 100 and 200.
2. Certificates
   
a. Laboratory test reports and mill or manufacturer's certificates to METRO with each design mix, indicating that concrete ingredients conform to Specifications.

b. If source, brand or characteristic properties of the ingredients need to be varied during the Work, a revised laboratory mix report to METRO for approval for each design mix affected by such variance. New design mixes shall not be used without written approval of METRO.

c. A certificate to METRO stating that each admixture used is identical in composition to the sample used for sampling and testing and is compatible with all other materials in the design mix for the application intended.

3. Scale Certifications

   Scale certifications to METRO as required in Article 3.02, A.6.d.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement

   ASTM C 150, Type I or Type II.

B. Admixtures and Additives

1. Chemical admixtures, including water reducing, retarding, and water reducing retarding admixtures: ASTM C 494.

2. Other Pozzolanic admixtures: ASTM C 618.

3. Calcium Chloride: The use of calcium chloride is prohibited.

4. Air-Entraining Admixtures: ASTM C 260, may be used in all concrete with the exception of structural concrete and topping concrete only with the written permission of METRO for the use in specific areas.

C. Water
Potable, from municipal supplies approved by the State or City Health Department.

D. Concrete Aggregate

1. No one size of the aggregate mix (both Coarse and Fine combined) shall exceed 18 nor be less than 8 percent of the aggregate mix.

2. Coarse aggregate: Class 5S, shall have a maximum size of 1-1/2 inches, and shall be well graded.

3. Fine aggregate: Shall be well graded washed natural sand, manufactured sand, or a combination thereof and have a fineness modulus between 2.50 and 2.90.

4. Flats shall not consist of more than 0.25 percent of either aggregate.
   a. Flat is defined as a particle where one (1) dimension is greater than 1.5 times any other dimension.

E. Fly Ash

1. Shall be Type F in accordance with ASTM C 618.

2. A minimum of 20 percent to a maximum of 30 percent of fly ash shall substituted for Portland Cement on a pound for pound basis.

3. Fly ash shall be obtained from a source approved by the Texas Department of Transportation.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Concrete Sampling

Molds and concrete shall be provided as required for casting specimens and for the specified sampling and testing in accordance with ASTM C 172.

B. Concrete Testing

1. Testing will be performed by METRO or METRO’s authorized representative as follows:
   a. Slump test for each 50 cu. yd. or fraction thereof, placed.
b. Yield test, unit weight tests for each 100 cu. yd. or fraction thereof, placed.

c. Compressive strength test with one set of four standard cylinders made and cured in accordance with ASTM C 31 for each 100 cu. yd. or fraction thereof, placed. Compression tests shall be performed at following time intervals:

First Cylinder - after 7 days of curing.

Second and Third Cylinder - after 28 days of curing.

Fourth Cylinder shall be retained as a spare, to be discarded after successful testing of second and third cylinders.

2. Tests as specified in Article 3.01 B1 of this Section shall be in accordance with the following:

a. Unit Weight, Yield, Cement Content and Unit Weight: ASTM C 138.

b. Slump: ASTM C 143.


d. Flexural Strength: ASTM C 293.

e. First Crack Strength: ASTM C 1018.

3.02 MIX EQUIPMENT

A. Batching Plant

1. Arrangement

Separate bins or compartments shall be provided for each size or classification of aggregate and for each type of bulk Portland Cement.

2. Compartments

a. The compartments shall be of ample size and so constructed that materials will be separated under working conditions. The batching plant shall be equipped so that the flow of each material into its
batcher is stopped automatically when the designated weight has been reached.

b. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials.

c. Aggregates may be weighed in separate weight batchers with individual scales or cumulatively in one batcher on one scale. Bulk cement shall be weighed on a separate scale in a separate weight batcher.

d. Water may be measured by weight or by volume. If measured by weight, water shall not be weighed cumulatively with another ingredient.

e. Batching controls shall be interlocked so that the charging mechanism cannot be opened until the scales have returned to zero. These requirements shall be satisfied by a semi-automatic batching system as defined in the CPMB's Concrete Plant Standards, with interlocking as described herein, or by an automatic batching system as defined in the Concrete Plant Standards.

f. Facilities shall be provided for obtaining representative samples of aggregate from each of the bins or compartments for test purposes.

g. Delivery of materials from the batching equipment shall be within limits specified in ASTM C 94.

3. Water Batcher

a. Equipment for batching water and admixtures shall be provided at the batching plant.

b. A suitable device shall be provided that is capable of measuring mixing water within the specified requirements for each batch. The mechanism for delivering water to the mixers shall be such that leakage will not occur when the valves are closed.

c. The filling and discharge valves for the water batcher shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed.

4. Admixture Dispensers
a. Measuring devices for admixtures shall be capable of ready adjustment to permit varying the quantity of admixture to be batched. The dispenser for admixtures shall be interlocked with the batching and discharging operations so that the batching and discharging of admixture will be automatic.

b. Non-interlocked dispensers may be permitted, provided that the calibration of the dispensers is periodically checked. The results of such calibration shall be recorded and available for review.

5. Moisture Control

a. At the time of batching, all aggregates shall have been dried or drained sufficiently to result in a stable moisture content such that no visible separation of water from aggregate will take place during transportation from the proportioning plant to the point of mixing.

b. In no event shall the free moisture content of the fine aggregate at the time of batching exceed 8 percent of its saturated, surface-dry weight. The batch-to-batch uniformity of all aggregates shall be such that variations in moisture content within 1 hour do not exceed 12 lb. in the batch quantity for 1 cu. yd. of concrete, or that a gradual change does not exceed 24 lb. in a period of 4 hours.

c. An electrically actuated moisture meter which will indicate on a readily visible scale the percentage of moisture in the fine aggregate as it is batched, within a sensitivity of 1/2 percent by weight of the fine aggregate shall be installed and maintained in operating condition.

6. Scales

a. Scales shall be used for the accurate measurement of each of the materials entering each batch of concrete.

b. If scales are of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

c. If scales are of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over- or under-weight. The indicator shall be so designed that it will operate during the addition of the last 200 lb. of any weighing. The over-travel of the indicator hand shall be at least one-third of the loading travel. Indicators shall be enclosed against moisture and dust.
d. Scales shall be tested by a commercial scale company and certified that the scales meet all requirements for weighing equipment. Certification shall be required whenever scale is relocated and at least once each 6 months.

7. Recorders

a. An accurate recorder shall be provided for producing a digital printout of the batch number and scale readings corresponding to each of the ingredients of each concrete batch, including zero initial readings. The individual ingredient shall be indicated by name or code corresponding to each weight.

b. Each printout shall indicate date and time of batching, identification number identical to that of the concrete delivery ticket and codes for the mix design and for the work section.

c. The printout shall be prepared in duplicate, with one copy delivered together with its corresponding concrete delivery ticket to Site.

d. Each recorder mechanism shall be enclosed in a locked, dust-tight cabinet and shall be placed in a position convenient for observation.

8. Protection

Weighing, indicating and control equipment shall be insulated against vibration or movement of other operating equipment in the plant.

B. Concrete Mixers

1. General

a. Mechanically operated batch mixers of the revolving drum type or pan type shall be used for mixing concrete, except that batches not exceeding 1/3 cu. yd. may be hand mixed.

b. A metal plate shall be attached on each mixer showing the rated capacity and the drum’s speed of rotation. A copy of the manufacturer’s design, showing dimensions and arrangements of blades, shall be available.

c. The interior of each mixer shall be free of accumulations that will interfere with mixing action. Pick-up and throw-over blades of the
revolving drum mixer shall be replaced when any part or section is worn as much as 10 percent below the original dimension.

2. On-Site Mixers
   a. On-site mixing shall be accomplished in paving or stationary type mixers. Mixers shall be operated at the speeds recommended by the mixer manufacturer, except that revolving drum mixers shall make neither less than 14 revolutions per minute, nor more than 18 revolutions per minute.

   b. The mixing time shall start when all cement, aggregates and initial water have entered the drum. The mixer shall be charged so that some of the mixing water will enter the drum in advance of the cement and aggregates. All of the mixing water shall be in the drum by the end of the first one-fourth of the specified mixing time. Water used to flush down the blades after charging shall be accurately measured and included in the quantity of mixing water.

   c. A timing device shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed.

   d. The total elapsed time between the intermingling of damp aggregates and the discharging of the completed mix shall not exceed 30 minutes.

C. Ready-Mixed Concrete
   1. Ready-mixed concrete shall be mixed and delivered in accordance with ASTM C 94. The ready-mixed concrete supplier shall be as approved by METRO.

3.03 MIXING AND DELIVERY

A. General

Concrete deposited in quantities greater than 2 cu. yd. shall be truck-mixed concrete, mixed and delivered in accordance with the requirements of ASTM C 94. Truck mixers shall be equipped with water tanks and measuring devices for positive measurement of mixing water.

B. Site Mixing
Mixing of batches of 2 cu. yd. and more shall continue 60 seconds plus 60 seconds for each additional cubic yard or portion thereof.

C. Hand Mixing

1. Hand mixed concrete shall be made in batches not larger than 1/3 cu. yd. and shall be mixed on a watertight, level platform.

2. Coarse aggregate shall be measured in measuring boxes, spread on the platform and the fine aggregate spread on the coarse aggregate. Total depth of the two layers shall not exceed 1 ft. The dry cement shall be spread on the aggregate and the whole dry mass shall be turned a minimum of two times. Clean water shall then be evenly added and the whole mass shall be turned a minimum of three times, not including placing in the carriers and forms.

END OF SECTION 03310
SECTION 03750

SEALER - CURING COMPOUND
FOR CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies the requirements for the furnishing and application of sealer-curing compound for concrete pavement.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section.

1. ASTM: American Society for Testing and Materials
     Section 7 - Water Absorption.
     Section 9 - Suction.
     Section 10 - Efflorescence.
   c. C 309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
   d. C 666: Freeze-thaw resistance.

2. AASHTO: American Association of State Highway and Transportation Officials.
   b. T260-84: Total Chloride Ion in concrete.
1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Product Data

Manufacturer's printed data for sealer-curing compound for concrete pavement, including description of products, list of properties and test results, mixing and thinning, and recommended procedures for time and method of application.

2. Samples

Panel of concrete at least 2 sq. ft. in area with one-half of the panel cured using sealer-curing compound.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers, clearly labeled with the manufacturer's name and the material brand, type, finish and color.

B. Store materials in an area protected from the elements and with labels intact.

C. Handle materials in a manner to prevent contamination.

1.05 JOB CONDITIONS

A. Apply sealer-curing compound to freshly placed and troweled concrete surfaces after concrete surface leaves no imprints when touched.

B. If concrete surface is extremely dry, fog surface lightly without causing visible collection of water before applying sealer-curing compound.

PART 2 - PRODUCTS

2.01 SEALER-CURING COMPOUND

A. Qualities

Shall be clear, odorless, non-toxic, non-yellowing, non-petroleum, penetrating concrete sealer-curing compound.
Shall produce long chain permanent insoluble polymers to depth of 2 inches minimum.

Shall prevent the absorption of oil, grease, hydraulic fluid, diesel fuel, low pH liquids and water.

Shall reduce vapor transmission by a minimum of 90% but still allow the concrete to breathe.

1. Solids content: before application 0%+
   after application 100%

2. Solvent content: none.

3. Water retention: 0.055 g maximum loss of water per 100 Mm² of surface in 72 hours according to ASTM C 156.


5. Water resistance: Product shall hold water out of concrete, in the form of droplets, when 0.01 liter is spilled on concrete cured with sealer-hardener. When water is sponged off after 1 minute, and allowed to dry 5 minutes, concrete shall show no wetting.

6. Gasoline resistance: Product shall demonstrate the same water resistance after sealed-hardened concrete has been sponged with gasoline for 1 minute and dried for 5 minutes.

7. Lubricating oil resistance: Product shall not absorb lubricating oil, other than slight discoloration, when 0.01 liter of oil is spilled on surface and wiped-off within 1 minute.

B. Location: The sealer-curing compound shall be placed on all concrete pavement.

C. Source: Protecrete by P. A. Thornburg, Inc. (713) 266-6910.

PART 3 - EXECUTION

3.01 SEQUENCE (NEW CONCRETE)

A. As soon as the concrete has been troweled or otherwise brought to its finished state for extended curing and leaves no imprints when touched, apply sealer-curing compound.
B. Coordinate application of sealer-curing compound with finishing of concrete so that sealer-curing compound is always applied to a wet surface that has not dried out.

3.02 SEQUENCE (OLD CONCRETE)

A. Treat all spills and/or stains with appropriate cleaning chemicals, agitate to start cleaning, allow to "work", then remove using 5000 psi minimum hydro-blower.

B. Clean all other flat areas with 5000 psi minimum hydro-blower.

C. Apply sealer, allow 30 minutes for reaction, then rinse clean with 3000 psi minimum water blaster.

3.03 MIXING

A. Mix according to manufacturer's recommendations for optimum concentration for the concrete type and finish to be sealed/cured.

3.04 APPLICATION

A. Not more than 200 sq. ft./gal.

B. Apply by spray.

END OF SECTION 03750
SECTION 05120

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for furnishing, fabricating, delivering and erecting structural steel in accordance with the details indicated on the Contract Drawings.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. AISC: American Institute of Steel Construction

2. ASTM: American Society for Testing and Materials
   d. A 90: Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
i. A 165: Specification for Electrodeposited Coatings of Cadmium on Steel.
l. A 325: Specification for High-Strength Bolts for Structural Steel Joints.
m. A 370: Methods and Definitions for Mechanical Testing of Steel Products.
n. A 441: Specification for High-Strength Low-Alloy Structural Manganese Vanadium Steel.
q. A 501: Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
r. A 572: Specification for High-Strength Low-Alloy Columbium-Vanadium Steel for Structural Quality.

3. AWS: American Welding Society

4. CE: U.S. Army Corps of Engineers

B. Source Quality Control

1. The fabricator's facility shall be subject to inspection and approval by the Engineer prior to commencement of fabrication. The Engineer shall be given written notice at least 14 days prior to scheduling fabrication. All fabrication shall be conducted by the approved fabricator at the approved facility.

2. The Contractor shall cooperate with the Engineer to ensure that all inspection work can be carried out in the shop, in storage and in the structure.

3. Power and utilities for operating inspection equipment, shop space for inspection work and handling facilities for positioning items being inspected, shall be provided.

4. Ultrasonic examination and magnetic particle inspections shall be performed as follows:
   a. Butt welds of flange material for compression and tension splices: 100 percent of welds inspected by ultrasonic and magnetic particle examination.
   b. Butt welds for web splices beginning at point of maximum stress: A minimum of 40 percent of welds inspected by ultrasonic and magnetic particle examination.
   c. Fillet welds connecting web plates to flange plates: A minimum of 25 percent of welds inspected by magnetic particle inspection.
   d. All other fillet weld connections: A minimum of 10 percent of welds inspected by magnetic particle inspection.

5. The Engineer will designate the portions to be inspected.

6. Specimens shall be prepared and tested in accordance with ASTM A 370.
7. For identified stock materials, two samples from each heat number shall be provided, one for a tension test and one for a bend test.

8. The Engineer will make a random selection of at least five bolts for test purposes from each bin of bolts to be used.

C. Qualifications for Welding

Welding procedures, welders, welding operators and tackers shall be qualified in accordance with AWS D 1.1.

D. Allowable Tolerances

All fabrication tolerances shall be within the tolerances permitted by ASTM A 6 and the AISC Specification for the Design, Fabrication and Erection of Structural Steel Buildings.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Shop Drawings

   a. Shop drawings shall be prepared in accordance with the standards indicated in AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings.

   b. Drawings shall indicate all shop and erection details including welding techniques and sequences, cuts, copes, gussets and all other members, connections, holes, fasteners, camber, fabrication and erection tolerances, type of finish, paint system or other coating, weights of members and critical clearances. Indicate all welding surface finishes and welds, both shop and field, by symbols conforming to AWS Standards.

   c. Drawings shall indicate design and details of all required temporary supports, staying, and bracing and shall include descriptive data and design calculations to illustrate the erection, transportation and handling procedures including sequence of erection and transfer of loads if critical.

2. Installation Information
a. The Contractor shall also furnish setting diagrams, templates, and instructions for the installation of structural framing anchor bolts, bearing plates and other embedded items.

3. Welding Records and Data

a. Prior to commencing any work requiring welding, the procedure which will be used for pre-qualifying welders and the actual welding procedures. For procedures other than those set forth in AWS D 1.1, a copy of procedure qualification test records shall be submitted.

b. Certified copies of qualification test records for each welder, welding operator and tacker who will be employed in the Work.

c. If requested, descriptive data for field welding equipment, including type and electrical power requirements.

4. Certificates and Reports

a. Mill certificates and certified copies of reports for all analyses and tests required by referenced ASTM and AWS specifications.

1.04 PRODUCT HANDLING

A. Care shall be taken to avoid bending, scraping and overstressing the steelwork during shipping and handling. Projecting parts which might be bent or injured shall be blocked with wood or by other means to protect against damage.

B. All members weighing more than 1 ton shall have their weights marked. All shop pre-fitted members shall be match-marked.

C. Small parts, such as rivets, bolts, nuts, washers, pins, filler and small connecting plates and anchors shall be shipped in boxes, crates or barrels. Bolts of each length and diameter and loose nuts and washers of each size shall be separately packed. An itemized list and description of the contents shall be securely attached and weatherproofed on the outside of each container.

D. Structural material shall be loaded, transported, unloaded and stored in such a manner that the material is kept clean and free from injury. Material shall be stored above ground on platforms, skids or other supports and shall be covered to protect from corrosion.

E. All material shall be identified by heat and lot, if applicable.
PART 2 - PRODUCTS

2.01 SHAPES, PLATES, AND BARS

A. Carbon Steel

ASTM A 36.

B. High-Strength, Low-Alloy, Structural Steel

ASTM A 242.

C. High-Strength, Low-Alloy, Structural Manganese Vanadium Steel

ASTM A 441.

D. High-Strength, Low-Alloy, Columbium-Vanadium, Structural Steel

ASTM A 572, Grade as indicated.

E. High-Strength, Low-Alloy, Structural Corrosion Resisting Steel

ASTM A 242, Grade and Type as indicated.

2.02 STUD SHEAR CONNECTORS

A. ASTM A 108 and conforming to the requirements of AWS D 1.1, Section 4, Part VI.

2.03 FASTENERS

A. Low Carbon Steel Bolts and Nuts

ASTM A 307, Grade A or B.

B. High-Strength Carbon Steel Bolts, Nuts, and Washers for Structural Joints:

1. Bolts: ASTM A 325, Type 1.

2. Bolts for ASTM A 242: ASTM A 325, Type 3.

C. Washers

ASTM A 325 or ASTM F 436, type of steel to match bolt.
D. Beveled Washers

Square, smooth, and sloped to make contact surfaces of bolt head and nut parallel. The diameter of the hole of square beveled washers shall be 1/16 in. greater than the bolt size for bolts not larger than 1 in. in diameter and 1/8 in. greater than the bolt size for bolts larger than 1 in. in diameter.

2.04 STRUCTURAL STEEL TUBING

A. Cold-Formed Carbon Steel

ASTM A 500, Grade as indicated.

B. Hot-Formed Carbon Steel

ASTM A 501.

2.05 CASTINGS

A. High-Strength Steel

ASTM A 148, Grade as indicated.

B. Mild-to Medium-Strength Carbon Steel

ASTM A 27, Grade as indicated.

2.06 PROTECTIVE COATINGS

A. Galvanizing

Steel products which are specified to be hot-dipped galvanized after fabrication shall be in accordance with the requirements of the applicable specifications listed below. Zinc coating shall weigh at least 2 oz. per sq. ft., when tested in accordance with ASTM A 90 unless otherwise indicated.

1. Products fabricated from rolled, pressed and forged steel shapes, plates and strip: ASTM A 123.


3. Assembled steel products: ASTM A 123.
B. Electroplated Zinc Coating

ASTM B 633, Type GS.

C. Cadmium Plating

ASTM A 165, Type NS.

D. Painting of Structural Steel

As specified in Section 09900 - Painting and Coating.

2.07 NON-SHRINK GROUT

A. Pre-mixed, factory-packaged, nonferrous, nonshrink aggregate grouting compound: CE CRD-C 621.

PART 3 - EXECUTION

3.01 FABRICATION

A. General

Steel work shall be fabricated and shop-assembled in accordance with the following reference standards, where applicable:

1. AISC Code of Standard Practice for Steel Buildings and Bridges.

2. AISC Specifications for Design, Fabrication and Erection of Structural Steel for Buildings.


B. Straightening Material

1. If necessary, rolled material shall be straightened before such material is laid out for fabrication, in a manner conforming to the mill tolerances provided in ASTM A 6 and by a process and in a manner which will not injure the material.

2. Sharp kinks and bends will be cause for rejection of the material.

3. Heat shrinking of low-alloy structural steel will not be permitted.
C. Cutting

1. Shearing, flame cutting and chipping shall be performed carefully and accurately so as not to induce residual stress in the metal being cut.

2. Flame-cut edges of members subjected to dynamic loading shall be cut by torch. All nicks shall be removed by grinding to a maximum depth of 1/4 in.

3. The radii of re-entrant gas-cut fillets shall be at least 3/4 in. and as much larger as practicable.

4. Flame cutting shall be performed in such manner than metal being cut is not carrying stress during the operation. Exposed edges, flame-cut by hand, shall be finished by grinding.

D. Stiffeners

1. Bearing stiffeners and stiffeners intended as supports for concentrated loads shall be milled or ground to secure full bearing on the flanges. On weldable steel, such stiffeners may be welded as indicated on the Drawings.

E. Bent Plates

1. Cold-bent load-carrying cold-rolled steel plates shall be taken from identified stock plates and shall be bent in a manner that will ensure that the direction of bending will be at right angles to the direction of rolling. The radius of bend, measured to the concave face of the metal, shall not be less than shown in the following table.

<table>
<thead>
<tr>
<th>Angle Through Which Plate is Bent</th>
<th>Minimum Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 to  90</td>
<td>1.0 x Thickness</td>
</tr>
<tr>
<td>91 to 120</td>
<td>1.0 x Thickness</td>
</tr>
<tr>
<td>121 to 150</td>
<td>2.0 x Thickness</td>
</tr>
</tbody>
</table>

2. If a shorter radius is required, the plate shall be bent hot. Plate edges shall be rounded to a radius of 1/16 in. before bending, where bending occurs.

F. Finish

Metal bearing surfaces which will come in contact with either performed fabric, elastomeric bearing pads or cement mortar grout shall be machine finished within 1/8 in. tolerance in 12 in. and to within 3/16 in. overall.
G. Connections

Shop connections shall be welded, unless otherwise indicated. Field connections shall be bolted, using ASTM A 325 bolts.

H. Bolted Connections

1. Holes shall be punched or drilled for bolts.
2. A steel template shall be used to subpunch or subdrill and ream assemblies.
3. Holes shall be subdrilled or subpunched at 3/16 in. less than the nominal diameter of the bolt. Holes shall be drilled or reamed at 1/16 in. greater than the nominal diameter of the bolt.

I. Welding

Welding shall be accomplished in the fabrication plant wherever practicable and shall be done by machine welding. Welding shall be performed in accordance with AWS D 1.1, except as modified herein.

1. Carbon steel shall be preheated to 200 F minimum when either the thickness of the base material exceeds 1-1/4 in. or the maximum specified carbon content exceeds 0.30 percent.
2. Preheat and interpass temperatures shall be determined by temperature-indicating crayons or other means approved by the Engineer.

J. Architectural Steel

Architecturally exposed structural steel members shall be fabricated straight within one-half of the standard camber and sweep tolerances allowed by ASTM A 6.

3.02 ERECTION

A. General

Steel structures shall be erected in accordance with AISC Code of Standard Practice for Steel Buildings and Bridges. AISC Specifications for Design, Fabrication, Erection of Structural Steel for Buildings and the following:
1. Steel structures shall be erected true and plumb following the match marks. Erection tolerances shall be such that the deviation from plumb, level and alignment does not exceed 1 in 500.

2. Surfaces to be joined shall be thoroughly cleaned.

3. Column bases and bearing plates for beams and similar structural members shall be aligned with steel wedges or shims. After the supporting members have been aligned and properly positioned and anchor nuts have been tightened, the entire area under the bearing plates shall be dry-packed with non-shrink grout.

B. Field Assembly

1. Temporary bracing shall be used where necessary to support all loads to which the structures may be subjected, including erection equipment or the operations thereof. Such bracing shall be left in place as long as may be required for safety.

2. As erection progresses, sufficient bolting shall be performed on the work to take care of dead load, wind, and erection loads.

3. The members forming parts of a complete assembly shall be aligned and adjusted after assembly and before fastening.

4. Splices of compression members shall be fastened after the abutting surfaces have been brought completely into contact.

5. Permanent bolting shall be performed when enough alignment has been attained to ensure as much of the structure as possible will be supported by such fastening work.

6. Holes may be enlarged to admit bolts for connections only if approved by the Engineer. Enlargement shall be done by reaming, not by burning. Hand reaming will not be permitted.

7. Main stress members shall not be welded in the field, except where indicated on the Contract Drawings.

8. Except in architecturally exposed structural steel, erection bolts used in welded construction shall be either tightened securely and left in place or removed and the holes filled with plug welds. Erection bolts used in the welded construction of architecturally exposed structural steel shall be
removed, the holes filled with plug welds, and the plug welds ground smooth and flush with the surrounding surface.

C. Column Bases and Bearing Assemblies

1. Except where elastomeric bearing pads are indicated, all column bases and bearing plates shall be set level to the elevations indicated on the Drawings.

2. Column bases and bearing plates shall be provided under all columns, beams, girders and trusses, resting on walls or footings.

END OF SECTION 05120
SECTION 05500
METAL FABRICATIONS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section specifies the requirements for providing metal fabrications including miscellaneous shapes, plates, strips, and tubes.

1.02 QUALITY ASSURANCE
A. Reference Standards Applicable to this Section
   1. ASTM: American Society for Testing and Materials
      e. A307: Specification for Bolts and Studs, 60,000 psi Tensile Strength.
      g. A384: Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
      h. A385: Providing High Quality Zinc Coatings (Hot-Dip).
      i. A446: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
      j. A500: Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes, Grade C, Welded.
k. A501: Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.


p. A607: Specification for Steel Sheet and Strip, Hot-Rolled and Cold-Rolled High-Strength, Low-Alloy Columbium and/or Vanadium.


2. AWS: American Welding Society

3. SSPC: Steel Structures Painting Council
   a. PA 1: Shop, Field and Maintenance Painting.
   b. PA 2: Measurement of Dry Paint Thickness with Magnetic Gages.
   c. SP 10: Near-White Metal Blast Cleaning.

4. American Galvanizer's Association, Inc. (AGA)
   a. The Design of Products to be Hot-Dip Galvanized After Fabrication.
   b. Recommended Details of Galvanized Structures.

B. Responsibilities
Fabricator is responsible for preparing all items to be hot-dip galvanized in accordance with Section 09871 - Hot-Dip Galvanizing of these Specifications.

C. Qualifications for Welding

Welding procedures shall be in accordance with AWS D 1.1. Welders, welding operators and tackers shall be qualified in accordance with AWS D 1.1.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Shop Drawings
   a. Shop Drawings showing materials, sizes, finishes, locations, attached hardware and fittings, and details for fabricated metalwork items. Drawings shall include field erection details and show cuts, copes, connections, holes, threaded fasteners and welds. Welds shall be indicated by symbols conforming to the AWS standards.

2. Manufacturer's Literature
   a. Manufacturer's literature, data sheets, product descriptions and specifications for all items.

3. Installation Information
   a. Setting diagrams, erection plans, templates and directions for installation and preparation of backing plates, anchors and similar items.

4. Certificates and Qualification Procedures
   a. Welder's qualification procedures and certificates for each welder, welding operator and tacker.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel material that is to be hot-dip galvanized after fabrication shall be manufactured from fully-killed or semi-killed steel conforming to ASTM A36 or A572.
except that the silicon content shall be in the range of 0 to 0.04%, or 0.15 to 0.25% only. Mill certificates shall be furnished.

B. Anchor mounts shall be ASTM A36 steel, hot-dip galvanized after fabrication in accordance with ASTM A123.

C. Where carbon steel externally threaded standard fasteners are used, comply with ASTM A307.

D. Where high strength bolt are used for structural steel joints or connections, comply with ASTM A325. All bolts shall have a minimum diameter of 1/2 inch. All bolts shall be hot-dip galvanized in accordance with ASTM A153, Class C.

E. Where steel sheet, zinc-coated structural quality steel is used, comply with ASTM A446.

F. Where cold-formed welded or seamless structural tubing is used, comply with ASTM A500 Grade C, welded, flash controlled to 0.010 in.

G. Where hot-formed welded or seamless carbon steel structural tubing is used, comply with ASTM A501.

H. Where structural steel with 42,000 p.s.i. minimum yield point (1/2 inch maximum thickness) is used, comply with ASTM A529.

I. Where hot-rolled carbon steel sheet and strip structural quality is used, comply with ASTM A570.

J. Where high-strength low-alloy Columbium-Vanadium steels of structural quality are used, comply with ASTM A572.

K. Where steel bars, carbon, merchant quality, M-grades are used, comply with ASTM A575.

L. Where steel sheet and strip, hot-rolled and cold-rolled high-strength, low-alloy Columbium or Vanadium are used, comply with ASTM A607.

M. Where steel sheet and strip, carbon, hot-rolled, drawing quality is used, comply with ASTM A621.

N. Non-Shrink Grout: Nonmetallic, premixed, non-shrink grouting compound conforming to ASTM C1107.

O. Painting: As specified in Section 09900 - Painting of these Specifications.
2.02  PAINTING
   A. Coats: As specified in Section 09900 - Painting of these Specifications.
   B. Galvanizing for steel items shall be in accordance with ASTM A123 or A153, as applicable.

2.03  GROUT
   A. Grout: ASTM C1107, non-shrink, non-metallic.

PART 3 - EXECUTION

3.01  FABRICATION
   A. Structural steel shall be fabricated generally in accordance with Class I, II or III guidelines as shown in Recommended Details for Galvanized Structures as published by the AGA.
   
   B. Fabrication practices for products to be galvanized shall be in accordance with applicable portions of ASTM A143, A384 and A385, except as specified herein. Care shall be taken to avoid fabrication techniques which could cause distortion or embrittlement of the steel. Before fabrication begins, the galvanizer shall review the fabricator's shop drawings and notify METRO of any potential warpage or embrittlement problems which may require a modification in the design.
   
   C. All welding slag and burrs shall be removed prior to delivery to the galvanizer.
   
   D. To facilitate handling during the galvanizing process, holes, lifting lugs, or both, shall be provided at positions as agreed between the designer, fabricator and galvanizer.
   
   E. Unsuitable marking paints shall be avoided and consultation by the fabricator with the galvanizer about removal of grease, oil, paint, and other deleterious materials shall be undertaken prior to fabrication.
   
   F. Surface contaminants and coatings which would not be removable by the normal chemical cleaning process in the galvanizing operation shall be removed by the fabricator using blast cleaning in accordance with SSPC SP 10.

3.02  HOT-DIP GALVANIZING
   A. As specified in Section 09871 - Hot Dip Galvanizing of these Specifications.
3.03 INSTALLATION

A. Metal fabrications shall be installed in the indicated locations, properly anchored, rigid, secure, plumb, level and in true alignment with adjoining and related work.

3.04 PAINTING

A. Metal fabrications shall be prepared and painted in accordance with Section 09900 - Painting, of these Specifications.

3.05 COLUMN BASES

A. Set column bases level and to correct elevation.

1. Grout in with full beds of non-shrink, non-metallic grout in accordance with ASTM C 1107.

2. Draw anchor bolts tight and burr threads.

END OF SECTION 05500
SS SECTION 05530
ALUMINUM HANDRAILS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum mechanical sub-assembled guardrails and fittings.
B. Guardrail extension at new walkover.

1.02 REFERENCES

A. ASTM 6061-T6 and/or ASTM 6063-T6.

1.03 DESIGN REQUIREMENTS

A. Railing assembly and attachments to resist a concentrated load of 200 pounds applied in any direction at any point and a uniform load of 50 pounds per linear foot applied to the horizontal rails in any direction. The loads shall not be applied simultaneously.
B. Space support posts 6 feet on center, maximum.
C. Guard Rail Extension - Space support posts 3 feet on center.

1.04 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals.
B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 PRODUCTS

2.01 RAILING SYSTEM

A. Railings shall be constructed 1-1/2 inch diameter aluminum pipe schedule 40 with anodized satin finish. Finish to be clear anodized (0.7 mil). All fittings shall be extruded aluminum pre-engineered for railing application.
B. All railing shall be mounted to the side of concrete walkway surfaces using 1/2 inch diameter stainless steel expansion anchors.
C. All hardware used on the railing system shall be stainless steel.

D. All railing surfaces in contact with concrete or dissimilar metals shall receive one coat of zinc chromate.

E. All fittings shall be secured to the post and railing with #17 x 1” stainless steel set screws.

F. Railings shall be provided with two horizontal rails. A 4-inch high toe board is required only where there is a walk space below railing.

G. Toe boards shall be 4 inch extruded aluminum “Z” shape. Toe boards shall be connected to each railing post with a minimum of two fasteners in horizontal slotted holes. Splices shall be located and detailed to allow for thermal expansion and contraction.

H. Openings in rail shall be provided for access to gates and valves. Provide double strand 3/16 inch diameter stainless steel chain.

I. Provide expansion joints at maximum 24 ft centers using splice sleeves.


PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

B. Beginning of installation means erector accepts existing conditions.

3.02 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Provide anchors and sockets required for connecting railings to concrete.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELEVATED WALKWAY, SUPPORTS, STAIRS as described in Section 05500.

END OF SECTION
SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Requirements.

1. This Section specifies the requirements for providing a three-coat aliphatic urethane paint system on hot-dip galvanized spaceframe components, and exposed or visible metal surfaces, two-coat lusterless (flat) latex finish on interior unglazed concrete masonry units; and a two-coat lusterless (flat) latex finish on drywall.

2. Aliphatic urethane paint shall be shop or factory applied, except where on-site application is approved by METRO, and where field touch-up is necessary.

3. Color selection for the aliphatic urethane paint system shall be as specified herein.

4. Color selection for the latex finishes for the interior unglazed concrete masonry units and the drywall shall be as indicated in the Color Schedule on the Drawings.

B. Painting shall include:

1. The solvent cleaning of all galvanized items to be painted in accordance with SSPC SP1 and the preparation of the cleaned galvanized surface in accordance with the paint manufacturer’s recommendations for painting over a hot-dip galvanized surface.

2. Paint system materials including primers, and materials used as sealers, prime, intermediate or finish coats.

C. Paint shall be applied to:

1. The painting of visible, exposed, bare piping, raceways, conduits, hangers, telephone backboard electrical equipment and enclosures, galvanized, steel
and iron work and primed metal surfaces of equipment installed under other Sections of these Specifications.

2. Electrical service and distribution cabinets.

3. Exposed surfaces, whether or not designated in schedules or indicated on Drawings except where natural finish of material is specifically noted as a surface not to be painted. Where surfaces have not been designated or indicated, such surfaces shall be painted the same as adjacent similar items, unless otherwise directed by METRO.

4. Painting inspection procedures.

5. Documentation stating that the paint has been applied in accordance with this specification.
   a. Paint thickness test reports.
   b. Surface preparation reports.

5. Exposed interior unglazed concrete masonry units.


D. Finished metal surfaces of steel, aluminum, stainless steel, chromium plate, copper, bronze and similar finished material will not require finish painting, unless otherwise indicated.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section.

   c. D 3359: Measuring Adhesion by Tape Test.
   d. D 3363: Film Hardness by Pencil Test.

2. FS: Federal Standards and Specifications.
   b. TT-F-1098: Filler, Block, Solvent-Thinned, For Porous Surfaces (Concrete Block, Cinder Block, Stucco, Etc.)
   c. TT-P-29: Paint, Latex.
   d. TT-P-650: Primer Coating, Latex Base, Interior, White (For Gypsum Wallboard).


4. SSPC: Steel Structures Painting Council, Steel Structures Painting Manual (SSPC) Volumes 1 & 2.
   a. PA2: Measurement of Dry Paint Thickness with Magnetic Gages.
   b. SP 1: Surface Preparation Specification No. 1 Solvent Cleaning.
   c. SP 10: Surface Preparation Specification No. 10 Near-White Metal Base Cleaning.
   d. SP 7: Surface Preparation Specification No. 7 Brush-off Blast Cleaning.

5. Caution is advised that this specification be read in its entirety. Submittal of a proposal constitutes acknowledgement that every paragraph of this Specification is fully understood and agreed to. The Contractor is responsible for informing METRO of any item as specified herein that is not sufficiently clear in order to complete the work in compliance with the requirements of this Specification.
6. Any expense incurred due to unforeseen circumstances which is the direct result of neglect in estimating or reviewing of the problems prior to the bidding shall be totally borne by the Contractor.

7. Paint system materials; primer, intermediate coat and top coat, shall all be obtained from a single manufacturer.

B. Responsibilities.

1. The painter is responsible for all surface preparation on all articles to be painted to insure against any paint system failure.

2. The galvanized surface to be painted shall be prepared as specified as a minimum. If the paint manufacturer requires additional measures to be performed in the surface preparation the paint applicator shall be contacted in writing advising him of any additional surface preparation required before any item is painted.

C. Matching of Samples.

Aliphatic urethane paint shall match the color, gloss, thickness, light resistance, chemical resistance, texture, application quality, hardness and durability of standard aliphatic urethane paint samples submitted to METRO.

D. Manufacturer and Applicator.

The manufacturer of the aliphatic urethane paint shall have produced the coating products for not less than 5 years and shall be capable of furnishing both products and instructions of their use. Applicators of paint shall have not less than 5 years of experience in successful application of paint such as those specified and indicated.

E. Standards of Finishing.

The manufacturer of the aliphatic paint coating shall provide each applicator or fabricator of items which receive the coating with 3 in. by 5 in. stepped samples of each color to be used, as standards of uniform quality during the shop-finishing operation.

F. Color Coordination.

Finishes and colors provided for the Work shall be as indicated in Color Schedule in the Drawings.
G. Optional Procedure.

To maintain uniform quality and color of the paint, the procedure of processing various items that are specified to receive aliphatic urethane paint in one shop is an option that may be exercised by the Contractor. Items to be in a special shop shall be protected in their galvanized state while in transit to the shop, since the primer shall be applied by the aliphatic urethane paint specialist, not the original fabricator, to comply with the recoating time specified.

1.03 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Sample panels of each application, 4 in. x 12 in. stepped to show each coat, including each color, texture and finish. Panels shall indicate each of the various coats to be applied with each coat identified as to manufacturer's name, brand, type, finish and color. Panels shall be identified as to the item to which the paint is to be applied and the location of the represented finish in the Project. The substrate for the samples shall be the same as the surface to which the paint will be applied.

2. Contractor shall submit one gallon samples of each coat of the paint system and one gallon samples of the paint manufacturer's approved thinner for each of the coats of the paint system.

3. Manufacturer's printed data for each aliphatic urethane paint, including recommended procedures for mixing, thinning, color matching, applying and precautions to be observed.

4. Letter stating the length of time this manufacturer has produced the specified paint, a list of three projects for which the paint has been furnished, and instruction on application and quality assurance to fabricators.

5. Letter stating names and years of experience of applicators.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers, clearly labeled with the manufacturer's name and material brand, type, finish and color.

B. Store coating material in an area protected from the elements and with labels intact. Handle materials in a manner that prevents contamination.
1.05 SHOP APPLICATION CONDITIONS

A. Apply and cure coating in dust free surroundings, in a humidity range of 30 percent to 95 percent, and in a surrounding air temperature of not less than 50 F.

B. Do not apply paints to surfaces which are dirty, dusty, rusty, damp or oily and substrate is less than 5 F above dew point.

C. Where repetitive items must be painted under production line conditions, the curing time may be accelerated using heat lamps and warmboxes as recommended by the paint manufacturer. Do not cure in temperatures greater than 150 F. Do not alter the formulation on the cured properties of the coating to achieve quicker cure.

1.06 FIELD APPLICATION CONDITIONS

A. Apply and cure paint when wind is less than 10 miles per hour, when a freshly painted test plate does not pick up visible dust upon two minutes exposure, in a humidity range of 30 percent to 95 percent, when rain is not falling, and in a surrounding air temperature between 40 to 110 F or minimum as recommended by paint manufacturer.

B. Do not apply paint to surfaces which are dirty, dusty, rusty, damp or oily. Shade and hood for 8 hours the surfaces to be painted.

C. If an item has received only a prime coat or prime and intermediate coats, do not field apply final coat(s) until the last coat has been prepared by cleaning, brush-off blast cleaning in accordance with SP-7 or other preparation as recommended by the paint manufacturer. This preparation is not necessary if the last shop coat is less than 48 hours old and clean.

PART 2 - PRODUCTS

2.01 MATERIALS FOR THREE-COAT SYSTEM

A. First Coat (also referred to as prime coat and primer).

Two component, high build, epoxy primer with rust-inhibitive pigment.


2. Pigment: Lead, chrome and cadmium free.
3. Standards:
   a. Adhesion, 5 rating, meeting ASTM D 3359, Method B.
   b. Exposure, 3,000 hours, meeting salt fog testing of ASTM B 117.
4. Primer shall have contrasting color to intermediate coat.
5. Sources:
   c. Awlgrip 545 Primer, by U.S. Paint Division, Grow Chemical Corporation, (314) 621-0525.
   d. Tnemec Series 66 Hi-Build Epoxoline, distributed by Barry & Company, Inc., (713) 975-9113.

B. Second Coat (also referred to as intermediate coat, and color coat).

Two component aliphatic-type system, non-yellowing. Do not provide either single component urethane, moisture-curing urethane, or isocyanate-reaction drying oil urethane systems.

1. First component: Pigmented polyol with organic/metallic catalyst.
3. Surface temperature: No yellowing, chalking, softening or crazing between 40 F and 120 F.
4. Chemical and solvent resistance: No yellowing, darkening, discoloration, chalking, softening, blistering or crazing after seven day immersion at 20 C in salt water, lubricating oil, gasoline, xylol, 0.1 N sodium hydroxide or 0.1 sulfuric acid.
5. Drying time: Coating shall not pick up dust after 4 hrs. curing in place on surfaces at 60 to 75 F.

6. Recoating time: Coating shall permit addition of a chemically similar coating without sanding or etching at any time from 16 to 48 hrs. without lessening adhesion of succeeding coating.


8. Colors: (As selected by Architect in conjunction with METRO.)

9. Standards.
   a. Flame Spread and Smoke Density, Class A of NFPA 101 and meeting ASTM E 84.
   b. Exposure, 1000 hours, meeting salt fog testing of ASTM B 117.
   c. Humidity, 1000 hours, meeting ASTM D 2247.
   d. Hardness, 3H Hardness meeting ASTM D 3363.
   e. Abrasion, Not more than 130 mg. loss after 1,000 cycles, meeting FS 141, Method 6192, 1,000 gm. load with CS 17 size wheels.
   f. Adhesion, Not less than 5 rating, meeting ASTM D 3359, Method B.

10. Sources:
   d. Tnemec Series 71 Endura-Shield, distributed by Barry & Company, Inc., (713) 975-9113.
C. Third Coat (also referred to as finish coat and top coat).

Two component aliphatic type system, non-yellowing. Do not provide either single component urethane, moisture-curing urethane, or isocyanate-reacted drying oil urethane systems.

1. First component: Pigmented polyol with organic/metallic catalyst.


3. Surface temperature: No yellowing, chalking, softening, or crazing between 40 F and 120 F.

4. Chemical and solvent resistance: No yellowing, darkening, discoloration, chalking, softening, blistering or crazing after seven day immersion at 20 C in salt water, lubricating oil, gasoline, xylol, 0.1 N sodium hydroxide or 0.1 sulfuric acid.

5. Drying time: Coating shall not pick up dust after four hours curing in place on surfaces at 60 to 75 F.


7. Color: Color shall be finish color and different from intermediate coat.

8. Standards.

   a. Flame Spread and Smoke Density, Class A of NFPA 101, and meeting ASTM E 84.

   b. Exposure, 1,000 hours, meeting salt fog testing of ASTM D 2247.

   c. Humidity, 1,000 hours exposure, meeting ASTM D 2247.

   d. Hardness, 4H Hardness meeting ASTM D 3363.

   e. Abrasion, Not more than 70 mg. loss after 1,000 cycles, meeting FS 141, Method 6192, 1,000 gm. load with CS 17 size wheels.

9. Sources:


c. Awlgrip 9263 Clear Urethane Enamel, U.S. Paint Division, Grow Chemical Corporation, (314) 621-0525.

d. Tnemec Series 71 Endura-Shield, distributed by Barry & Company, Inc., (713) 975-9113.

e. Tnemec Series 73 Endura-Shield III, as above.


D. Shop Prime Coat for Ancillary Equipment or Structural Members.

Where field application of intermediate and top coats cannot be avoided, use a shop-applied prime coat that will permit adhesion of color coat if the latter is applied within 90 days after prime coat. Use either an inorganic zinc-rich prime coat or a shop coat/tie coat system consisting of a polyamide epoxy with corrosion-inhibiting pigment augmented by a polyamide epoxy zinc chromate coat.


E. Field Repair Prime Coat.

Only where field application of intermediate and top coat cannot be avoided and where priming of surfaces which have been welded or damaged by welding must be performed, use a field repair prime coat. Use either a polyamide epoxy zinc-rich prime coat or an epoxy shop coat/tie coat system.


2.02 ACCESSORY MATERIALS

A. Provide sandblast materials, cleaning, etching and thinning materials as needed to prepare surfaces, to thin coatings and to clean up.

PART 3 - EXECUTION

3.01 SHOP OR FACTORY SURFACE PREPARATION

A. General

Remove nameplates, bright plated fasteners and other finish items from surface before preparing for coatings.

B. Hot Rolled Steel, Structural Steel Shapes, Oxidized Steel Surfaces.

Near-White metal blast cleaning in accordance with SSPC SP 10.

C. Cold Rolled Steel Shapes, Steel Sheet, Bright Steel Surfaces.

Remove oil, dirt and contaminants with solvent cleaning in accordance with SSPC SP 1. Remove rust and scale in accordance with SSPC SP 10.

D. Galvanized Steel: Remove soluble contaminants in accordance with SSPC SP 1, solvent cleaning. Rinse surface with clean water. Etch surface in accordance with paint manufacturer's recommendations.

3.02 SITE SURFACE PREPARATION

A. General

Remove hardware, accessories, nameplates and other finish items from surface before preparing for coating system.

B. Galvanized Steel
Remove soluble contaminants in accordance with SSPC SP 1, solvent cleaning. Rinse surface with clean water. Etch surface in accordance with paint manufacturer's recommendations.

C. Previously Shop Primed Metal.

Where primer has cured more than 72 hours, brush-off blast clean in accordance with SSPC SP 7. Remove all dust from blasted surfaces.

1. Provide manufacturer's recommended barrier coats over incompatible primers or remove and re-prime as required. Notify METRO in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

D. Previously Aliphatic Urethane Painted Metal (touch-up).

Remove dirt, grease and bond breaking substances and roughen areas to be touched up and with fine abrasive paper.

E. After field welding of shop-fabricated steel items is complete all welds shall be ground smooth and all welding residue shall be removed to a near-white condition. Apply the specified field repair prime coat to minimum of 4.0 mils above metal profile. If a tie coat is used, apply to a thickness of not less than 1.0 mil.

F. Cementitious Materials

1. Concrete masonry units, and plaster surfaces shall be prepared by removing efflorescence, chalk, dust, dirt, grease and oils.

2. Alkalinity and moisture content of the surfaces shall be determined. Where the alkalinity exceeds the paint manufacturer's recommendations for application of the paint, the condition shall be corrected in accordance with the paint manufacturer's recommendations. Paint shall not be applied to surfaces while the surface moisture content exceeds the paint manufacturer's moisture content limitations.

3.03 COLOR MATCHING

A. Aliphatic urethane paints shall be formulated and applied to maintain uniform color, texture, gloss and match the samples approved by METRO.

3.04 MIXING, GENERAL APPLICATION REQUIREMENTS
A. Mix and apply each element of the aliphatic urethane paint system according to manufacturer’s published recommendations.

B. Due to the sensitivity of these paints to dust pickup during their extended curing times, apply all coats of aliphatic urethane paint system at shop or factory, under dust free, temperature and humidity-controlled conditions, unless otherwise approved by METRO, and except where field touch-up of damaged coats is necessary.

C. The specified prime coat shall be followed by the specified intermediate coat within 48 hours of priming, unless the surface of the primer is lightly abraded or otherwise prepared as recommended by the manufacturer of the coating.

3.05 SHOP OR FACTORY APPLICATION

A. Apply intermediate coat and top coat as flow coats to build specified dry film thickness.

B. Apply each coat in accordance with paint manufacturer’s published recommendations.

C. Re-install nameplates, fasteners and other items removed prior to coating.

D. Finished surfaces shall be fully and uniformly coated without pinholes, bubbles, sag, runs, lumps, brush marks or discoloration, and shall be of uniform color and gloss. The samples submitted to METRO shall be used as the standard to judge all painted members and structures.

3.06 SITE APPLICATION

A. When applying over galvanized surfaces, prepare surfaces for optimum adhesion by use of cleaning and etching washes.

B. When applying coats or touching up over previously shop primed or urethane painted metal, degrease the surface of the soft primer or urethane coating and flow on the coats to build each coat to specified dry film thickness. Use type of brush or other means of application that provides a paint system that matches the appearance of shop or factory-applied paints. When applying aliphatic urethane coats over the hard primer specified in this Section, lightly abrade the prime for optimum adhesion.

1. Provide manufacturer’s recommended barrier coats over incompatible primers or remove and re-prime as required. Notify Architect in writing of
any anticipated problems in using the specified coating systems with substrates primed by others.

C. Apply each coat in accordance with coating manufacturer's published recommendations.

D. Reinstall hardware, accessories, nameplates and other items removed prior to coating.

E. Finished surfaces shall be fully and uniformly coated without pinholes, bubbles, dust, sag, runs, lumps, brush marks, abraded areas, scratches or discoloration, and shall be of uniform color and gloss equal in quality and appearances to shop or factory coated work.

F. Where shop-fabricated steel items must be assembled by welding at the Work site, and a soft prime coat has been applied by the fabricator followed by a field repair prime coat after grinding and wire brushing, complete the aliphatic urethane painting by applying the specified intermediate coat and top coat after cleaning the soft prime coat and field repair coat.

3.07 TOUCH UP

A. After aliphatic urethane paints have been in place at least 15 days, and within 30 days of METRO's inspection of the product prior to certification that the Work is complete, check all aliphatic urethane painted surfaces for damage, missed areas and discoloration.

B. Prepare surfaces and touch up damaged, missed and discolored areas to bring paint system to full dry film thickness, in color and gloss matching that of adjacent coat areas.

3.08 PAINTING SCHEDULE

A. Exterior Enamel on Exterior Steel.

1. Type of Coating: Rust-inhibitive epoxy prime coat; aliphatic urethane intermediate coat; aliphatic urethane top coat.

2. Dry film thickness:
   a. Prime coat: 4 mils minimum.
   b. Intermediate coat: 2.0 mils minimum.
c. Top coat: 2.0 mils minimum.

B. Exterior Enamel on Exterior Galvanized Steel.

1. Type of coating: Rust-inhibitive epoxy prime coat; aliphatic urethane intermediate coat; aliphatic urethane top coat.

2. Dry film thickness:
   a. Prime coat: 4.0 mils minimum.
   b. Intermediate coat: 2.0 mils minimum.
   c. Top coat: 2.0 mils minimum.

C. Concrete Masonry Units (Unglazed).

1. Two-coat lusterless (flat) latex finish over a filler coat:
   a. First Coat: Blockfiller, FS TT-F-1098.
   b. Second Coat: Latex emulsion, FS TT-P-29.
   c. Third Coat: Latex emulsion, FS TT-P-29.
   d. Total Dry Film Thickness: Not less than 3.5 mils, excluding the first coat.

D. Drywall.

1. Two-coat lusterless (flat) latex finish:
   a. First Coat: Latex primer, FS TT-P-650.
   b. Second Coat: Latex emulsion, FS TT-P-29.
   c. Total Dry Film Thickness: Not less than 2.5 mils.

3.09 MEASUREMENTS

A. Measurements of paint thickness shall be in accordance with SSPC PA2.
END OF SECTION 09900
SECTION 09901
PROTECTIVE COATINGS

PART 1  GENERAL

1.01  SURFACES TO RECEIVE PAINT

A. Equipment, buildings, machinery, and all metal work not covered elsewhere except stainless steel, aluminum, bronze, brass, copper, lead, electrical conduit in unfinished areas, PVC, fiberglass, or other plastic pipe. Galvanized surfaces are to be coated only when designated.

B. All exposed and submerged metal piping.

C. Interior and exterior surfaces of buildings.

D. All cabinets and woodwork.

E. Flooring

1.02  PIPE COATINGS

Protective coatings for ductile iron piping are covered under applicable pipe specification.

1.03  EQUIPMENT PRIMED SURFACES

Final field finish painting of manufacturer’s primed equipment not to be accomplished until operational testing and approval have been completed.

PART 2  MATERIALS

The paint schedule and painting schedule in table 3.04 and 3.05 of this specification includes the paint and protective coatings, and sealers to be used on this project. The painting schedule in table 3.05 presents the surface types and the manner in which they are to be prepared and coated. The paint schedule in table 3.04 presents various products which meet a particular coating schedule.

PART 3  EXECUTION

3.01  WORKMANSHIP

Employ only skilled workmen to apply paints and finish materials. Apply paints with brush or spray equipment in even and thorough coats, without runs, sags or other blemishes. Allow all coats of paint, regardless of material used, to dry thoroughly before application of succeeding coat, except when
manufacturer recommends otherwise. Properly sand painted surfaces between coats of enamel, paint or shellac when applied to any surface with the exception of masonry. Apply paints in accordance with manufacturer's recommendations.

### 3.02 PREPARATION OF SURFACES

#### A. Metal Surfaces: Unless otherwise designated, surface preparation shall be in accordance with the following table.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SPECIFICATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent Cleaning</td>
<td>SSPC-SP-1</td>
<td>Removal of oil, grease, dirt, soil, salts contaminants by cleaning with a solvent, va alkali, emulsion or steam.</td>
</tr>
<tr>
<td>Hand Tool Cleaning</td>
<td>SSPC-SP-2</td>
<td>Removal of loose rust, loose mills scale, and loose paint to degree specified, by hand chipping scraping, sanding or wire brushing.</td>
</tr>
<tr>
<td>Power Tool Cleaning</td>
<td>SSPC-SP-3</td>
<td>Removal of loose rust, loose mill scale, and loose paint to degree specified by power tool chipping, descaling, sanding, wire brushing and grinding.</td>
</tr>
<tr>
<td>White Metal Blast</td>
<td>SSPC-SP-5</td>
<td>Removal of all visible rust, mill scale, paint and foreign matter by blast cleaning by wheel or nozzle (Dry or Wet) using sand, grit or shot.</td>
</tr>
<tr>
<td>Commercial Blast</td>
<td>SSPC-SP-6</td>
<td>Blast cleaning until at least two thirds of each element of surface area is free of all visible residue</td>
</tr>
<tr>
<td>Bruch-off Blast</td>
<td>SSPC-SP-7</td>
<td>Blast cleaning of all except tightly adhering residue of mill scale, and coating, exposing numerous evenly distributed flecks of underlying metal.</td>
</tr>
<tr>
<td>Near White Blast</td>
<td>SSPC-SP-10</td>
<td>Blast cleaning nearly to White Metal cleanliness, at least 95% of each element of surface area is free of all visible residues.</td>
</tr>
</tbody>
</table>
Power Tool Cleanir SSPC-SP-11 to Bare Metal

Power tool cleaning to produce a bare metal surfa and to
retain or produce a minimum 1.0 mil surface prc
This standard is suitable where a roughened, clean t
metal surface is required but where abrasive blasting is
feasible or permissible.

Surface preparation SSPC-SP-12 and cleaning of me;
by
water jetting prior to recoating

Pressure wash (2500 psi, minimum) with tri-sodium
phosphate solution (4 ounces TSP per gallon of
water); clean water wash until surface pH is 7
to 7.5

B. Concrete Surfaces

CONCRETE

Surface Preparation SSPC –SP-13
The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptably prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.

Acid Clean
Wash concrete to be painted with 15 percent
solution of muriatic acid, and then wash clean
with fresh water and thoroughly dry all surfaces. "Spot-in" with additional primer all
"hot" or "flat" spots which appear on cement
surfaces after application of priming coat. If
such spots persist after application of finish
coat, completely refinish surface.

Power Wash
Power Tool Clean
Power Wash and Power Tool Clean the
surface to remove all form release agents,
dust, dirt, curing compounds, oils, greases.
Allow the surface to dry a minimum of 24 hours.
3.03 APPLICATION OF PAINT

A. General

Use one convenient location for storing and mixing of paint materials and keep fire extinguisher available in this area as long as it is used for such purpose. Protect floor of this area, and all other areas where painting is done, with suitable drop cloths; remove oily rags and waste from building at close of day. On completion of painting operations, clean off all paint spots, oil, and stain from all surfaces and leave entire project in perfect condition as far as painting work is concerned. Remove from premises all containers and debris resulting from painting operations.

B. Weather

1. No coating work shall be done under unfavorable weather conditions unless the work is under cover, well protected, and specific approval from the Engineer is obtained.

2. No coating or painting shall be applied when the surrounding air temperature or the temperature of the surface to be coated is below 50°F or within 5°F of the dew point or as specified by manufacturer.

C. Colors

Refer to Section 3.06 for color schedule. Apply to Owner for colors on equipment not listed.

D. Samples

Submit for approval samples of paint materials proposed for use in three displays of each kind and color of paint to be applied to metal and masonry. Submit in addition, if required, one-quarter pint of each kind of paint or stain proposed for use. Make panels used for display representative of respective types of surfaces to which several kinds and colors of paint and stain are to be applied in actual work. Do not deliver paint materials to site of work until after respective samples thereof have been approved.

E. Drying Time

Thoroughly dry each coat of paint before succeeding coat is applied. Allow full drying time between coats as specified by manufacturer of particular paint involved.

F. Coverage

As recommended by manufacturer of particular paint involved.
G. Delivery of Paint

Deliver to site in original (unbroken) sealed containers with manufacturer's label attached.

H. Thinners and Solvents

Use only those thinners and solvents specified in paint formulas of paint being used and mix in proportions as recommended by paint manufacturer.

I. Brush Application

1. Brushes

Use first quality hog hair or suitable synthetic bristle brushes. Use of horse hair bristle brushes not permitted. Keep brushes clean and free from accumulation of dried paint or dirt, and when brushes for oil or varnish base paints are not in use, keep them suspended in raw linseed oil bath. Clean brushes with turpentine or mineral spirits before reuse.

2. Application

Apply in uniform thickness consistent with specified coverage and with sufficient cross-brushing to insure filling of surface irregularities. Exercise particular care in painting around rivet heads, bolt heads and nuts, and in corners and other restricted spaces.

3. Roller

Roller application equipment shall comply with SSPC Vol. I Chapter 5.1 Section C. In addition, the contractor shall consult with the coating manufacturer to establish the correct core and nap length to produce as smooth of a surface as possible.

J. Spray Application

Apply with adjustable air gun equipped with suitable water trap to remove moisture from compressed air, and with paint pot having hand agitator. Apply with width of spray not less than 12 inches or more than 18 inches, and with suitable pressure for particular type of paint being used. Make frequent checks to insure correct spreading rate and coating, and apply without sags, runs, or "orange peel" effect. Correct all such imperfections. Take special care to cover edges, corners, and rivet heads without bridging over of paint film.

K. Shop-Coated Metal Surfaces

1. Prior to Installation

*After delivery to site of work and prior to installation, keep all shop-coated*
metal work clean and free from corrosion. Where directed, clean and retouch or repaint damaged areas with additional primer.

2. After Installation

After erection or installation of shop-coated metal work, clean and retouch all rust spots, all places where paint has been rubbed or scraped off, and all field rivet and bolt heads and nuts. After previously applied paint has hardened and when surfaces to receive succeeding coats of paint have been perfectly cleaned and dried, apply paint in accordance with Section 3.05 "Painting Schedule". Allow five (5) days for hardening of final coat before placing in water.

L. Machinery and Electrical Equipment

After installation of machinery and electrical equipment, check base coats carefully and retouch all damaged surface areas. Do not paint nameplates, serial number bases, chrome or bronze trim, or any rotating parts. Clean off any excess paint that impairs convenient removal of covers on gauges, instrumentation or other equipment fitted with doors or covers.

M. Galvanizing

Galvanizing shall conform to the requirements of ASTM Standards A-123, A-120, and A-153, latest edition. Abraded or otherwise damaged surfaces and cut ends of galvanized members shall be touched-up with a single component, non-toxic, zinc rich compound with 95 percent zinc in the dried film, per Section 05120.

Galvanizing is not recommended for use in chemical exposures outside the pH range of 4.0-13.0. Testing of galvanized coated sheet with primers and/or adhesion promoters must be performed prior to applying coatings.

3.04 PAINT SCHEDULE

The following schedule establishes various paints and primers required under this specification. Specific instructions in other detail specifications supersede paint schedule for shop-coated materials and equipment. Substitutions of paints are not allowed unless specifically approved in advance. Include with request for substitution, complete information as to formulation, coverage, application, etc. Do not mix coating systems of different manufacturers.
# PRODUCTS AND VENDORS

<table>
<thead>
<tr>
<th>Product</th>
<th>Sherwin Williams</th>
<th>Tnemec</th>
<th>Carboiline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block Filler</td>
<td>Heavy Duty Block Filler 1.01A</td>
<td>Series 27-WB Typoxy</td>
<td>Sanitile 100</td>
</tr>
<tr>
<td>Acrylic Polyurethane</td>
<td>Acrolon 218 HS</td>
<td>Series 73 Endura-Shield</td>
<td>Carbothane 134HG</td>
</tr>
<tr>
<td>Fast Cure Epoxy</td>
<td>Macropoxy 646</td>
<td>Series 161 Tneme-Fascure</td>
<td>Carboguard 60</td>
</tr>
<tr>
<td>Zinc- Rich Coating</td>
<td>Zinc Clad II Plus</td>
<td>Series 90-97 or Series 90-1K97 Tneme-Zinc</td>
<td>Carbozinc 859</td>
</tr>
<tr>
<td>Zinc Primer</td>
<td>Corothane I Galvapac Two Pack</td>
<td>Series 90-97 or Series 90-1K97 Tneme-Zinc</td>
<td>Carbozinc 621</td>
</tr>
<tr>
<td>Polyamidoamine Epoxy (High Build Epoxy)</td>
<td>MP646, Tile-Clad II HS</td>
<td>Series N69 Hi-Build Epoxoline II</td>
<td>Carboguard 891HS</td>
</tr>
<tr>
<td>Exterior Wood Primer</td>
<td>A-100 Latex Wood Primer</td>
<td>Kilz Original</td>
<td>Sanitile 120</td>
</tr>
<tr>
<td>Exterior Latex</td>
<td>A-100 Exterior Latex Coating (A6 Series)</td>
<td>Series 6 Tneme-Cryl</td>
<td>Carborylic 3359</td>
</tr>
<tr>
<td>Epoxy Primer/Sealer</td>
<td>ArmorSeal 33</td>
<td>Series 201 Epoxoprime</td>
<td>Semstone 110</td>
</tr>
<tr>
<td>Self-Leveling Epoxy</td>
<td>ArmorSeal 650 SL-RC</td>
<td>Series 280 Tneme-Glaze</td>
<td>Sanitile 945 SL</td>
</tr>
<tr>
<td>Coal Tar Epoxy</td>
<td>Hi-Build Tneme Tar Series 46H-413</td>
<td></td>
<td>Bitumastic 300</td>
</tr>
</tbody>
</table>
3.05 **PAINTING SCHEDULE**  
Architectural and Structural

A. Exterior

<table>
<thead>
<tr>
<th>Type of Surface</th>
<th>Preparation</th>
<th>Primer</th>
<th>1st Coat</th>
<th>2nd Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural Metal Work</td>
<td>SSPC-SP6 or SSPC-SP2 &amp; SSPC-SP3</td>
<td>Polyamide Epoxy 4.0 to 6.0 mils</td>
<td>Polyamide Epoxy 4.0 to 6.0 mils</td>
<td>Polyurethane 2.0 to 5.0 mils</td>
</tr>
<tr>
<td>Structural Steel and Misc. Steel</td>
<td>SSPC-SP-6</td>
<td>Zinc Rich Primer 2.5 to 4.0 mils</td>
<td>Polyamide Epoxy 4.0 to 6.0 mils</td>
<td>Polyurethane 2.0 to 5.0 mils</td>
</tr>
<tr>
<td>Concrete Block /Precoat Building</td>
<td>Power – Wash &amp; Power Tool Clean</td>
<td>Block Filler 2 Coats 10 to 18 mils</td>
<td>Polyurethane 3.0 to 6.0 mils</td>
<td>Polyurethane 3.0 to 6.0 mils</td>
</tr>
<tr>
<td>Wood</td>
<td>Sand</td>
<td>Latex Wood Primer 2.0 to 3.0 mils</td>
<td>Exterior Latex 2.0 to 3.0 mils</td>
<td>Exterior Latex 2.0 to 3.0 mils</td>
</tr>
<tr>
<td>Ductile Iron Piping</td>
<td>SSCP-SP -1</td>
<td>Zinc Primer</td>
<td>Acrylic Polyurethane 3.0 to 5.0 mils</td>
<td>Total film thickness 9.0 mils</td>
</tr>
</tbody>
</table>

B. Interior

<table>
<thead>
<tr>
<th>Type of Surface</th>
<th>Preparation</th>
<th>Primer</th>
<th>1st Coat</th>
<th>2nd Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural Metal Work</td>
<td>SSPC-SP6 &amp; SSPC-SP2 &amp; SSPC-SP3</td>
<td>Polyamide Epoxy 4.0 to 6.0 dry mils</td>
<td>Polyamide Epoxy 4.0 to 6.0 dry mils</td>
<td>Acrylic Polyurethane 4.0 to 6.0 dry mils</td>
</tr>
<tr>
<td>Structural Steel &amp; Misc. Steel</td>
<td>SSPC-SP-6</td>
<td>Zinc Primer 1 coat 2.5 mils</td>
<td>Polyamide Epoxy 4.0 to 6.0 dry mils</td>
<td>Acrylic Polyurethane 4.0 to 6.0 dry mils</td>
</tr>
<tr>
<td>Concrete Block /Precoat Building</td>
<td>Power-Wash &amp; Hand Tool Clean</td>
<td>Block Filler 10-18 dry mils (1 or 2 coats as needed)</td>
<td>Exterior Latex Coating 2.0 to 3.0 mils</td>
<td>Exterior Latex Coating 2.0 to 3.0 mils</td>
</tr>
<tr>
<td>Concrete floors</td>
<td>Acid Clean 15% Muratic</td>
<td>Epoxy Primer/Sealer</td>
<td>Self-Leveling</td>
<td>Self Leveling Epoxy</td>
</tr>
</tbody>
</table>
acid solution | 6.0 to 8.0 mils | Epoxy (may add aggregate, allow to dry before removing excess) | 6-8 mils

C. Submerged Metal/Piping, and Mechanical

<table>
<thead>
<tr>
<th>Type of Surface</th>
<th>Preparation</th>
<th>Primer</th>
<th>1st Coat</th>
<th>2nd Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submerged metal and piping</td>
<td>SSPC-SP10 or SSPC-SP6 per manufacturer</td>
<td>Coal Tar Epoxy 10 mils</td>
<td>Coal Tar Epoxy 10 mils</td>
<td></td>
</tr>
<tr>
<td>Shop Primed metal work</td>
<td>SSPC-SP6</td>
<td>Epoxy Primer 4-8 mils</td>
<td>Epoxy 3-6 mils</td>
<td>High Solids Polyurethane 2-4 mils</td>
</tr>
<tr>
<td>Exterior Exposure Machinery Pumps</td>
<td>SSCP-SP-3</td>
<td>Epoxy Primer 4-8 mils</td>
<td>Epoxy 3-6 mils</td>
<td>High Solids Polyurethane 2-4 mils</td>
</tr>
<tr>
<td>Interior Machinery, Pumps</td>
<td>SSCP-SP-3</td>
<td>Epoxy 4-10 mils</td>
<td>High solids Polyurethane 2-4 mils</td>
<td>N/A</td>
</tr>
</tbody>
</table>

3.06 COLOR SCHEDULE

In an effort to standardize colors of equipment and comply with TCEQ requirements [30 TAC 217.329 and 30 TAC 290.42(d) (13)], the following colors will be used on the equipment indicated.

- Doors and Hatches: Gray
- Structural Steel: Gray
- Pumps, Motors, Machinery: Gray
- Exposed Lines, Valve Boxes: Gray
- Valve Operators: Blue
- Ladder Handrails, Guardrails: Safety Yellow
- Fire Hydrants, Fire Exit Signs, Fire Pump: Red
- Chain Guards, Belt Guards, Gear Guards: Safety Orange
- Compressed Air Lines: Light Green
- Chlorine: Safety Yellow
- Sulfur Dioxide: Lime Green with Yellow bands
- Potable Water: Light Blue
- Sludge: Brown
- Nonpotable Water: Purple
3.07 INSPECTION

During and after final application of protective coatings, all metal surfaces shall be checked mechanically with an Elcometer, Mikrotest or other approved dry film thickness gauge to insure that the specified dry film thickness has been attained. All submerged or intermittently submerged metal surfaces and metal in areas subject to severe chemical attack shall be electrically tested for film continuity by means of an approved low voltage flaw detector such as Tinker & Rasor's M-I or K-D's "Bird Dog." The inspection described in this paragraph shall be conducted by a laboratory designated by the Engineer and the cost included in price of the work.

END OF SECTION
SS SECTION 11501

WASTEWATER TREATMENT PROCESS EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

Furnish & install the oil and grease removal system for a 20,000 gallon per day (gpd) bus vehicle washwater oil removal treatment system, including an oil and water separator, oil storage tank, sludge storage tank, two flow equalization tanks, a dissolved air floatation (DAF) feed system, complete with pumps, piping and valves, instrumentation, control panel, walkway and supports, stair, handrail, all required fasteners, couplings, flanges and all other equipment and accessories as required for a complete and operable wastewater treatment plant as specified herein.

1.02 QUALITY ASSURANCE

A. All materials used shall be new and of high grade and of properties best suited to the work required.

B. Manufacturer/Supplier Qualifications

1. Equipment provided under this Section shall be designed and fabricated by Manufacturer/Supplier whose similar products have proven reliable in similar service for at least ten (10) years.

1.03 SUBMITTALS

A. Submit shop drawings and product data in accordance with Specification 01340 – Shop Drawings, Product Data, Samples, and Record Documents.

1.04 OPERATIONS & MAINTENANCE DATA

A. Submit four (4) copies of operation and maintenance data in an approved format prior to start-up.

1.05 DELIVERY, STORAGE & HANDLING

A. Store all structural components and mechanical and electrical equipment off the ground under protective cover.
PART 2  PRODUCTS

2.01 GENERAL

A. The wastewater treatment plant equipment shall be designed to treat a
design average wastewater flow of 20,000 gallons per day (gpd) and a
maximum flow rate of 50 gallons per minute.

2.02 ACCEPTABLE EQUIPMENT MANUFACTURER/SUPPLIERS

A. Forward Equipment, LLC. – Houston, Texas
B. Newman Regency – Stafford, Texas
C. Other pre-approved qualified suppliers

2.03 PROCESS DESIGN REQUIREMENTS

1. Oil/Water Separator

   Major Components:

   1. One (1) Coalescing Oil Water Separator built from 304 S.S.
      Including a 150-Gallon Sump, Sludge Hopper, and 120-
      Gallon Oil Storage Compartment
      A. Dimensions: 88” L x 52” W x 60 ” H
      B. Acceptable Manufacturers
         1. Pan America Environmental, Inc.
         2. Ecologix Environmental Systems
         3. Other manufacturers pre-approved by Engineer

   2. One (1) Self-Priming Centrifugal Sludge Transfer Pump

2. Flow Equalization Tanks

   Major Components:

   1. Two (2) Equalization Tanks
      A. Dimensions: 12’ Diameter x 12’ Height
      B. Fiberglass construction for S.G. 1.9

   2. Two (2) 7.5 HP Positive Displacement Blowers, each 110 cfm
      at 8 psi with a maximum noise level of 75 dBA at a distance of
      3.0 feet from the unit
3. Twenty-Eight (28) 304 S.S. Coarse Bubble Diffusers including two (2) 304 S.S. Air Diffuser Grids

4. Two (2) Pressure Transducer, 4-20 mA, Tank Level Monitors with local display

5. Two (2) Tank Level Switches

3. Dissolved Air Flotation (DAF) Feed System

   **Major Components:**
   
   1. Two (2) DAF Feed Self-Priming Centrifugal Pumps
   2. Provide Two (2) Pressure Gages
   3. Provide One (1) 3-Inch Electrically Actuated Control Valve
   4. Provide One (1) 3-Inch Electromagnetic Flow Meter in a NEMA 4 Enclosure

4. Dissolved Air Flotation System

   **Major Components:**
   
   1. 3-Inch Schedule 80 PVC flocculation tube with 2-Inch turns, three (3) chemical inject ports including check valves and shut-off valves
   2. Galvanized welded steel DAF catwalk including stairs providing access to the DAF System
      A. Dimensions: 30” W x 12’ H
   3. One (1) Aluminum Chloride coagulant electronic metering pump
      A. 120 VAC/1 Phase/60 Hz
   4. Plastic containment with splash proof hatch for mounting of coagulant pump
   5. Double wall 1,000-gallon coagulant bulk chemical containment tank
   6. Calibration Column
A. 500 mL calibration column with ¾-Inch FNPT connections
B. 100 mL calibration column with ½ - Inch FNPT connections

7. Polymer feeder blending system

8. Chemical tote containment

9. DAF Unit
   A. 304 S.S. Construction
   B. Recycle Pump System
      1.) 15 HP/ 460V/ 3 Phase/ 60 Hz/ TEFC
   C. Flight & Chain Top Skimmer System
      1) 304 S.S. Construction
      2) 0.5 HP/ 460 V/ 3 Phase/ 60 Hz/ TEFC Drive Motor
   D. Bottom Auger System
      1) 0.25 HP/ 460 V/ 3 Phase/ 60 Hz/ TEFC Drive

10. 4-Inch Electrically actuated S.S. ball valve with disc and stem

11. Approved Manufacturers
    A. ETS Environmental
    B. Ecologix Environmental Systems
    C. Other manufacturers whose equipment has been pre-approved by the Engineer

5. DAF Float and Sludge Handling

   Major Components:
   1. 4-20 mA loop powered, pressure transducer DAF float level switch with local display
   2. Rotary lobe float transfer pump package
      A. 7.5 HP/ 460 V/ 3 Phase/ 60 Hz/ TEFC Motor
   3. Stainless bezel pressure gauge with isolation diaphragm
   4. 2- Inch NPT float transfer pump pressure relief valve
5.  24V DC level switch

6.  Controls

**Major Components:**

1.  Main Control Panel (MCP) in NEMA 4X 304 S.S. Enclosure
   
   A.  Allen Bradley CompactLogix Programmable Logic Controller (PLC) with appropriate inputs and outputs for the system
   
   B.  Allen Bradley Panel View 1000+ HMI
   
   C.  Ethernet connection with remote panel

2.  Duplex Blower Control Panel in NEMA 4X Enclosure

3.  (1) ½ - Inch NPT 24V DC Low Profile Strobe Red Alarm Light

4.  One (1) 100 dB ½ - Inch Alarm Warning Horn

**2.04 GENERAL WASTEWATER TREATMENT PLANT DESIGN REQUIREMENTS**

A.  Basin Dimensions: Equipment shall be designed to operate in basins having dimensions as shown on the Drawings.

B.  Structural Design and Fabrication:

1.  All fabricated structural steel shall conform to the requirements of “Standard Specifications for Steel Bridges and Buildings”, ASTM Designation A-36. All shop and field welding shall be seal welding and conform to AWS D1.1 - Welding in Building Construction.

2.  Unless specifically noted otherwise, all structural carbon steel plate and shapes shall have a minimum thickness of 0.25 inches unless noted otherwise.

3.  To the degree feasible, all exposed metals shall be non-corrosive type either hot-dip galvanized steel or stainless steel.

4.  All anchorage and fasteners on 316 stainless steel equipment shall be type 316 stainless steel.

5.  All anchorage and fasteners shall be series 300 stainless steel, unless noted otherwise.
6. All submerged fabricated metals shall be hot-dip galvanized steel, unless noted otherwise.

D. Protective Coatings


PART 3 EXECUTION

3.01 INSTALLATION

A. The Wastewater Treatment Plant Equipment Manufacturer/Supplier will provide all equipment and controls for the treatment plant. All electrical work, including installation of control panels, conduit, wiring, disconnects, wireways, lighting, lighting panel, outlets, etc., shall be by Contractor.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Installation adjustment and initial start-up of equipment shall be under direction and supervision of qualified operations technician.

B. Prior to putting wastewater in wastewater treatment plant, fill unit with water for testing and demonstration of air diffusion equipment, sludge collection equipment, and skimming equipment.

3.03 START-UP SERVICES

A. The Wastewater Treatment Plant Equipment Manufacturer/Supplier shall provide the services of an experienced wastewater treatment plant start-up technician to assist Owner during the start-up of the new plant until such time as the operation is stable and approved by the Engineer.

3.01 TRAINING

A. The Contractor shall provide services of his Technician and a factory trained Technician to instruct plant-operating personnel for a period of at least two (2) full days after completion of the contract work. Training requirements in specific specification sections shall have precedence over requirements of this section.

B. Provide Engineer with an outline of training course and topics to be covered.

C. Schedule with Owner two (2) weeks in advance. Where Operators must alternate training schedule, more than two (2) days may be required.
D. Approved final Operations and Maintenance (O&M) manuals and As-Built Drawings shall be used during training.

## PART 4  SUMMARY OF EQUIPMENT

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Responsibility</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oil Water Separator</strong></td>
<td>Coalescing oil water separator, 304 SS</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td><strong>Oil Transfer Pump</strong></td>
<td>Self-priming centrifugal pump; cast iron construction open type ductile impeller, 316 SS shaft; oil lubricated bearings; carbon/ceramic/Viton mechanical seals; removable inspection plate; 2” intake/discharge flanges; close-coupled to a 2HP TEFC high efficiency 460VAC/3/60 Hz 1750 rpm electric motor capable of at least 50 gpm @ 30’ TDH</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td><strong>Oil Transfer Pump Pressure Gauge</strong></td>
<td>Liquid filled pressure gauge; stainless bezel, 0-30 psi</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td><strong>Float Switches</strong></td>
<td>SS float switch, 24V DC</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td><strong>Equalization Tank</strong></td>
<td>12' diameter x 12' height FRP tank; 10,000-gallon capacity, flat bottom, domed top; side hatch, top hatch, flanged vent</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td><strong>EQ Tank Blowers</strong></td>
<td>Positive displacement blower; enclosed blower package including: PD blower with 7.5 HP/460V/3 ph/60 Hz motor, V-belt drive, intake air filter, pressure relief valve, discharge check valve, discharge pressure gauge, integral base with discharge silencer, steel enclosure with vents and cooling fan, 110 cfm @ 8 psi minimum capacity</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td><strong>EQ Tank Diffusers</strong></td>
<td>304 SS coarse bubble diffusers; tray type, 24” long, ¾ NPT</td>
<td>ETS</td>
<td>28</td>
</tr>
<tr>
<td><strong>EQ Tank Diffuser Grid</strong></td>
<td>Air piping (304 SS) from blowers to diffusers (X-301/302), including diffuser grid</td>
<td>Contractor</td>
<td>2</td>
</tr>
<tr>
<td><strong>EQ Tank Level Monitor</strong></td>
<td>Pressure transducer, 4-20 mA loop powered, local display</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td><strong>Level Switch (HHL)</strong></td>
<td>“Teardrop” urethane switch, 24V DC</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td><strong>DAF Feed System</strong></td>
<td>Self-priming centrifugal pump; cast iron construction open type ductile impeller, 316SS shaft; oil lubricated bearings; carbon/ceramic/Viton mechanical seals; removable inspection plate, 3” intake/discharge flanges; close-coupled to a 5 HP TEFC high efficiency 460</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td>Component</td>
<td>Description</td>
<td>Supplier</td>
<td>Quantity</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>VAC/3/60 Hz 1740 rpm electric motor capable of 100 gpm @ 35' TDH; speed controlled by VFD</td>
<td>Liquid filled pressure gauge; stainless bezel, 0-30 psi</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td>Control Valve</td>
<td>3” electrically actuated, SS ball valve with SS disc and stem. Actuator will have 4-20mA positioner with 4-20mA feedback</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Flow Meter</td>
<td>3” electromagnetic flowmeter with 316: electrodes, PTFE liner, local display in NEMA 4 enclosure, 4-20mA output, 304 SS grounding rings; 115V</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Dissolved Air Floatation</td>
<td>Floc Tube: Rated for 40-110 gpm flow range; ETS Model FT-32 flocculation tube; 3” Sch80 PVC piping with 2’’ turns; three chemical injection ports with check and shut-off valves; integrated into DAF catwalk</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>DAF Catwalk</td>
<td>30” width x 12’ length catwalk with stairs for providing access to the DAF system, galvanized welded steel construction; Floc Tube integrated into catwalk frame</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Coagulant Pump</td>
<td>Electronic metering pump, Kynar head/fittings, ceramic balls, Teflon seats/O-rings, ¼” O.D. suction/discharge tubing 120 GPD pump, bleed/prime valve included; 120VAC/1 ph/60 Hz; stop function, 4/20mA input control of stroke rate</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Coagulant Pump Containment</td>
<td>Plastic containment shelf with splash proof hatch for mounting chemical pump</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Coagulant Bulk Chemical Tank</td>
<td>Double wall chemical tank, 1,000-gallon capacity with containment</td>
<td>Chemical Vendor</td>
<td>1</td>
</tr>
<tr>
<td>Calibration Column</td>
<td>500 mL calibration column, ½” FNPT connections</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Polymer Feeder</td>
<td>Polymer blend system including: neat polymer pump with feed capacity of 0.1 to 5.7 gpd. Pump rate can be controlled locally or by a 4-20mA signal. 10 to 120 gph primary dilution water capacity. One-gallon aging-blending chamber. Lower water flow switch. Water solenoid valve is included. A start-stop switch controls the polymer and water flow. Self-cleaning sight glass. SS frame. 115V</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Neat Polymer Tote</td>
<td>225-gallon chemical tote</td>
<td>Chemical Vendor</td>
<td>1</td>
</tr>
<tr>
<td>Tote Containment</td>
<td>Polyethylene tote containment</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Calibration Column</td>
<td>100 mL calibration column, ½” FNPT connections</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>DAF Unit</td>
<td>ETS Model RT-50; 304SS construction, whitewater/recycle system with 15 HP/460V/3 ph/60 Hz/TEFC recycle pump, 304SS flight and chain top skimmer system driven by 0.5 HP/460 V/3 ph /60 Hz/TEFC drive</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Bottoms Valve</td>
<td>4” electrically actuated, SS ball valve with SS disc and stem. Actuator will be on-off control</td>
<td>ETS</td>
<td>1</td>
</tr>
</tbody>
</table>
## DAF Float/ Sludge Handling

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Supplier</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAF Float Level Switch</td>
<td>Pressure Transducer, 4-20mA loop powered, local display</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Float Transfer Pump</td>
<td>Rotary lobe pump package including: cast iron housing, 4&quot; ANSI nozzles; galvanized baseplate, coupling with guard, 7.5 HP/460V/60 Hz/3 ph/TEFC motor; 110 gpm @ 40 psig with water</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Pressure Gauge</td>
<td>Liquid filled pressure gauge; stainless bezel with isolation diaphragm</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Float Transfer Pump Pressure Relief</td>
<td></td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Float/ Oil Decant Tanks</td>
<td>10' I.D. x 14' height FRP dome top tank, 7,500-gallon capacity with side hatch and top hatch. Internal sloped bottom toward effluent nozzle</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Float Tank Level Monitor</td>
<td>Pressure transducer, 4-20mA loop powered, local display</td>
<td>ETS</td>
<td>2</td>
</tr>
<tr>
<td>Level Switch (HHL)</td>
<td>“Teardrop” urethane switch, 24V DC</td>
<td>ETS</td>
<td>2</td>
</tr>
</tbody>
</table>

## Controls

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Supplier</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Control Panel (MCP)</td>
<td>ETS custom panel for loads and instrumentation in the pretreatment building; frame mounted, NEMA 4X 304SS enclosure, Allen Bradley CompactLogix PLC with appropriate I/O for system inputs and outputs, PV 1000+ HMI, programmed; all motor protection in panel; ethernet connection for communication with remote panel</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Blower Control Panel</td>
<td>Panel dedicated to packaged blower system; all motor protection in panel; includes hour meter, control switches, NEMA 4X enclosure, alarm output to MCP</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Alarm Light</td>
<td>½” NPT low profile strobe, red, 24V DC</td>
<td>ETS</td>
<td>1</td>
</tr>
<tr>
<td>Alarm Horn</td>
<td>100 dB warning horn; ½” NPT mounting box</td>
<td>ETS</td>
<td>1</td>
</tr>
</tbody>
</table>

### PART 5 - MEASUREMENT AND PAYMENT

#### 5.01 MEASUREMENT

A. **METRO STAFF TRAINING** shall be measured per Hour and the measurement shall include all personnel and materials required to provide demonstrations and instructions on plant operations.

B. **OIL WATER SEPARATOR** shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.
C. 10,000 GALLON EQUALIZATION/STORAGE TANKS shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

D. SLUDGE TRANSFER PUMP TANKS shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

E. AIR BLOWER & AIR DIFUSSERS shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

F. DAF FEED PUMPS shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

G. FLOW METER shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

H. CONTROL VALVE & INSTRUMENT SENSORS shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

I. FLOC TUBES shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

J. COAGULANT PUMP shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

K. COAGULANT BULK CHEMICAL TANK shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

L. COAGULANT CONTROL PANEL shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.
M. POLYMER FEEDER shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

N. POLYMER TANK CONTAINMENT shall be measured by each at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

O. DAF TREATMENT UNIT shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

P. MAIN CONTROL PANEL shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

Q. DAF CATWALK shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

R. FLOAT PUMP & CONTROLS shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

S. MISC. CHEMICAL CONDUIT, TUBING & PIPING shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

5.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. System Description:

1. Rigid frame type utilizing tapered beams with rigid connections to maintain original angles between interacting members after erection and loading.

2. Provide rigid frame with interior columns.

3. Roof slope: 1 in. per ft.

B. Design Requirements:

1. Structural steel members: AISC S 326

2. Light gage steel members: AISI "Specification for the Design of Cold-Formed Steel Structural Members".

3. Primary and secondary members and covering for loads and combination of loads: MBMA "Low Rise Building Systems Manual".

4. Welded connections: AWS D1.1

5. Design loads:

   b. Frame live load: 12 psf + hoist loads as required
   c. Wind Load: 110 mph
   d. Uplift on roof: UL 90 rated
   e. Maximum deflection:
      Roof panels: 1/180th of span.

1.02 SUBMITTALS

A. Product Data:

1. Manufacturer's product information, specifications, and installation instructions for building components and accessories.
2. Manufacturer's standard color charts for selection.

B. Shop Drawings:

1. Submit design and erection drawings showing anchor bolt settings; roof framing; transverse cross sections; and coverings and flashing details.

2. Indicate assembly of building parts.

3. Submit design calculations with the Seal of the Registered Texas Professional Engineer that prepared them.

C. Guarantee:

1. Guarantee watertightness of roof during ordinary wear and tear by elements for five year period from final acceptance.

2. Guarantee factory applied finish for the installed wastewater treatment plant environment for 20-year period.

1.03 HANDLING

A. Deliver and store prefabricated components, sheets, panels, and other manufactured items to prevent damage or deformation.

B. Stack materials on platforms or pallets.

C. Cover with tarpaulins or other weather tight ventilated covering.

D. Store metal sheets or panels to allow water to drain freely.

E. Do not store sheets or panels in contact with materials which cause staining.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. American Steel Building Co., Inc.

B. Metallic Building Systems

C. Mid-West Steel Building Company

D. Whirlwind Steel Buildings
E. Other manufacturers acceptable to Engineer.

2.02 STRUCTURAL FRAMING COMPONENTS

A. Rigid Frames:
   1. Hot rolled structural steel complying with ASTM A 36 or ASTM A 529.
   2. Factory welded and galvanized built-up "I" shape or open web rigid frame consisting of tapered or parallel flange beams and tapered columns.
   3. Include attachment plates, bearing plates, and splice members.
   4. Factory drill for bolted field assembly.

B. End Wall Columns:
   1. Factory welded, built-up "I" shape complying with ASTM A 36 or ASTM A 529; or cold formed sections complying with ASTM A 607, Grade 50.
   2. Fabricate of minimum 14 ga. material.
   3. Hot dip galvanize after fabrication

C. Wind Bracing:
   1. Adjustable, threaded steel rods, ½ in. diameter minimum.
   2. ASTM A 36 or ASTM A 572, Grade D.

D. Secondary Framing:
   1. Purlins, eave struts, end wall beams, flange, and sag bracing:
      a. 16 ga. minimum rolled formed sections complying with ASTM A 529, A 570, or A 572.
      b. Minimum yield strength: 42,000 psi.
      c. Fabricate from pre-galvanized coil stock
   2. Base channel, sill angle, end wall structural members except columns and beams, and purlins spacers:
      a. 14 ga. minimum cold formed steel complying with ASTM A607, Grade 50.
      b. Hot dip galvanize after fabrication
E. Tubing or Pipe: ASTM A 500, Grade B; A 501; or A 53.

F. Bolts:
   1. ASTM A 307 or A 325 as required for design loads and connection details.
   2. Bolts in contact with panels: Zinc or cadmium plated.
   3. Other bolts: Shop paint.

G. Shop Painting:
   1. Clean surface of loose mill scale, rust, dirt, oil, grease, or other matter.
   2. Follow procedures of SSPC-SP3 for power tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSPC-SP1 for solvent cleaning.
   3. Prime structural steel primary and secondary framing members with red zinc chromate primer complying with FS TT-P-645, Type II, or zinc chromate iron oxide alkyd complying with FS TT-P-664.
   4. Treat galvanized members with phosphoric acid and prime with zinc primer complying with FS TT-P-641.

2.03 STANDING SEAM ROOF

A. Standing Seam Steel Sheets: 24 ga. Galvalume™ aluminum-zinc alloy coated steel. Coating to be 55% aluminum, 43.5 % zinc and 1.5 % silicaon by weight applied to the steel substrate by the hot-dip process in accordance with ASTM-A-792.

B. Panels to be in 24 inch widths with a 3 inch high rib on each side and shall have factory applied hot melt mastic

C. Machine joined using double fold field rolled seaming process.

D. Sheet Metal Accessories: Provide flashings, closers, clips, fasteners, fillers, metal expansion joints and other miscellaneous sheet metal items factory formed of same materials and finish as roofing.

E. Fasteners:
1. Manufacturer's standard system of self-tapping screws, bolts, nuts, self-locking rivets, self-locking bolts, end welded studs, and other miscellaneous fasteners.

2. Designed to withstand UL90 loads.

3. Exterior application: Aluminum or stainless steel coating painted to match panel.

4. Interior application: Galvanized or cadmium plated fasteners.

5. Washers: Metal backed neoprene or EPDM washers for use under heads of fasteners bearing on weather side of panel.

F. Flexible Closure Strips:

1. Closed cell, expanded cellular rubber, self-extinguishing.

2. Cut or premolded to match corrugation configuration.

G. Sealing Tape:

1. 100 percent solids, pressure sensitive polyisobutylene compound tape with release paper backing.

2. ½ in. wide by 1/8 in thick minimum.


H. Joint Sealant: One part elastomeric polyurethane, polysulfide, or silicone rubber as recommended by building manufacturer.

2.04 SHEET METAL ACCESSORIES

A. Gutters:


2. Form in sections 8 ft. in length minimum.

3. Include end pieces, outlet tubes, and special pieces as required.

4. Join sections with rivets and solder or seal joints.

5. Provide expansion type slip joint at center of runs.
6. Furnish gutter supports spaced at 36 in. o.c. constructed of same material as gutter.

7. Provide standard bronze, copper, or aluminum wire ball strainers at each outlet.

8. Finish to match roof fascia and rake.

B. Down Spouts:


2. Form in 10 ft. long sections with elbows and offsets.

3. Join sections with 1 ½ in. minimum telescoping joints.

4. Provide fasteners for top, bottom, and at 5 ft. o.c. intermediately between.

5. Design fastener to hold down spouts 1 in. minimum away from walls.

6. Finish to match wall panels.

2.07 FABRICATION

A. Structure:

1. Shop fabricate to indicated size and section with welded plates and holes shop drilled or punched to template dimension.

2. Make shop connections with power rivets, bolts, or welds.

3. Make field connections with bolts.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine foundation and area for conditions detrimental to construction.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.02 ERECTION

A. Framing:
1. Erect structural framing true to line, level, and plumb.

2. Level base plates to true even plane with full bearing to support structures.

3. Set plates with double nutted anchor bolts.

4. Use non-shrinking grout to obtain uniform bearing and to maintain level base line elevation.

5. Moist cure grout for seven days after placement.

B. Purlins and Girts:

1. Locate and space wall girts to suit door and window arrangements and heights.

2. Secure purlins and girts to structural framing and hold rigid to straight line using sag rods.

C. Bracing:

1. Provide diagonal rod or angle bracing in both roof and sidewalls.

2. Movement resisting frames may be used in lieu of sidewall bracing.

3. Where diaphragm strength of roof or wall covering is designed to resist wind forces, rod or other forms of bracing will not be required.

3.03 ROOFING

A. General:

1. Arrange and nest sidelaps so prevailing winds blow over lapped joints.

2. Lap ribbed or fluted sheets one full rib corrugation.

3. Apply panels and associated items to form weather tight enclosure.

4. Protect factory finishes from damage.

5. Install weather seal under ridge cap.

6. Flash and seal roof panels at eave and rake with rubber or neoprene closures to exclude weather.
B. Roof Sheets:

1. Install sealant tape at lapped joints of ribbed or fluted roof sheets, protruding equipment, vents, and accessories.

2. Apply sealant tape to clean dry surface of weather side of fastenings on end laps, on side laps of corrugated or nesting type ribbed or fluted panels, and as required to make weatherproof to driving rains.

3.04 SHEET METAL ACCESSORIES

A. Install gutters, down spouts and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weather tight mounting.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. DESIGN, FABRICATE & ASSEMBLE BUILDING COMPONENTS shall be measured per Square Foot as indicated on the drawings and the measurement shall include all design calculations, personnel, equipment, labor and materials required to provide a complete and serviceable design and installation.

B. ERECT BUILDING shall be measured by Square Foot at the location indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

5.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
SS SECTION 15062

DUCTILE IRON PIPING

PART 1  G E N E R A L

1.01  H A N D L I N G

A. Handle pipe, fittings, and accessories to ensure installation in work in sound, undamaged condition.

B. Use equipment, tools, and methods for unloading, reloading, hauling, and laying pipe and fittings that will not cause damage.

C. Use broad, well padded contact surfaces on hooks inserted in ends of pipe.

1.02  E N V I R O N M E N T A L  R E Q U I R E M E N T S

A. Do not lay pipe under unsuitable weather or trench conditions.

PART 2  P R O D U C T S

2.01  C A S T  D U C T I L E - I R O N  P I P E  (DIP) (4 IN. THROUGH 60 IN.)

A. General:


2. Exterior coating:

   a. 1.0 mil dft minimum asphaltic coating.


B. Underground Installation:

1. Pipe:


c. 2 in. and 4 in. sizes: Class 51, minimum, pressure rated for 200 psi.
d. 6 in. and greater sizes: Class 50, minimum, pressure rated for 200 psi.
e. Pipe plain ends: Beveled.
f. Joint ends: ANSI/AWWA C110/A21.10 bell and spigot dimensions modified for type of joint used.

2. Fittings: Ductile iron or gray cast iron complying with ANSI/AWWA C110/A21.10.

3. Joints:
   a. Push-on joints for underground pipe - NOT ALLOWED:
   b. Mechanical joints for underground pipe:
      1) Design in accordance with ANSI/AWWA C111/A21.11.
      2) Gaskets: Rubber.
      3) Lubricant: As recommended by manufacturer.
      4) Mechanical joint retainer:
         a) Ductile iron with tee head bolts.
         b) Acceptable product: "F-1058", Clow.

C. Aboveground Installation:

1. Pipe:
   a. 3 in. and 4 in. sizes: Class 51, minimum, pressure rated for 200 psi.
   b. 6 in. and greater sizes: Class 50, minimum, pressure rated for 200 psi.

2. Joints:
   b. Use only ductile iron flanges.
   c. Gaskets:
      1) ANSI/AWWA C115/A21.15.
      2) Rubber.

3. Fittings: Ductile iron or gray cast iron complying with ANSI/AWWA C110/A21.10.
PART 3  EXECUTION

3.01 PREPARATION

A. Thoroughly clean interior of pipe and fittings and contact surfaces of foreign matter before installation and keep clean until work has been accepted.

B. Remove lumps, blisters, and excess coating from exterior spigot and interior bell surfaces.

C. Wire brush and wipe clean, dry, and free from oil and grease before placing spigot in bell.

D. Take precautions to prevent foreign material from entering pipe during installation; do not place debris, tools, clothing, or other materials placed in pipe.

E. Replace pipe and fittings in which cement lining has been broken or loosened.

F. Where damaged areas are small and readily accessible, repair lining. Repair damaged pipe coating before installing pipe.

G. Cutting Pipe:

1. Cut cast iron pipe in neat manner, without damage to pipe or cement lining.

2. Pipe cuts shall be smooth, straight, and at right angles to pipe axis.

3. Cut pipe with mechanical pipe cutters of acceptable type except in locations where use of mechanical cutters would be difficult or impracticable, existing pipe may be cut with saws or other tools which will cut pipe without damaging impact or shock.

3.02 LAYING PIPE

A. During installation, while suspended and hanging free, inspect each pipe and fitting for defects and ring with light hammer to detect cracks.

B. Protect pipe from lateral displacement by means of pipe embedment material installed as provided in Section 02223.

C. Do not lay pipe in water.
D. Lay pipe with bell ends facing direction of laying except when making closures.

3.03 JOINTING

A. Mechanical Joints:

1. Assemble mechanical joints in accordance with manufacturer's recommendations.
2. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble joint.
3. Do not overtighten bolts to compensate for poor installation.

B. Flanged Joints:

1. When bolting flanged joints, take care to ensure there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in flanges.
2. One flange shall be free to move in any direction while flange bolts are being tightened.
3. Pack or assemble bell and spigot joints until flanged joints affected have been tightened.
4. Tighten bolts gradually, at uniform rate, so gasket compression is uniform over entire area of gasket.

D. Flange Coupling Adapter:

1. Install flange coupling adapters if required.
2. After installation of pipe and bolting of flanges, drill holes in ductile iron pipe for anchor studs.

E. Anchorage and Blocking: Provide unugged bell and spigot or all-bell tees, y-branches, and bends deflecting 22-1/2 deg. or more which are installed in piping subjected to internal hydrostatic heads in excess of 15 ft. in exposed, or 30 ft. in buried, piping with suitable reaction blocking, struts, anchors, clamps, joint harness, or other adequate means for preventing movement of pipe caused by unbalanced internal liquid pressure.

F. Leakage: The hydrostatic leakage rate for ductile iron (DI) pipe and appurtenances shall not exceed the amount allowed or recommended by formulas in America Water Works Association (AWWA) Standard C-600 as required in 30 TAC §290.44(a)(5).
DUCTILE IRON PIPING
METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, TX
JUNE 2019

100% CONSTRUCTION DOCUMENT

METRO Project No. 7018000058
Hiram Clarke Bus Operating Facility WWTP Replacement

3.04 TRENCH INSTALLATION

A. Where in trench, provide fittings with concrete thrust blocking between fitting and solid, undisturbed ground in each case, except where solid ground blocking support is not available.

B. At tops of slopes, anchor vertical angle bends by means of sufficient weight of concrete mass to resist hydraulic thrust at maximum pressures to which pipe will be subjected.

C. Install concrete blocking and anchors so joints between pipe and fittings are accessible for repair.

D. Bearing area of concrete reaction blocking against ground of trench bank shall be as shown on Drawings or as required.

E. In event that adequate support against undisturbed ground cannot be obtained, install metal harness anchorages consisting of steel rods or bolts across joint and securely anchored to pipe and fitting or other adequate anchorage facilities to provide necessary support.

3.05 PROTECTION OF METAL SURFACES

A. Provide steel clamps, rods, bolts, and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete from corrosion with not less than two coats of bituminous coating applied to clean, dry metal surfaces.

B. Allow first coat to dry before application of second coat.

C. Paint metal surfaces exposed above grade or within structures shall be painted with two coats of paint in accordance with Section 09901.

3.06 FIELD QUALITY CONTROL

A. Testing:

\[
L = \frac{SDP}{148,000}
\]

Where:

- \( L \) = the quantity of makeup water in gallons per hour,
- \( S \) = the length of the pipe section being tested, in feet,
- \( D \) = the nominal diameter of the pipe in inches, and
- \( P \) = the average test pressure during the hydrostatic test in pounds per square inch (psi).
1. Subject piping for one hour to hydrostatic pressure test of 125 lb. per sq. in.

2. Make test after pipe is installed, joints completed but exposed for examination.

3. Carefully examine exposed pipe, joints, fittings, and valves during pressure test.

4. Tighten or remake joints showing visible leakage.

5. Replace and retest cracked or defective pipe, fittings, valves, or flushing valves.

6. Where actual visible inspection of each joint cannot be made because of necessity for immediate back-filling, where line is laid below water level and it is impracticable to lower water level by pumping, or where leakage diminishes as material in joints ages, provide suitable means for determining quantity of water lost by leakage under normal operating pressure (leakage test).

7. Conduct leakage test after pressure test has been completed.

8. Leakage test shall be 2 hours in duration.

9. Subject water line to 150 psi hydrostatic pressure.

10. No piping will be accepted until leakage is less than rate in gallons per hour per 1000 feet evaluated at 150 psi, as calculated according to AWWA C600.

11. In calculating leakage, allowance will be made for added joints in pipeline above normal for unit lengths of pipe.

12. Should any test of combined sections of pipeline disclose leakage greater than specified limit, locate and repair defective joints until leakage is within specified limits.

13. Schedule tests with Engineer.

14. Furnish gages, plugs, valves, pumps, other equipment, and labor for conducting tests.

B. Disinfection (Potable Water Service only):
1. Isolate area of system to be disinfected from rest of system.

2. Disinfect each unit of completed distribution system with chlorine before acceptance for domestic operation.

3. Use chlorine amount to provide dosage of not less than 50 parts per million.

4. Introduce chlorinating material to waterlines and distribution systems in compliance with AWWA C651.

5. Thoroughly flush lines before introduction of chlorinating materials.

6. After contact period of not less than 24 hours, flush system with clean water until residual chlorine content is not greater than 1.0 part per million.

7. Open and close valves in lines being sterilized several times during contact period.

8. Collect samples for bacteriological analysis to check efficiency of disinfection procedures.

9. Take minimum of one sample for each 1000 feet of piping.

10. Repeat sample collection if health authority tests show that contamination persists.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. DUCTILE IRON PIPE shall be measured by linear feet at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

4.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
PART 1 GENERAL

1.01 SUBMITTALS

A. Submit shop drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

1.02 QUALITY CONTROL

A. All products and materials that come into contact with potable water must conform to ANSI/NSF Standard 61

B. Lead Ban: the following provisions are herein adopted and apply to the use of lead in plumbing:

1. The use of pipes and pipe fittings that contain more than 8.0 percent lead or solders and flux that contain more than 0.2 percent lead is prohibited in the following circumstances:

a. For installation or repair of any public water supply

b. For installation or repair of any plumbing in a residential or nonresidential facility providing water for human consumption and connected to a public drinking water supply system

C. No previously used piping may be incorporated into the work

D. Welding shall comply with AWS D1.1

1.03 HANDLING

A. Store pipe materials off the ground and in a manner as to prevent damage.

B. Cover ends to prevent foreign materials from entering pipe and to prevent damage to pipe ends.

C. Handle thin wall pipe and factory beveled ends in accordance with manufacturer's recommendations.

D. Handle pipe, fittings and accessories to ensure installation in work is in
sound undamaged condition.

E. Do not use equipment, tools and methods used in unloading, reloading, hauling and laying pipe and fittings that will damage materials.

F. Hooks inserted in ends of pipe shall have broad, well padded contact surfaces.

PART 2 PRODUCTS

2.01 GENERAL PURPOSE CARBON STEEL PIPE

A. Pipe

1. 6-inch and smaller: Welded or seamless, ASTM A 53, Grade A or B, Type E or S, plain ends.

2. 8-inch and larger: Welded or seamless, ASTM A 53, Grade A or B, Type E or S, beveled ends.

3. Minimum thickness shall comply with following nominal pipe sizes:

   a. 2-inch:
      1. 2.375 inch outer diameter (O.D.)
      2. 0.154 inch minimum wall thickness
      3. 3.653 pounds per linear foot (approximate), uncoupled

   b. 4-inch:
      1. 4.50 inch outer diameter (O.D.)
      2. 0.237 inch minimum wall thickness
      3. 10.79 pounds per linear foot (approximate), uncoupled

   c. 6-inch:
      1. 6.625 inch outer diameter (O.D.)
      2. 0.280 inch minimum wall thickness
      3. 18.97 pounds per linear foot (approximate), uncoupled

   d. 8-inch:
      1. 8.625 inch outer diameter (O.D.)
      2. 0.322 inch minimum wall thickness
      3. 28.55 pounds per linear foot (approximate) uncoupled

   e. 12-inch:
      1. 12.750 inch outer diameter (O.D.)
      2. 0.375 inch minimum wall thickness
      3. 49.56 28.55 pounds per linear foot (approximate) uncoupled
B. Fittings

1. Bends shall be long radius

2. Dimensions shall conform to AWWA C208

3. 2-1/2 inch through 6-inch: Standard weight, factory forged steel, butt weld ends, ASTM A 234 WPB and ANSI B16.9


5. Wall thickness: Equal to or greater than pipe to which fitting is welded

C. Flanges, Bolting and Gaskets

1. Flanges: AWWA C207, Class D or ANSI B16.1

2. Bolting, carbon steel: ASTM A 307, Grade B

3. Carbon Steel hexagonal nuts: ASTM A 194, 2H

4. Gaskets: FS HH-P-46 or ASME B16.21, full face, compressed asbestos, 1/16 inch thick

2.02 STEEL PIPE COUPLINGS

A. Gasketed steel sleeve with two steel followers and two rubber compound, wedge section gaskets

B. In air piping use gaskets with minimum temperature rating of 200 degrees Fahrenheit

C. Sufficient track-head 40,000 psi yield strength, rolled thread steel bolts and corrosion resistant steel nuts to compress gaskets so water at 200 psi will not leak from coupling

D. Acceptable product: Dresser Style 38 or approved equal

2.03 STEEL PIPE EXPANSION JOINTS

A. Single or double end

B. Welded steel construction

C. Alternate split rubber compound and split jute rings
D. In air piping use gaskets with minimum temperature rating of 200 degrees Fahrenheit

E. Will not leak at 200 psi water pressure

F. Acceptable Product: Dresser Style 63 or approved equal

2.04 STEEL PIPE COATINGS

A. Water Service

1. Interior Coatings: AWWA C205, cement mortar lining for pipe, fittings and joints, factory applied unless hot dip galvanized

2. Exterior Coatings

   a. Surface preparation: Clean to bare metal, SSPC 6
   b. Buried service: Thixotropic coal tar mastic; Acro 4467 Coal Tar Epoxy, Koppers Bitumastic No. 50, Tnemec 46-450 Themecol or approved equal.
   c. Aboveground service: All aboveground water lines shall be galvanized iron pipe. All fittings and connectors shall also be galvanized iron to match pipe.

B. Laying Lengths:

1. 20 feet single random lengths

2. Shop fabricated pieces of proportions to facilitate transportation to job site

C. Seams:

1. Girth: 20 feet ransom maximum spacing

2. Longitudinal: Maximum number for 4-inch through 24-inch pipe is one

D. Fittings:

1. Minimum of 15 degree angular change for shop fabricated miter turns

2. Inside dimensions shall match adjoining pipe

3. Thickness shall be same or greater than adjoining pipe
PART 3 EXECUTION

3.01 PREPARATION

A. Repair pipe coating which has been damaged before installation of pipe.

3.02 INSTALLATION

A. All pipe fittings that are to be buried shall be mechanical joint fittings.

B. Flanged Joints;
   1. When bolting flanged joints, ensure there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in flanges
   2. The flange shall be free to move in any direction while flange bolts are being tightened
   3. Tighten bolts gradually and at uniform rate with gasket compression uniform over entire area of gasket
   4. To provide maximum flexibility and ease of alignment correction by taking advantage of slack between flange bolts and bolt holes for slight angular rotation of connecting piping with gaskets in place, with only portion of flange bolts (not less than four per joint) installed

C. Flanged joints between steel and cast iron flanges shall be electronically isolated
   1. Use epoxy-coated bolts, nuts and washers
   2. Install insulating type gasket

D. Pipe Supports:
   1. Each length of steel pipe shall be continuously supported by pipe bedding if buried; and shall be supported at two points approximately one-quarter length in from joints by one anchored (fixed) and one sliding support when installed above ground
   2. Lower 120 degree of pipe circumference shall be contact supported at each support
E. Reaction Anchorage and Blocking: Provide plugs, caps, tees, and bends deflecting 22-1/2 degrees or more with concrete thrust blocking placed between solid ground and item to be anchored, adequate to resist reactive forces without movement.

3.03 FIELD QUALITY CONTROL

A. Hydrostatic test piping at 150 psi

B. Inspect and test coatings and repair or replace defects

END OF SECTION
PART 1 GENERAL

1.01 Scope of Work

A. The contractor shall furnish all materials, tools, equipment, transportation, labor, supervision and incidentals required to supply, store, install, clean, and test the shop fabricated stainless steel pipe & fittings as shown on the drawings and as specified herein.

1.02 Description of System(s)

A. Shop fabricated stainless steel piping shall be used for the following applications. [List, table or otherwise describe services, sizes applications, locations, service conditions, etc. and/or refer to pipe schedule.]

1.03 Related Work Not Included in This Section

A. Steel piping is included in Section 15066
B. Concrete work is included in Section 03100
C. Painting is included in Section 09901
D. Pipe hangers & supports are included in Section
E. Valves & appurtenances are included in Section 15110
F. Testing is included in Section 02724

1.04 Qualifications

A. All shop fabricated stainless steel pipe and fittings shall be furnished by a single fabricator who is reputable and qualified and can demonstrate 10 years’ experience in the fabrication of lightwall stainless steel piping. The pipe and fittings shall be shop fabricated and field installed in accordance with common industry wide practices and methods and shall comply with these specifications. Pipe and fittings shall be as fabricated by Douglas Brothers, Portland, Maine.

1.05 Submittals

A. The contractor shall submit for review and approval piping layouts, schedules, shop fabrication drawings, specifications, catalog cuts and other data necessary to show conformance of the complete piping systems to these specifications. The contractor's submittal shall include dimensions, fittings, locations of equipment, valves, and appurtenances, joint locations and details, types and locations of supports, coordination
with all other work and existing conditions, and all other pertinent technical specifications for the piping systems to be furnished.

B. Shop fabrication spool drawings shall show alloys, diameters, pipe wall thickness, fittings, branches, flanges and other joint preparation details, dimensions, and other appurtenances to be supplied.

PART 2 MATERIALS

2:01 Pipes and Fittings, 3" diameter and larger.

A. Pipes shall be manufactured from ASTM-A240 annealed and pickled sheets and plates in accordance with ASTM A778 in Grade TP [304L or 316L] stainless steel. Pipe shall be manufactured to nominal pipe sizes as listed in ANSI B36.19, Table 2, and shall have [the following nominal wall thickness.]

<table>
<thead>
<tr>
<th>Nominal Pipe Size (IN.)</th>
<th>Actual O.D. (IN.)</th>
<th>Schedule/Gauge/Plate</th>
<th>Nom. Wall Thickness (IN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.500</td>
<td>Sch. 5s</td>
<td>0.083&quot;</td>
</tr>
<tr>
<td>4</td>
<td>4.500</td>
<td>Sch. 5s</td>
<td>0.083&quot;</td>
</tr>
<tr>
<td>6</td>
<td>6.625</td>
<td>Sch. 5s</td>
<td>0.109&quot;</td>
</tr>
<tr>
<td>8</td>
<td>8.625</td>
<td>Sch. 5s</td>
<td>0.109&quot;</td>
</tr>
<tr>
<td>10</td>
<td>10.750</td>
<td>12 Ga. Sheet</td>
<td>0.109&quot;</td>
</tr>
<tr>
<td>12</td>
<td>12.750</td>
<td>12 Ga. Sheet</td>
<td>0.109&quot;</td>
</tr>
<tr>
<td>14</td>
<td>14.000</td>
<td>11 Ga. Sheet</td>
<td>0.125&quot;</td>
</tr>
<tr>
<td>16</td>
<td>16.000</td>
<td>11 Ga. Sheet</td>
<td>0.125&quot;</td>
</tr>
<tr>
<td>18</td>
<td>18.000</td>
<td>11 Ga. Sheet</td>
<td>0.125&quot;</td>
</tr>
<tr>
<td>20</td>
<td>20.000</td>
<td>10 Ga. Sheet</td>
<td>0.140&quot;</td>
</tr>
<tr>
<td>24</td>
<td>24.000</td>
<td>3/16&quot; Plate</td>
<td>0.188&quot;</td>
</tr>
<tr>
<td>30</td>
<td>30.000</td>
<td>3/16&quot; Plate</td>
<td>0.188&quot;</td>
</tr>
<tr>
<td>36</td>
<td>36.000</td>
<td>3/16&quot; Plate</td>
<td>0.188&quot;</td>
</tr>
<tr>
<td>42</td>
<td>42.000</td>
<td>1/4&quot; Plate</td>
<td>0.250&quot;</td>
</tr>
<tr>
<td>48</td>
<td>48.000</td>
<td>1/4&quot; Plate</td>
<td>0.250&quot;</td>
</tr>
<tr>
<td>54</td>
<td>54.000</td>
<td>5/16&quot; Plate</td>
<td>0.312&quot;</td>
</tr>
<tr>
<td>60</td>
<td>60.000</td>
<td>5/16&quot; Plate</td>
<td>0.312&quot;</td>
</tr>
</tbody>
</table>

The above table lists our standard light wall piping thickness’ which are generally lighter than schedules 5s and 10s. As an alternative, the designer may specify a schedule 10S nominal wall. or a schedule 5s nominal wall.

B. Fittings shall be butt weld type manufactured in accordance with ASTM-A-774 of the same grade (alloy) and in the same thickness as the pipe. Long radius elbows (i.e. centerline to end of elbow equals 1.5 times the nominal...
pipe size) up to 24” diameter shall be smooth flow type. All short radius, special radius, and reducing elbows; and long radius elbows greater than 24” diameter shall be of mitered construction with at least (5) miter sections for 90 degree bends, (3) mitered sections for 45 and 60 degree bends, and (2) mitered sections for 30 degree and smaller bends. Reducers may be straight tapered, cone type. Tees, crosses, laterals and wyes may be shop fabricated from the specified pipe.

C. The finish on the raw material, manufactured to ASTM A-240 will be No. 1, HRAP (hot rolled annealed and pickled) or better. The finish on the completed pipe and fittings shall be as specified in ASTM A778 and A774, respectively.

D. Grade TP316L products may be substituted for TP 304L products. Heavier wall pipes or fittings may be substituted for a lighter wall thickness specified. ASTM A312 pipe and A403 fittings may be substituted for A778 and A774 products, respectively.

2.02 Flanges, 3” diameter and larger

The following is our standard economical lightweight flange specification. The designer is to determine the proper flange for their applications

A. Flanged pipe ends shall be made up of grade TP [304L or 316L] stainless steel slip-over type rolled angle face rings and hot dipped galvanized steel or ductile iron backing flanges drilled to ANSI 16.1 class 125 standard. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded and it shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes. The back-up flanges shall be supplied with the following nominal thickness.

<table>
<thead>
<tr>
<th>Nom. Pipe Size (IN.)</th>
<th>Flange Thickness (IN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 1/2</td>
<td></td>
</tr>
<tr>
<td>4 9/16</td>
<td></td>
</tr>
<tr>
<td>6 – 10 5/8</td>
<td></td>
</tr>
<tr>
<td>12 – 16 3/4</td>
<td></td>
</tr>
<tr>
<td>18 – 20 7/8</td>
<td></td>
</tr>
<tr>
<td>24 – 30 1</td>
<td></td>
</tr>
<tr>
<td>36 1-1/8</td>
<td></td>
</tr>
<tr>
<td>42 1-1/4</td>
<td></td>
</tr>
<tr>
<td>48 1-3/8</td>
<td></td>
</tr>
<tr>
<td>54 1-3/8</td>
<td></td>
</tr>
<tr>
<td>60 1-1/2</td>
<td></td>
</tr>
</tbody>
</table>

Back up flanges can be specified to be our standard lightweight stainless steel, if desired. Substitute ‘TP [304 or 316] stainless steel’ for ‘hot dipped galvanized steel or
ductile iron’ in the above paragraph and follow with the table below.

<table>
<thead>
<tr>
<th>Nom. Pipe Size (IN.)</th>
<th>Flange Thickness (IN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – 8 1/2</td>
<td></td>
</tr>
<tr>
<td>10 – 14 5/8</td>
<td></td>
</tr>
<tr>
<td>16 – 20 3/4</td>
<td></td>
</tr>
<tr>
<td>24 – 30 1</td>
<td></td>
</tr>
<tr>
<td>36 -54 1 1/4</td>
<td></td>
</tr>
<tr>
<td>60 13/8</td>
<td></td>
</tr>
</tbody>
</table>

2.03 Couplings

A. The piping will be shop prepared for pipe couplings where shown on the drawings.

1. Sleeve type couplings shall be of standard steel construction [specify gaskets, coating etc]. Pipe shall be plain end with external weld beads ground smooth to insure proper gasket seating. For pressure pipe lines, sleeve coupling joints will be restrained where indicated on the drawings. Restraint shall be by the use of harness rods connecting across the joint to plate lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs, as detailed on the drawings, shall be welded to the pipe to receive the harness rods. All sleeve couplings, plate lugs, harness rods and hardware will be provided by the contractor.

2. Arched band type couplings shall be stainless steel of equal or superior alloy as the pipe and will be Depend-O-Lok type as manufactured by Victaulic or equal. Couplings will be Fixed – FxF, Expansion – ExE, or Fixed by Expansion – FxE as noted on the drawings. The pipe shall be plain end with external weld beads ground smooth and with stainless steel restraining rings shop welded to the piping ends for fixed type couplings. [specify gaskets]

3. Split type couplings shall be malleable iron or ductile iron, Style 77, as manufactured by Victaulic. Gaskets shall be suitable for the service conditions. The pipe ends shall be roll grooved to the coupling manufacturers specifications. Where roll grooving is impractical, the pipe shall have heavy wall, schedule 40s minimum, machine grooved pipe nipples or machined ring collars fully welded to the pipe or fitting ends. Nipples shall be taper bored to the I.D. of the adjoining pipe to allow full weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

4. Expansion couplings shall be the flanged rubber arch type. Pipe flanges shall be provided for these couplings where shown on the drawings.
2.04 Threaded Connections

A. Threaded pipe, gauge or instrument connections shall be made using stainless steel 3000-pound threaded half couplings conforming to ASTM A182 or ASTM A-276, shop welded to the pipe at the locations shown on the drawings.

2.05 Joints

A. Flanges shall be provided as a minimum at all flanged valves, meters, couplings, and other equipment. Couplings will be provided where shown on the drawings.

B. Pipe and fitting spools shall be shop fabricated to the fullest extent possible in 0’0” maximum lengths with 7’6” maximum widths for efficient commercial transport to the project site. Spools with fittings may exceed 40’0” so long as length allows commercial transport. Smaller pipe spools shall be provided with joints as shown on the drawings for special handling, installation, and/or disassembly requirements.

C. All other joints required for shipping, handling and installation of the piping pools shall be (field welds, flange joints, sleeve couplings, band couplings, or split couplings).

2.06 Bolting

A. The contractor shall supply and install flange bolting as follows. [specify]
weld passes performed using the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler metal of equal or superior ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed; weld reinforcement shall be as follows.

Wall Thickness Weld Reinforcement (Max)
I.D. O.D.
Up to 12 Ga. (0.109") 1/16" 3/32"
11 Ga. (0.125") to 3/16" Pl. 3/32" 1/8"
1/4" Plate & Larger 1/8" 3/16"

Concavity, undercut, cracks or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert argon gas shielding shall be provided to the interior and exterior of the joint. Angle face rings shall be continuously welded on both sides to pipe or fitting. Exterior welds, such as the back side of face rings or flanges and structural attachments, may be welded by the MIG (GMAW) or Metallic Arc (SMAW) process; however care must be taken to avoid melting through to the interior surface on very light walls. Excessive weld deposits, slag, spatter and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

B. Spools shall be fabricated to the “Pipe Fabrication Institute” fabricating tolerances ES-3 (1981).

D. After shop fabrication into pipe spools, exterior welds shall be manually scrubbed or brushed with non metallic pads or stainless steel wire brushes to remove weld discoloration, rinsed with clean water and allowed to air dry.

E. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece marked with identifying numbers or codes which correspond to the contractors layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart.

F. The piping supplier during manufacturing, fabrication and handling stages, and the contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be non ferrous or stainless steel or rubber lined. Nylon slings or straps or alloy chains or cable shall be used for handling stainless steel piping. After installation, the contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the contractor shall
pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes and rinse clean.

G. After installation, the contractor shall paint all steel or iron flanges, couplings and appurtenances in accordance with Section ( ). Painting of the stainless steel pipe is not required. However, the contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and rinsed clean. Final marking of the pipeline will be in accordance with ( ).

H. After installation, the piping system shall be tested by the Contractor according to ( ).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. STAINLESS STEEL PROCESS PIPING shall be measured by lump sum at the locations indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable installation.

4.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.
SS SECTION 15110

VALVES FOR WASTEWATER SERVICE

PART 1  GENERAL

1.01  SUBMITTALS

A.  Product Data:

  1.  Submit catalog cut sheet for each different product make and
      model proposed for installation.

  2.  Submit chart for each make, model, and size of valve proposed for
      installation:

      a.  Flow through valve versus pressure drip.
      b.  Percent of maximum flow versus valve percent open.
      c.  Flow versus head loss.

B.  Affidavit of Compliance:  Manufacturer shall supply affidavit of compliance
    with stated reference standards and specified provisions of this Section
    when requested by Engineer.

C.  Provide valves in compliance with submitted certified drawings and
    material specifications.

D.  When requested by Engineer, provide certified records of ASTM or other
    specified tests met by valve.

PART 2  PRODUCTS

2.01  GATE VALVES

A.  3 In. and Larger Gate Valves:  AWWA C509, resilient-wedge gate type,
    non-rising stem.

B.  Gate Valves Smaller Than 3 In. Size:  Solid wedge type.

C.  Provide buried valves with valve boxes.

2.02  VALVE BOXES

A.  Cast iron, extension sleeve type, suitable for depth of cover shown on
    Drawings.
B. Not less than 5 in. in diameter, and thickness at any point of not less than 3/16 in.

C. Provide valve boxes with suitable cast iron bases and covers.

D. Covers: Cast thereon on appropriate name designating service for which valve is used.

E. Parts of Valve Boxes, Bases, and Covers: Coated by dipping in bituminous varnish, FS TT-V-51.

2.03 CHECK VALVES (4 in. Through 20 in.)

A. General: Swing check valves shall be manufactured in accordance with AWWA standard C-508, “Swing-Check Valves for Ordinary Waterworks Service”, with the following additional requirements or exceptions.

B. Valve Description: All valves shall be iron body, fully bronze-mounted, metal to metal seating, and the disc shall be swing type.

C. Installation: Valves in vaults shall be installed in a horizontal position with exterior lever and adjustable weight operation.

D. Service: All valves shall be suitable for frequent operation as well as service involving long periods of inactivity. The operating pressure for all sizes shall be 150 psi gauge.

E. End Connections: All check valves shall be furnished with flanged ends. The size and drilling shall be in accordance with A.N.S.I.-B16.1 Class 125 Specifications; flanges shall be machined to a flat face with a finish of 250 micro-inches or machines to a flat surface with a serrated finish in accordance with AWWA Standard C-207.

2.04 ECCENTRIC PLUG VALVES

A. Eccentric plug valves shall be the non-lubricated eccentric type with cast iron bodies, resilient-faced plugs or replaceable resilient seats in the bodies.

B. Operators: All valves 4-inch and larger service shall have worm gear operators, nickel or stainless steel seats, and ANSI 125 psi flanged ends. Operators shall clearly indicate valve position. Operators on valves in submerged or buried service shall be lubricated and sealed to prevent entry of dirt and water into the operator.
C. Valves in vertical piping runs shall be equipped with chain-wheel and chain installed according to manufacturer's recommendations.

D. Resilient facing shall be suitable for the intended service.

E. All shaft bearings shall be of stainless steel, furnished with permanently-lubricated bearing surfaces.

F. Valves up to and including 20 inches in size shall have an unobstructed port area of no less than 80 percent of the full pipe area, and not less than 70 percent for larger valves.

2.05 AIR PRESSURE AND VACUUM RELEASE VALVES

A. Designed to exhaust air in pipeline out orifice during filling sequence and to close watertight when liquid enters valve. Valve shall also permit air to enter through orifice when pipeline is being drained to break vacuum.

B. Provide with cast iron body and cover with stainless steel trim and float.

C. Provide with Buna N seat.

D. Equip with antislam device to throttle flow into air valve.

E. Equip with throttling device with exterior adjusting nut.

F. Provide 3 in. flanged inlet connection.

G. Acceptable Products

1. "APCO Series Model No. 146", Valve and Primer Corp.


H. Refer to Drawings for location of valves.

2.06 BUTTERFLY VALVES (3 IN. THROUGH 24 IN.)

A. Provide valves complying fully and strictly with AWWA C504, Class 150B, including compliance with bill of materials, dimensions of parts, tolerances, performance, construction, and testing requirements, and following:

1. Nonshock shutoff to 150 psi on one side of disc and 0 psi on opposite side.
2. Short lug wafer type designed for closing against flow velocity of 16 fps at normal working pressure of 150 psi.

3. Rated for 150 psi working pressure, 300 psi body hydro test pressure.

4. Bubbletight closure at rated design pressure.

5. Packing or body does not leak at two times rated test pressure.

6. Joint ends: Lug wafer design with dimensions and drilling complying with ANSI B16.1, Class 125.

7. Maximum operating torque: AWWA C504, Table 1.

8. Shop coating
   a. Shop coat ferrous metal surfaces of valves and accessories, both interior and exterior, for corrosion protection.
   b. Protect internal iron surfaces of valves with coating of 4 mils minimum dft of two part thermosetting epoxy or coal tar epoxy complying with AWWA C550, Protective Interior Coatings For Valves and Hydrants.
   c. Protect external iron surfaces of valves with coating of asphalt varnish, FS TT-V-51.

B. Bodies
1. Ductile iron, ASTM A 536, Grade 65-45-12.
2. Thickness and laying length complying with AWWA C504, Table 3.

C. Discs
1. Ductile iron, ASTM A 536, Grade 65-45-12 or alloy cast iron, ASTM A 436, Type 1 or Type 2.
2. Disc sealing edge: 360 deg. of uninterrupted corrosion resistant sealing surface.
3. Rotate 90 deg. from full open position to tight shut position.

D. Shafts
1. Minimum shaft diameter through bearings and into valve disc: AWWA C504, Table 4.
2. Stainless steel: ASTM A 276, Type 304 or Type 316.

3. Shaft design: One-piece through type or stub type with at least 1-1/2 in. shaft diameter engagement into the disc hub.

4. Shaft to disc connection: Designed to transmit 75 percent of torsional strength of shaft minimum diameter.

5. Size: Valve shaft shall be full size through bearings, disc, and shaft seal.

6. Shaft seals: Buna N O-ring type or split-V (chevron) type, replaceable without removing shaft.

7. Plugged body at bottom end of shaft.

E. Seats

1. Seats shall mate with seat surfaces of ASTM A 276, Type 304 or Type 316 stainless steel or ASTM A 436 Type I or Type II alloy cast iron.

2. Rubber Seats
   Butterfly valve seats for the following services shall be EPM:
   - Air distribution piping
   Butterfly valve seats for all other services shall be Buna N.

3. Valves over 30 in. size: Removable and replaceable seats without removing valve from line.

4. Valves manufactured with rubber liners are not acceptable.

F. Bearings: Self-lubricating sleeve type complying with AWWA C504 at both top and bottom of stem.

G. Valve Operators

1. Manual operators and gearing complying with AWWA C504.

2. 2 in. square operating nut for buried valves, lever for in-plant aboveground valves.

3. Holds valve in intermediate position between open and fully closed without creeping or fluttering.
4. Aboveground valves: Weatherproof indicator to show position of valve disc.

5. Traveling nut design or worm and segment design: AWWA C504.

6. Moving penetrations: Bronze or stainless steel surfaces in contact with housing seals.

H. Acceptable Products

1. "Model 2FI" (3 in. through 20 in.), "Triton XR-70" (24 in. through 144 in.), Henry Pratt Co.


4. "Model 27F-GRB“ or Model 27F-SSF“ (3 in. through 12 in.), Crane.

5. "Model F504“ (3 in. to 24 in.) or "Model E47“ (30 in. to 144 in.), Keystone Valve Co.

6. “Model “ (3 in. to 12 in.), Matco-Norca

2.07 RELATED ITEMS

A. Manual Operators: Provide valves with operators equipped with operating wheel, except valves equipped with power actuated operators or designed for automatic operation.

B. Wrench Nuts:

1. Provide wrench nuts on buried valves, on valves which are operated through floor boxes, and where shown on Drawings.

2. Wrench nuts shall comply with Section 19, AWWA C500.

3. Provide not less than two operating keys for operation of wrench nut operated valves.

C. Rotation Indicator:

1. Each valve body or operator shall have cast work OPEN and arrow indicating direction to open.
2. Direction of rotation of wheel, wrench nut, or lever to open valve: Left, counterclockwise.

D. Ends:

1. 3 in. or larger buried valves: Push-on or mechanical joint ends.
2. Other 3 in. or larger valves: Flanged ends.
3. 2-1/2 in. or smaller valves: Threaded or solder ends.

F. Unions: Provide union or flanged connection within 2 ft. of each threaded end valve unless valve can be otherwise easily removed from piping.

2.08 SHOP PAINTING

A. Shop paint ferrous metal surfaces of valves and accessories, both interior and exterior, for corrosion protection.

B. Protect internal and external iron surfaces of valves with coating of 10 mils dft of two part thermosetting epoxy: AWWA C550.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves in accordance with manufacturer's recommendations.

B. Valve Boxes:
1. Set valves and valve boxes plumb; place each valve box directly over valve it serves, with top of box brought flush with finished grade.

2. After being placed in proper position, fill in earth around each valve box and thoroughly tamp on each side of box.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. All Operation and Maintenance materials concerning electrical, instrumentation, and controls matters shall be from General Contractor and shall have statement that General Contractor has verified the correctness or validity of the documentation in respect to contractual requirements of the plans and specifications.

1.02 GENERAL REQUIREMENTS

A. All hardcopies provided to Owner after approval by Electrical Engineer are to be professionally assembled with tabs and coversheets.

1. Wiring diagrams shall be on same size pages (8.5x11 or 11x17 pullout sheets) as used in Operations and Maintenance Manuals and shall be placed in a separate section of the Manuals identified as Wiring Diagrams.

2. Each O&M Manual hard copy shall include a CD that contains the complete, organized O&M Manual in PDF format inserted in a pocket near front of Manual. All O&M Manuals shall be professionally written and bound.

3. O&M manuals shall be submitted in hard-back three-ring loose-leaf binders with a complete table of contents and drawing indexes for each binder and dividers for each section. Binders shall have transparent plastic overlays on front cover and spine. Enclose in the pocket a printed label including facility name with project name.

B. Requirements of this section apply to all other electrical, instrumentation, and control related specifications for this project. Submittals provided without all required information are subject to be rejected without review.

C. In addition to O&M Manual, provide detailed wiring diagrams of all control panels on clear plastic laminated pages to be placed in pocket affixed to inside of cabinet door.

1.03 SUBMITTALS

A. Preliminary Operation and Maintenance (O&M) Manuals

1. The Contractor shall provide electronic format version of Preliminary O&M for review by Engineer. In addition to “as-built” system drawings, the manuals shall include internal wiring diagrams and operating and maintenance literature for all
components provided under this section. The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument. The O&M manual shall be professionally composed and compiled for project specific components—no assembly of generic product cut-sheets. Engineer shall have sole discretion of acceptance of O&M manual contents and composition.

2. Contractor shall verify with contract General Requirements (Specification Division 01) for submittal procedures and quantities. Electronic submittal is adequate for Electrical Engineer review, but Contractor is responsible for meeting requirements for all other reviewers involved in the project.

3. The contents of the O&M manuals shall be generally organized as follows:

   a. System Hardware/Installation
   b. System Software (where applicable)
   c. Operation (step-by-step procedures)
   d. Electrical and Control Wiring Diagrams.
   e. Maintenance and Troubleshooting
   f. Warranty Certificates
   g. Device Information

      (i) Instrument and electronic devices calibration ranges and scales for this specific project. (Manufacturer’s general information is not sufficient. Include range of 4-20 mA signals, i.e., 4 mA = X psi or Y feet, etc. for each specific instrument and device.)

      (ii) Setting and adjustments of all solid-state and non-solid-state starters, SCADA, PLC’s, circuit breakers, controllers, instruments, and other equipment and devices with adjustable settings both manual and programmable settings. Provide this information in table format and show current settings of each adjustable device for this installation, in each motor control center section and each control panel.

      (iii) Statement of satisfactory demonstration of all instruments, devices and equipment functions over full range of operation. (Any failures or incorrect calibrations or settings detected shall be reason to halt demonstration tests and reschedule after adjustments and recalibrations have been completed.)

      (iv) Factory Technician report stating that all calibrations, settings and adjustments have been completed and that equipment has been
functionally tested by Factory Technician on site. Where report is found to be inaccurate, the Technician shall make necessary on-site adjustments and shall issue new report, and where second report is required, a Factory Manager shall sign report attesting to its accuracy. Contractor shall be responsible for all factory set up, testing and demonstration costs until system is accepted by the Design Engineer. Any additional testing as result of non-acceptance by Engineer shall be at Contractor’s expense.

h. As-Built Drawings (Point to point wiring diagrams for every electrical device installed on this project.)

B. Final Operation and Maintenance (O&M) Manuals

1. After Engineer’s review of Preliminary O&M Manuals and all comments have been addressed, Contractor shall produce the final O&M Manuals for the project. All information shown in Preliminary O&M’s shall be included with Final version, as well as any adjustments needed to illustrate the final, as-built conditions of the project.

2. The Contractor shall provide complete hard copy sets of O&M manuals and one (1) in electronic format on CD. Electronic format shall include files in the latest version of Microsoft Word format for any written documentation and in AutoCAD 2016 or earlier format for drawings wherever possible, and in PDF as necessary. Cut sheets may be PDF.

3. Contractor shall verify with contract General Requirements (Specification Division 01) for exact number of copies required. Provide the number shown in this section if not specified elsewhere, ensuring a minimum of one (1) hard copy with CD/DVD including all electronic files is delivered to project site, with additional copies provided as required.

4. Submit final O&M electronically for Engineer’s review and file. Coordinate with Engineer for file delivery instructions if file is too large for email delivery.

C. Record Drawings and Documentation

1. Where Electrical and Instrumentation Equipment is to be installed under this contract or where existing and noted, the Contractor shall further provide a complete set of as-built plans, diagrams, parts and materials list, parts source, operational instructions, programming data, maintenance and troubleshooting instructions, service data, calibration data, testing data, required service, and wiring diagrams sufficient for complete operation and maintenance of the Electrical and Instrumentation Equipment by plant technicians and operators or by outside service technicians. This information shall be provided on CD in AutoCAD 2016, or earlier version for drawings, and in the latest Word format and shall be arranged in final order for insertion into Electrical and Instrumentation Equipment files. Where AutoCAD drawings are not available,
PDF files will be accepted. Allow adequate man-hours for adjustment of layout and contents during Electrical and Instrumentation Equipment testing and Owner review. All data submitted will be reviewed by Engineer for acceptance and where deemed insufficient by Engineer, data shall be revised and resubmitted.

2. Provide Record Drawing that clearly shows any work that varies from the Contract Drawings. Remove any lines or text from drawings that no longer apply as a result of as-installed variations.

3. All underground conduits entering any building under or in slab shall be accurately dimensioned as to location. Show accurate dimensioned layout of conduits under or encased in building slabs.

4. Show accurate dimensioned location of all conduits and ductbanks on site and on structures that are installed or modified under this contract. Identify conduits by tag number.

5. Show location and identify all new or relocated devices and equipment in rooms and on structures.

6. Provide accurate and complete point-to-point wiring diagrams for all power, control and instrument circuits. Identify each conductor, conduit, terminal block, and device terminal. Use manufacturer’s device terminal numbers and do not assign new conflicting termination numbers. Quality and content of diagrams and drawings shall be such that future troubleshooting or modifications may be done without additional information from field observations. Contractor may be asked to demonstrate certain circuits selected by Engineer or Owner to assure accuracy and completeness of diagrams. Any errors shall be corrected before acceptance of work. This work includes every circuit installed or modified under this contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLOSEOUT ACTIVITIES

A. Final Operations and Maintenance (O&M) manuals and “As-Built” drawings shall be used during training. Training must be scheduled after Preliminary O&M’s have been reviewed, and Final O&M’s have been produced.
PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
SECTION 16002
ELECTRICAL SUBMITTAL PROCEDURES

PART 1 GENERAL

1.00 GENERAL REQUIREMENTS

A. Requirements described by this section are in addition to any requirements of the General Conditions of the project. The electrical engineer requires electronic submittals for all equipment provided under the electrical and controls specifications. Do not submit hardcopies to the electrical engineer. This does not eliminate any requirements for hardcopies required by the Owner as required by the General Conditions.

B. General Contractor shall route all Vendor submittals with electrical requirements to Electrical Contractor who shall review and coordinate all power and control requirements and affix stamp certifying coordination. Any variation to plans or specifications shall be noted accordingly on Vendor's submittal.

C. The Contractor shall submit shop drawings and/or product data electronically in Portable Document Format (PDF) document exchange format. If submittal file size is too large or contractor has issue sending via email, please contact Engineer for alternative method.

D. Submit all products covered under all sections for Engineer’s approval. Specify which items are to be used by circling or highlighting individual items. Any items not submitted are the responsibility of the Contractor. If it is not submitted, it is not approved. Requirements of this section apply to all other electrical instrumentation and control related specifications for this project. Local Representative shall verify that equipment or materials submitted conform to the plans and specifications before shop drawings are submitted to Engineer.

E. Contractor is to provide a schedule showing estimated start dates, completion dates, shop test dates, and field test dates. Provide updated schedules for any variations to original schedule.

F. Where submittals for a particular piece of equipment, device or material item vary from that specified or shown on plan drawings, and where that item is not specifically noted as acceptable and, where installation of submitted item results in improper or undesirable operation of the system, Contractor shall be liable for removal and/or replacement of that item with the item specified or shown on plan drawings at no additional cost to Owner. Such items submitted as substitutions shall be listed separately and clearly noted as “Substituted Item”.
G. Do not include Manufacturer’s catalog data pages that do not apply to specific equipment or devices used for this project.

H. Where various equipment interfaces or wiring interconnections are of same unit, submittals for all of the equipment shall be made simultaneously.

I. Submittals require a minimum of two (2) weeks for review from time of receipt by Electrical Engineer. Contractor shall submit all shop drawings in time to account for this period of review.

J. With each submittal, include an electronic copy of the applicable specification(s) page(s) for the item submitted and mark “Complies” or “Non-Compliance” or “Exception” adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

K. Contractor is fully responsible for coordinating/submitting correct operating voltage, horsepower, current, phase, and starter sizes requirements of all equipment furnished and installed under this contract. Shop drawing review by Engineer does not remove this responsibility. Data sheets shall have model numbers that correctly identifies equipment and accessories as described and included on plans and in specifications.

L. All submittals for motor control centers, control panels, control sections, controllers, lift pump panels, and Vendor furnished panels must contain statement of U.L. certification and identifying name and number of U.L. certification from fabricating shop. All submittals without this information will be rejected. Any MCC’s or panels installed without U.L. listing and where not acceptable by Engineer or Owner will be replaced at Contractor’s expense.

M. Submittals shall contain statement that all controls for this project have been coordinated in respect to equipment interfacing, conduit and conductor sizing, and interlock circuits.

N. All equipment shop drawings shall indicate changes or modifications as a result of previous submittal variances. No shop drawings shall be submitted that have not been coordinated as required by this specification. Any submittals not coordinated as such will be at Contractor’s risk and at no additional cost to Owner for required changes necessary for a complete operating system as intended by the plans and specifications for this project.

O. Provide detailed sketch of all unistrut racks and other type mounting assemblies for Engineer’s review before starting work. Items not submitted and determined as not acceptable after construction shall be replaced at no additional cost to Owner.

P. Provide detailed drawings of any modifications, concrete cutting or breaking, or any work not shown on drawings for Engineer’s approval. Non-submittal of any such work may result in corrective action at Contractor’s expense.
Q. Do not order equipment, MCC’s, or panels until submittal has been approved by Engineer in writing.

R. Where Equipment Manufacturers supply power and/or control cables, Contractor shall coordinate cable and conduit size and lengths. Failure to do so will be at Contractor’s expense.

S. Wiring Diagrams: Provide complete wiring diagrams and one-line diagrams for all MCC’s, control panels, controls sections, and related field wiring. Provide wire terminal and wiring tag numbers. Show all wiring as it will appear in final fabricated panels. Designate field wiring, local control panel wiring and MCC wiring and show interface terminals. Show type of terminations. Forked lugs are not acceptable. Show one-line diagram for motor control centers and control panel.

T. Component Layout:

1. Provide layout of each component installed inside control panel, motor control centers and related back plates. Show designation of each component and provide identification legend for each one. Provide cross-referencing to applicable data sheet and Table of Contents. List exact model number of each item. Note any substitutions. Show method of mounting. No components shall be located in panels that are not securely mounted.

2. Show method of covering or protecting live parts above 300 volts from accidental contact by service personal or operations. No adjustable devices that may normally be set by Operator shall be located near live parts over 300 volts without adequate protection.

1.01 SUBMITTAL REQUIREMENTS

A. All submittal covers must have Electrical Engineer’s project number and Prime Engineer’s project number marked clearly on front of submittal. In addition, submittal cover shall have name, address, and telephone number of General Contractor, Electrical Subcontractor, or Subcontractor making submittal and the local Manufacturer Representative.

B. Contractor is to submit all shop drawings, and product data required per the relevant specifications section at one time. All related submittals are to be submitted at one time.

1. Contractor to follow a consistent naming convention such as: Submittal Number – Submittal Title – Revision Number.File Extension (##-Submittal Title-Rev#.PDF)

C. Submittals are to be formatted as a single PDF format with a table of contents.

D. The following information must be provided with each submittal:
1. Date and Revisions Dates
2. Project Title matching plans and specifications
3. Prime Engineer’s Project Number
4. Electrical Engineer’s Project Number
5. Name of Project Manager, Address and Telephone Numbers of:
   a. General Contractor
   b. Electrical Contractor
   c. Vendor
   d. Manufacturer
6. Specification Section Number
7. List of Deviations and Reasons
8. Specifications Compliance Checklist
9. General Contractor Signature

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
   A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 CONDITIONS

A. General Contractor is solely responsible for coordinating all electrical requirements of all equipment installed under this contract. Electrical Subcontractor shall confirm this with General Contractor before bidding.

Within 10 days of “Notice to Proceed,” the General Contractor shall appoint a person responsible for coordination of all electrical controls and equipment that are a part of this project and provide contact information to Engineer.

B. This specification section is an inherent part of all work performed on this project and its contents shall apply for any and all electrical power, controls, and instrumentation related work. Contractor shall advise all Subcontractors and Vendors accordingly.

C. WARNING: Electrical systems for this project have lethal voltages present. Contractor shall not work on energized equipment except when absolutely necessary and then only in the presence of another trained, experienced Electrician, and with proper protective gear.

D. All correspondence, RFI’s, and submittals concerning electrical, instrumentation, and control matters shall be from General Contractor and shall have statement that General Contractor has verified the correctness or validity of the correspondence, etc. in respect to contractual requirements of the plans and specifications.

E. Unless defined otherwise by the General Conditions, references to “days” in the electrical, mechanical, instrumentation, and controls specifications are defined as standard “working days” (M-F). All requirements for prequalifications under this specification shall be submitted no later than ten (10) days prior to bid date.

F. Installation shall conform to most recent National Electrical Code, International Building Code, and Local Codes. In addition, Contractor shall follow all requirements of NFPA 70E - “Standard for Electrical Safety in the Workplace.”

G. Plans and diagrams are illustrative and may not contain all devices wiring and controls required to perform the function intended without reference to Specifications. Location and alignment of Motor Control Centers or other equipment shown on Plans may require adjustment for some Equipment Manufacturers products, and this requirement is the sole responsibility of the Contractor.
H. Substitutions for equipment specified or shown on plans shall be submitted to Engineer for approval prior to bidding, unless specified or shown on plans as “or equal.” Where noted as “pre-approved,” indicates approval is required by Engineer prior to bid acceptance.

I. All software or programs provided by any Vendor or Contractor shall be open activation without undisclosed passwords, keys, and/or means or devices that prevent Owners access to programs. All software shall be new copies for Owner with no cost attachments.

J. All references to plans and/or drawings refer to the complete set of contract plans and not specifically electrical only, unless stated otherwise.

K. Additions or modifications to existing facilities involves a certain degree of uncertainty and all existing, hidden or unknown conditions may not appear on plans. Contractor is to consider this when bidding and shall cover all reasonable unknown conditions not evident in pre-bid site visit, which is necessary to familiarize Contractor with observable pre-existing conditions. Contact Engineer concerning any questions prior to bidding job.

L. Control panels and MCC’s shall be fabricated to fit the available space shown on plans. Install control panels, instruments, and motor control centers to allow a minimum of four (4) foot clearance for access to control devices. This may require special enclosures. Relocation up to 40 feet from where shown on plans may be required and shall be included in bid cost. Supplier and Contractor shall notify Engineer of any variations in size, location or orientation before fabricating equipment. Listing of acceptable Equipment Manufacturers does not limit or remove the intent of this requirement.

M. All devices, fittings, connectors, supports, brackets, and miscellaneous hardware normally used for installation of electrical equipment may not be shown in detail. Contractor shall provide all these items and included them in bid price.

N. Any change orders or additional work beyond the scope of this project as bid by Contractor shall be approved in writing by Engineer. Any unapproved work performed is at Contractor’s risk.

O. Installation shall conform to layout, routing, and details shown on Plans and described in Specifications. Any variations shall be pre-approved in writing by Engineer before work starts. Any unauthorized work shall be removed at Contractor’s cost and with no delay in project schedule.

1.01 SUMMARY

A. Subject to the General and Special Conditions, this Section includes basic requirements specifically applicable to the work of Division 16 – “Electrical”.

B. All work shall include providing materials and equipment required for installation of
a complete and functioning electrical system as specified and as shown on the drawings.

C. This section is an integral part of all Specification Sections related to electrical, control and instrumentation construction under this contract. Contractor shall check all other plans and specifications for this project and include items and circuits accordingly. The total set of construction documents make up the requirements for work for this project and shall be included in Contractor's bid at no additional cost to Owner or Owner's Representative.

D. All plans and specifications for this project are representative of the design intent and may not contain minute details associated with normally accepted electrical construction, as described in applicable codes or as described in manufacturer's literature. Contractor shall provide all appurtenances normally associated with a particular equipment or device, and as required for a proper operating system. Some devices, equipment or materials may appear in only one location on the plans or in the specifications. Every item shown or described is to be included for this project. All required circuits and devices necessary for intended operation are to be included without additional cost to Owner. Where discrepancies occur between various plans or specifications for this project and where clarification is not requested by Contractor prior to bidding, the most stringent requirement shall be included in the Contractor's bid price.

E. Contractor shall review all specifications for all trade disciplines with electrical requirements prior to bidding and shall include most stringent and higher cost requirements in bid price. No elements or requirements of the plans or specifications shall be omitted in Contractor’s bid price unless specifically deleted in writing by Engineer. Failure to follow this specification requirement is at Contractor’s expense and at no additional cost to Owner.

F. Prior to bidding and during construction, Contractor shall coordinate with equipment vendors and suppliers and determine requirements for power, control and interconnection wiring and shall provide conduits and conductors accordingly for a complete operating system.

G. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor.

1.02 MAJOR SCOPE OF WORK ITEMS AS FOLLOWS

A. All work shown on plans and described in specifications including as follows:
   1. Installation of control panels.
   2. Installation of lighting and receptacles.
   3. Coordination with vendor supplied systems and providing connection of supply-side power to all vendor supplied panels as shown in drawings.
4. Installation of equipment disconnect.

5. Installation of new conductors from main distribution panel to Treatment Plant location, in conduit extended from field-selected intercept location.

6. Installation of all other miscellaneous electrical systems, as shown on plans.

1.03 PLANT CONTROL SYSTEM

A. The Contractor shall furnish and install a complete operating control system. The control system shall include but shall not be limited to all circuit breakers, motor starters, alternator, contactors, indicating lights, selector switches, surge protector, phase failure relays, programmable controllers, alarm light and horn, push buttons, control transformer, electronic devices, sensors, interlock wiring, control relays, blocks, snubbers, valves, nameplates, and all other associated items required to provide a working system. All control circuits to be “fail-safe” type. All motor starters to have ETM, HOA, time delay relay, and run light as a minimum. All motor controls to have phase fail relay contacts to protect from single phasing.

B. Provide circuit conductors, conduits, circuit breakers, and related devices for furnishing power to all motor heaters, instruments, devices, lights, controls, and all other motors and equipment indicated on plans or provided by Vendors or others for this project. Provide circuits and related devices per NEC, local, and state jurisdictions.

C. Control diagrams shown on plans are illustrative in nature and may require additional devices such as time delays, relays, and other devices required for the intended control functions.

D. All controls shall be fully tested in shop for proper and satisfactory operation, prior to installation at site. Contractor to provide written certification before delivery to site. Any installations without certification notice are done at risk by Contractor, who shall be obligated to make all necessary corrections in field at no additional cost to owner.

E. Where any equipment includes a Manufacturer furnished control panel, the Equipment Vendor or Manufacturer shall be responsible for coordination of all interconnecting wiring at related devices.

F. Provide interlock circuits between vendor furnished equipment and control panels. Coordinate with each vendor. Do not submit control panels until interlocks are coordinated. Where generator is present or proposed, provide interlock relay with bypass switch for each motor control circuit to limit or to inhibit loads when on generator power.

G. All multiple pump installations shall have means of alternating pumps and provisions for bypassing pumps not in service in primary and backup mode of operation.
H. All multi pump lift station controls to have separate elapse time meter to record flow time of all pumps simultaneously.

1.04 SUBMITTALS


1.05 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Refer to Specification 16001 – “Operation and Maintenance of Electrical Systems”

1.06 CONTRACTOR QUALIFICATIONS

A. Contractor, Subcontractors, and Controls Vendors shall be experienced with all types of electrical systems covered under this contract. No work shall be undertaken where Contractor’s firm, project supervisors and project electrical workers have not had recent experience in similar projects in area of project location. Contractor will be required to furnish proof of experience where requested by Owner or Engineer or their Representatives.

B. Contractor’s Project Manager or his Assistant shall be familiar with types of electrical construction required by this project in order to determine that all subcontractor and vendor’s work is in conformance with the plans and specifications.

C. Electrical Contractor shall have a State issued Electrical Contractors License, in which project is located; and all work shall be supervised by a Master Electrician holding a State issued Master Electrician License.

D. Contractor shall have an established safety-training program in effect for the duration of this project and will be required to submit proof of safety training for all employees working on this project.

1.07 CONTRACTOR’S RESPONSIBILITIES

A. Contractor shall review all sections of the plans and specifications for this project and shall note all electrical requirements for devices and equipment shown or implied and shall provide service accordingly for a complete operating control system. Any discrepancies in Electrical or Mechanical requirements noted in various plans and specifications shall be brought to the attention of the Engineer prior to ordering equipment or materials, or prior to starting construction related to the item in question. Coordination of all equipment and systems is Contractor’s sole responsibility. Failure to coordinate all equipment requirements shall be the responsibility of the Contractor, at no additional cost to Owner.

B. Contractor is specifically responsible for coordination of all electrical, mechanical, and process systems, devices and equipment provided or installed under this
contract and shall assure that all requirements by all trades are met such as to insure a complete and operating electrical, control, process or instrumentation system. Special attention shall be given to coordination of motors supplied, MCC components supplied, mechanical systems supplied, horsepower and voltage and phase requirements of each. Where motor horsepower varies from plans, Contractor shall adjust circuit and control devices accordingly. This includes verification of compatibility of all interfacing connectors and devices at new, existing, and Owner furnished equipment. Notify Engineer of any discrepancies before ordering equipment. Failure to do so may result in additional cost to Contractor.

C. Contractor shall assure that all systems have been properly installed, adjusted and tested prior to final inspection and shall notify Engineer at time that electrical installation is ready for final inspection and testing. Unless Engineer has been duly notified in writing that certain equipment are not ready for final testing and such is acceptable with Engineer, additional final inspections and testing will be at Contractor’s expense and at no additional cost to Owner.

D. Contractor shall fully inspect all motors and nameplates, controls, conduit, wiring devices and other items before starting work, ordering materials, or submitting shop drawings in order to verify existing conditions are as shown on plans and, shall immediately notify Engineer of any discrepancies between plans, specifications, and existing conditions. Failure to do so may result in Contractor’s responsibility for any required changes in construction. This includes verification of compatibility of all interfacing connectors and devices for new, existing, and Owner or Contractor furnished equipment. Notify Engineer of any discrepancies before ordering equipment.

Where available review “As-Built” drawings before bidding where existing conditions are unknown. Where available refer to “As-Built” drawings during construction of this project. Note that “As-Built” drawings may not be available in which case Contractor is required to determine wiring connections and device types as part of this contract. Where Manufacturer’s delivered motor size varies from design size shown on one-line diagram or, described in specifications, Contractor shall provide conductors, conduits, and all motor control devices sized for the delivered motor size at no additional cost to Owner. Where motor current transducers are required for use by Manufacturer control panels, Contractor to provide current transducers and conductors sized by Control Panel Manufacturer at no additional cost to Owner.

E. At completion of project and before final inspection, Contractor shall provide the Electrical Engineer with full size prints, redlined to reflect the “As-Built” electrical installation. Any variation from plans shall be shown on each applicable plan sheet. In addition, provide completed As-Built drawings in AutoCAD format for Engineer’s records. As-Built drawings are to be in accurate detail of finished work including dimensioning of all underground conduits enter under building slabs.

F. When work involving modifications or additions to existing plant will interrupt normal service, Contractor shall make provisions for continuous electrical service thru
Contractor furnished standby generator power. Where a standby generator exists but will be temporarily out of service during construction, Contractor shall provide substitute generator power for duration of outage. In no event shall plant be without operating power or, without standby generator service. Include all transfer switches, fuel tank, fuel, attendance and appurtenances required for a complete power system as needed for interim plant operation. Where work disrupts power and/or control to new or existing equipment, furnish temporary bypass circuits, as required, to maintain equipment operation.

G. Where power outage is required, it shall be coordinated with Owner and Engineer. An outage shall not exceed 4 hours. Contractor shall plan work and provide equipment as required to maintain electrical power to facilities.

H. Where work involves additions, modification, demolition, or renovations to existing facilities, Contractor shall remove, relocate, and extend existing installations to accommodate new construction. This includes relocation of conduits, equipment and materials that may obstruct placement of new equipment. Existing spare conduits and equipment may not be located at exact place shown on plans. Relocations and adjustments up to 40 feet are required as part of this contract. Where spare buried conduits are to be reused, conduits shall be cleaned out of all debris before use. It further includes extension or modification of existing circuits that are related to work covered under this project. Route all existing alarms to autodialer, alarm panel, and PLC where available. Include all conduit and wiring. Extend all existing power and control circuits as required for proper operation of electrical systems. Contractor shall field observe existing conditions prior to submitting a bid to become familiar with existing conditions and shall account for any relocations or extensions in bid. Refer to “As-Built” drawings and existing O&M Manuals. Failure to do so is at Contractors’ risk and at no additional cost to Owner.

I. Provide electrical circuits to all equipment as required by manufacturer. Verify location and characteristics of all equipment shown on plans and in specifications and size circuits accordingly. All conductors and conduits to comply with NEC Article 250 and Article 310. All terminations to vendor furnished control panels shall be done by Contractor, unless specifically noted otherwise on plans or in specific specification sections. All panel calibrations and adjustments shall be done by Vendors Representative. When preparing bid or when performing work, observe all plan sheets for vendor furnished equipment and provide all required interface wiring between various panels and/or equipment necessary for a complete operating system. Provide electrical circuits to all equipment, devices, controls, controllers, and other items shown on plans, or described in specifications. Provide circuit breaker, conductor, local disconnects, and connections to equipment in compliance with National Electrical Code. All circuits may not be shown on plans and must be verified and installed accordingly.

J. Equipment, instruments, controllers, VFD’s, conduits, and related appurtenances are shown in approximate locations. Contractor shall field select optimum location
and where necessary, relocate up to 40 feet from location shown on plans to accommodate installation, at no additional cost to Owner.

K. Where circuit problems such as irregular power conditions, breaker trips, relay trips, controls failure, etc. develop during construction, or prior to, or within the warranty period, Contractor shall furnish a multi-channel recording device with all appurtenances for a total period of 60 days per event and, shall include setup and data retrieval. Work shall be performed when requested by Engineer and shall be at no additional cost to Owner. These conditions also apply to electrical problems during construction where operations of the plant are affected.

L. Where any equipment performance does not conform to specifications or, where in Engineers opinion, parameters are out of tolerance or erratic in performance, the Contractor shall remove and replace equipment at no additional cost to Owner.

M. Location of outlets and equipment shown on Drawings is approximate. Field verify exact location. Minor modification in location of outlets and equipment is considered incidental up to distance of 40 feet with no additional compensation.

N. Where training is required by any specification sections, Contractor shall provide training manuals for Operators. Manuals shall be approved as substantial quality by Engineer. All training manuals must be pre-approved by Engineer. Instructors shall be pre-approved by Engineer as qualified for training. Provide a training manual for each Trainee attending class. Training manuals and approved O&M Manuals shall be used during training.

O. Provide fail and problem alarms for controls and Manufacturer’s equipment. Route circuits to autodialer. Provide circuits, relays, expansion modules, and programming. Route all existing alarms to autodialer where work involves modification or additions to existing equipment.

P. Contractor shall provide the equipment necessary for locating all underground pipes, conduits, and structures before digging. All locations of intersection shall be properly staked and identified. Locating all underground lines is the sole responsibility of the Contractor and shall be at no additional cost to Owner. Any damage to underground lines is the responsibility of the Contractor. Where obstructions are present in existing spare U.G. conduits to be used in this project, use video camera to determine cause of obstruction and contact Engineer for directions on how to proceed.

Q. Contractor shall coordinate all conduit stub-ups into control panels. Any mis-located conduits shall be relocated at Contractor’s expense.

R. Change orders submitted by Contractor shall include a full technical explanation of request and shall contain statement confirming that Contractor has reviewed all plans and specifications and that all work was coordinated with other trades.

S. All equipment, devices and other items shown or indicated on plans and described
in specifications are to be provided, furnished and installed by the Contractor unless, specifically and clearly marked or noted as “N.I.C.” (Not in Contract). Failure to include all items is at Contractor’s expense and at no additional cost to Owner.

T. Contractor shall be responsible for maintaining and adjusting all equipment for safe and damage free operation where equipment must be operated by Owner during construction. This especially pertains to existing equipment and controls that may be modified under this contract but are required to be operated by Owner. All valves, motors, and controls shall be properly locked out in a safe position to prevent inadvertent damage by Owner during the course of operating the plant. Contractor shall notify Owner in writing of any equipment that cannot be safely operated.

U. All requirements for instrumentation and control equipment shall be reviewed by Manufacturer’s Representative prior to shop drawing submittal and, Engineer shall be notified in writing when installation and application indicated on plans may not result in satisfactory and/or accurate operation of equipment specified. Failure to abide by this requirement is at Contractor’s risk and expense.

V. Motors:
1. Motor Voltage:
   a. All three phase motors to be wound for dual voltage 240/480 or 208/480. Single phase motors to be 120/240 or 120/208 volts. This includes all submersible motors except well motors.

2. Testing:
   a. Before connecting motor to power source, meg test each conductor and motor. Record results for Engineer’s review.
   b. After energizing motor, measure load current of each phase leg. Record measurements for Engineer’s review.
   c. Verify measurements are acceptable before energizing motor.

W. All conduits stubbed out for future use shall be routed clear of all paving, structures, sidewalks, or any other obstruction that may limit future access for connection to conduits. Stub out minimum 5 feet clear and cap end of conduit. Do not apply adhesive or cement to PVC caps at end of conduit. Install marker at end of conduit as show in plans.

X. All underground conduit routing on site plan shall be followed as close as practical. Do not route conduits diagonally across property unless clearly shown as such or, with Engineer’s written approval. Any conduits added or changed shall be indicated to Engineer on marked up drawing and submitted for approval. Any unauthorized changes shall be corrected at Contractor’s expense, regardless of time discovered by Engineer and, in which case existing concrete shall not be cut or damaged but,
shall be replaced in its entirety as shown on the plans as new construction. Do not route underground conduits in conflict with structures or obstructions. Allow in bid for relocation of underground conduits up to 40 feet to avoid obstructions shown on all other drawings issued under this contract. Coordinate prior to installation of conduits.

Y. Cabinet and Enclosures Heights: Cabinet, panel, and enclosure fasteners heights shall not exceed six (6) feet from floor or grade to top fastening devices to allow access by Operator without use of ladders or steps to open enclosure doors.

Z. Provide diagrams of all controls panels and MCC’s in clear plastic laminated pages. One (1) copy in ring binder for Operator and one (1) copy in pocket affixed to inside of cabinet door.

AA. Provide all required wire adapters for oversized feeder conductors at panels, switches, breakers, and other equipment.

BB. For outdoor conduit top entry to enclosures, provide CSBE seals at top of conduits to avoid water entry. This applies to service bus weatherhead entries and other applications.

CC. Methods of work and devices described in all electrical specification sections are intended to facilitate a properly constructed and operating electrical system that meets Owner’s operational requirements and satisfies the requirements of local and national codes. The Electrical Engineer may approve methods or devices that vary from the requirements described in any particular specification if, in the Engineer’s judgment, the installation meets the intent of the Engineer’s design and, where the electrical system performance meets the general requirements of the facility operation and, where the installation is deemed to present a safe installation that does not present a danger to persons operating or maintaining the electrical installation. This variance may be authorized during the submittal or inspection stage of the project, as the Engineer deems appropriate.

DD. All equipment, conduits, panels, and devices shall be installed in the most strict, professional manner to present a neat installation. Where a question arises concerning intent of method for installation or where details are not clear, Contractor is to contact Engineer for clarification before proceeding with work. Any work not suitable or not installed in a professional manner will be modified to an installation acceptable to Engineer and Owner at no additional cost.

EE. Provide arc flash warning tags on all electrical equipment where required by NFPA 70E. Submit arc flash analysis for Engineers review.

FF. All motors, motor control centers, and all other electrical equipment shall be stored in a climate-controlled area prior to installation. Space heaters in motors and equipment shall be energized while stored. After installation space heaters shall be energized at all times. Contractor is liable for any corrosive damage and any
defective equipment.

GG. Any equipment, devices, or software shown or indicated on Contract Documents as required for this project, and that may be overlooked by Owner or Engineer on submittals or at Final Acceptance inspection, shall still be provided by Contractor at no cost to Owner regardless of period of time that expires before Owner requests to be furnished and installed.

HH. Do not cut or break existing or new concrete foundations, pads, sidewalks or slabs without specific direction from Engineer. Submit detailed drawing of intended work. Concrete damage, breaking or cutting will result in entire concrete replacement at Contractor’s expense. This includes any materials replacement and excavation resulting from said damage or work.

II. Vendors for equipment with solid-state controller shall include provisions for both hardwired and data path status, command and alarm functions included under contract without additional cost to Owner, Programmer, or Engineer.

JJ. Conduits shall not be connected directly to vibrating equipment or motors. Flex connections shall be used.

1.08 WARRANTY

A. Contractor shall provide full 3-year service warranty on the overall installation and shall include all labor and materials required to repair or replace equipment and/or components that are defective or malfunctioning. Included under this warranty shall be all equipment, devices, hardware, and software. This warranty shall begin at date of written final acceptance of electrical systems and shall include both labor and materials at no additional cost to owner. There are no exceptions to this requirement. Contractors warranty shall guarantee 24-hour service response time and shall provide whatever labor, work, or materials needed to maintain plant operation when replacement parts are on order. In no case shall plant electrical systems be out of service for over 24 hours from time Owner calls for warranty service. This shall be at no additional cost to Owner. All materials and equipment installed shall have full warranty from manufacturer that guarantees equipment is rated for the harsh Industrial Electrical/Mechanical environment in which it is installed. Where manufacturer’s products fail prematurely, manufacturer shall be fully responsible for new replacement and shall not have option of declaring that failures were caused by environment and its effect on the product. Contractor is fully responsible for assuring that product manufacturers are aware of this condition and that warranty statement is included in shop drawings. Failure to do so will be at full expense of Contractor and at no additional cost to Owner. Where warranty requirements are shown in other sections, the more stringent requirement shall have precedence.

B. All critical warranted repairs shall be made within 24 hours of receipt of required parts from Manufacturer with reasonable delivery time of overnight shipping. Any
repairs not completed within five (5) working days from date of notice are subject to Owner making other arrangements for repair and backcharging Contractor.

C. Where equipment or instrument problems remain unresolved by Contractor beyond a reasonable time, a Factory Technician shall be provided on-site to take any corrective actions necessary to put equipment or instruments in operating order. Owner and Engineer reserve the right to determine a reasonable time for corrective action by Contractor.

PART 2 PRODUCTS

2.01 MATERIALS

A. All materials provided under all sections of the specifications shall be new and the standard products of manufacturers regularly engaged in the production of such equipment. Motor control centers, control panels, controller panels, pump panels, blower panels, and all similar equipment shall be manufactured by a firm located within 200 miles of the project facility or, firm shall have an established full time Service Representative’s office located within 200 miles of project facility. This is to assure local service for Owner when needed on a 24-hour basis. Any items furnished that do not meet this requirement will be replaced at expense of Contractor.

All materials shall conform to the National Electrical Code and shall be approved by Engineer and listed by the Underwriters’ Laboratories. Materials described by manufacturer’s name and catalog number are selected to set a definite standard of design and quality to be required. There is not any intention to discriminate against a product of another manufacturer, which is equally durable in construction, similar in design, and will serve the purpose for which it is intended. All equipment, hardware, materials, motors, towers, masts, brackets, or accessories shall be installed in strict accordance with Manufacturer’s instructions.

Contractor shall contact Manufacturer’s designated local Representative for confirmation of exact model, options, configuration and services that are to be included in bid cost. Manufacturer’s Representative shall make all critical adjustments to electronic modules and controls. Where plans, details, or specifications indicate instructions that are contrary to Manufacturer’s instructions, consult with Engineer before ordering or installing. Failure to follow the requirements of this paragraph is at Contractor’s expense and at no additional cost to Owner. Within 30 days after award of the contract and before any materials and equipment are placed on order, the Contractor shall submit shop drawings to the Engineer for approval.

B. Materials and equipment specifications are general in coverage and may contain reference to construction items that apply in only particular situations and may not apply as a general rule for materials installed on this project. Provide all required accessories required by Equipment or Materials Manufacturer for proper installation.
Failure to do so is at Contractor's expense. Store all electrical equipment on job site in humidity-controlled spaces. Provide means of heating to avoid moisture build-up, and provide moisture sealed protective covering. Any equipment not properly stored may be rejected at Engineer's discretion.

C. All equipment and devices shall be installed according to manufacturer's instructions. Coordinate installation with manufacturer's representative to assure correct installation methods have been applied. Prior to submittal review, Manufacturer's Representative shall review plans and specifications and shall notify Engineer in writing where application shown on plans will not provide satisfactory and/or accurate performance. Failure to abide by this requirement shall be at Contractor's risk and cost. All equipment and materials shall be rated for the harsh Industrial, Electrical, and Mechanical environment in which installed and shall be warranted by manufacturer accordingly. This includes all enclosures located in water and wastewater facilities, including all outdoor control panels, breaker panels, switches, junction boxes, and similar electrical equipment at other facilities which shall be NEMA 4X 316 stainless steel without exception. This requirement is paramount to all other drawings or specification requirements unless specifically noted or, unless approved otherwise by Engineer in writing.

D. Outdoor equipment shall not have exposed devices or controls, unless specifically called for on plans. The outer door shall cover all such items. No see thru windows are allowed unless specifically approved. All outer doors to have locking hasp and door restraint to hold door open at 90°position. Keyed handles for indoor panels are only acceptable where specifically approved. All NEMA 4X equipment enclosure doors to have three (3) point latching handle and locking hasp. NEMA 4X splice box enclosures shall have quick release latches. Plexiglas inner or outer doors are not acceptable.

E. All PLC’s, controllers, instruments and electronic equipment installed outdoors or in unconditioned spaces shall have means of cooling to allow satisfactory operation in local environment and at conditions required by equipment manufacturer’s specification. All motor starters over 100 horsepower shall have forced fan cooling in the starter section. All outdoor enclosures are to have sufficient forced fan cooling. Provide rain hood, intake louvers, insect screens, and fan motor circuits with t-stat and on/off controls.

F. All control panels and motor control centers that are not standard manufacture, off the shelf products shall be manufactured in accordance with Plans and Specifications with high quality materials and components, bear a UL listed label, and be constructed by a UL listed shop. Manufacturer shall have local manufacturing and/or repair facility within 200 miles and have a local Service Technician that can provide prompt service when required by Owner.

Equipment Manufacturers who fabricate their own panels may provide control panels for this project. However, no outsourced panels are allowed except for Control Panel Manufacturers listed below. Service Technicians shall have detailed
knowledge of control panels specific to this project.

The following Manufacturers are acceptable:

1. Texas Industrial Controls Manufacturing
2. Weimar Manufacturing Co.
3. B.L. Technology, Inc.
4. W.W. Payton
5. Ace Controls, LLC
7. Control Panel Manufacturers listed in other Specification Sections.
8. Pre-approved in writing 10 days before bid date.

G. Substitution items may be acceptable where deemed by Engineer to be of equal type, service, value, or suitable for a particular application. The Engineer reserves the right of decision on all substitutions unless specifications state, “no substitutions allowed”.

H. Equipment ratings shown on plans are the “minimum” acceptable sizes. All Equipment Manufacturer’s products may not be available in the exact rating shown, in which case next greater available size shall be provided.

I. All control panels and MCC’s shall have single piece door with door-mounted devices mounted directly to door. Plexiglass plates are not acceptable. Auxiliary mounting plates shall not be used to mount devices to door. All panels must be fabricated in a neat and professional manner. Metalwork shall be performed with proper commercially available tools, with no hacksaw or nibbler cuts allowed.

J. All transmitter displays to be in actual unit values and not percent scale.

K. Door-mounted, rotating operating mechanisms for circuit breakers are not allowed for control panels.

L. All components inside enclosures shall be fastened down with proper hardware. All cables shall be bundled and bound with waxed cord or nylon tie-wraps manufactured for that purpose. Adhesive tie down blocks are not allowed. Provide threaded press-in or welded studs for nylon cable clamps as required. All work shall be done in a neat and professional manner.

M. All control panels, SCADA panels, and MCC’s shall have 120 VAC GFI duplex receptacles with low voltage circuit inside controls section for test equipment use. Control section shall have interior lighting.
N. For combination starter units provide interlocks so disconnect means must be in “Off” position before door can be opened and so door cannot be closed with disconnect means in “On” position, except by consciously operating permissive release device. Rotating type operators located outside of door are not acceptable.

O. All gauges, instruments, transmitters, and meters to read 75% of scale at system maximum rated parameters such as voltage, amp, pressure, level, and flow.

P. All controls circuits for PLC’s, solid-state starters, power monitors, and all such products wired into a panel assembled by a panel fabricating shop or system integration shop shall be reviewed and approved by the Product Manufacturer’s Representative. Contractor and Supplier shall allow for any additional cost associated with this review and approval process and shall certify such approval has been issued at time shop drawings are submitted.

Q. Submersible pump power cables shall be a single cable assembly. Multiple cables with parallel conductors less than size 1/0 are not acceptable unless approved in writing by Engineer. Where multiple power and/or control cables are approved for use, Contractor shall provide all required conduit, conductors and junction boxes at no additional cost to Owner.

R. CT’s for power monitor device, controller input, or other instrument inputs shall be sized to detect peak inrush motor current.

S. All panels, equipment enclosures, and motor control centers are to have 120-volt space heater and t-stat.

T. All solid-state controllers shall have 24 hour UPS to power PLC, I/O modules, and output relays.

U. All electrical devices attached to or, normally a standard part of an equipment item shall be provided by that Equipment Manufacturer. For example, limit switches, solenoids, and transducers for flow control valves are to be provided by the Flow Control Valve Manufacturer. This is to be coordinated by the General Contractor and the Electrical Subcontractor.

V. All underground manholes and pull boxes to have cable racks and grounding. Cables and conductors are to be neatly dressed on racks around perimeter walls and properly secured to racks and tagged. Provide ample slack in cables and conductors. No splicing will be allowed where there is not enough slack to route cables and conductors around perimeter and, new ones will be installed at no additional cost to Owner.

W. All equipment installed on this project shall incorporate all devices and features to protect that equipment from the influence of other equipment, line voltage and phase irregularities, harmonics and other disturbances that may affect the proper and safe operation of that equipment whether these required features are a standard component of that equipment as an off-the-line product. No equipment shall be
installed without these features.

X. All submersible pump over-temperature and seal leak modules shall have latching circuit with reset and alarm indicator light built-in or provided as external circuitry.

Y. All equipment installed shall include all DC power supplies operated from a 120-volt circuit. No equipment shall be battery powered only unless required by the specifications. Include all cabling and other components necessary for a complete operating system. Where firmware, software, or programming is required for operation satisfactory to Engineer, it shall be included accordingly.

Z. All equipment and devices shall be NEMA rated. IEC rated equipment and devices are not acceptable.

AA. Provide NEMA 4X stainless steel enclosures in all outdoor locations.

BB. All electrical work shall be performed in a neat and orderly manner. Any work that does not appear as professional workmanship shall be corrected or replaced, at Engineers discretion.

CC. All slabs around electrical equipment shall be constructed and sloped to avoid any standing water.

DD. Where equipment model numbers are shown on plans or specifications, provide most current model or version.

EE. All display screens or readouts shall be mounted in MCC or panel with top of screen at height of 60 inches above level where Operator stands. This must be accounted for where panels or MCC sections are installed on concrete pads or other elevated structures.

FF. Measure spaces for enclosures and equipment and verify fit before submitting, ordering, or construction installation.

GG. For rehab or expansion work on controls, provide additional new Panduit wireways. Do not overfill Panduit on new or rehab projects.

HH. Install GFI receptacles for all devices shown in wet areas, pump rooms and all outdoor locations. Provide W.P. in-use covers.

II. All service and feeder breakers to have removable adjustable trip plug or be electronic type with adjustable trips.

JJ. All service and feeder conductors to be XHHW-2.

### 2.02 PLANS AND SPECIFICATIONS

A. Electrical plans and specifications are not intended to discriminate against any
particular manufacturer. Specific values shown for a particular manufacturer’s product may vary slightly for another product. Work required under this contract consists of each and every item, equipment, material and device shown on any of the Civil, Structural, Mechanical, Process, Electrical or other plan sheets contained in the contract documents and includes items shown in details, schedules, diagrams, sections or other means of illustration presented. If any item is shown on a single sheet at any place, it is to be included under this contract unless specifically noted otherwise and, all piping, wiring, and connections for operation of the item shall be included at no additional cost to Owner. If there is any doubt or question, Contractor shall request a “clarification” from Engineer before bidding. The Electrical Engineer reserves the right to interpret the electrical specifications and to make judgment as to acceptance of a product, regardless of minute details in the specifications or on the plans.

B. Specifications shall be reviewed for applicability of materials under certain conditions and in certain environments and, where not shown otherwise on plan drawings, these application directions shall be adhered to.

C. Where a particular reference on drawing plans does not conform to standard acceptable construction methods for a particular type project, the Contractor shall immediately notify the Engineer and request a clarification before ordering materials or starting construction.

D. Plans are general in nature and may not show minute details of existing conditions or proposed work. Existing conditions may include undocumented buried pipes, conduits and structures that lie in the route, or at location, of equipment or conduit installation required for this project. These uncertainties shall be accounted for in the Contractors Bid. Contractor shall adjust conduit routes, equipment pads, and equipment mountings, as required, for a satisfactory installation for the conditions imposed and at no additional cost to the Owner.

E. Electrical site plan drawings shall only be scaled when “Scalable Drawing” appears on the drawing sheets.

F. All electrical equipment, controls, and devices used in this project shall have self-protection features that prevent damage of that equipment from overload, overvoltage, and undervoltage conditions. Any failures caused by lack of this provision shall be at full cost to Contractor and at no additional cost to Owner. Where Engineer determines this to be the case and where Contractor disagrees, Contractor shall provide full evidence of failure cause at their own expense.

G. All overcurrent protection devices for controls shall be circuit breakers. No fuses of any size are allowed, except for fast action or very high fault current ratings where shown on plans.

PART 3 EXECUTION
3.01 WORKMANSHIP

A. All wiring shall be installed in accordance with current NEC and local codes. Field select routing of conduits to avoid underground piping, conduit or structures that may not be shown on plans.

B. All construction and equipment fabrication shall be of highest quality and installed in a professional manner. All devices shall be manufactured specifically for the purpose installed and shall be installed according to Manufacturer’s recommendations.

C. Adjust route of electrical conduits and ductbanks below proposed or existing buried piping. Provide minimum 24-inch clearance vertically and horizontally. This work shall be performed in a satisfactory manner and at no additional cost to Owner.

D. A fish wire shall be left in all conduits in which the permanent wiring is not installed.

E. All fixtures, switch, and receptacle locations shall be approved by Engineer.

F. Refer to other sections of this specification for controls. Under this section of the specifications, the Contractor shall install the control devices and provide control wiring switches, outlet boxes, and shall make all final connections. Control wiring and interlocks shall conform to wiring diagrams furnished by equipment manufacturers.

G. Seal all conduits entering motor control centers, control panels, and equipment enclosures with non-hardening silicon sealant (GE RTV.). Seal all conduits leaving chemical equipment rooms in chemical storage areas with EYS. Sealing glands shall be selected specifically for each conduit and conductor.

H. Where conduits are stubbed out from building for future use, extend conduits 5 feet past building wall or past edge of pavement, whichever is applicable. Do not leave under pavement. Cap ends of conduits.

I. Provide strain relief device at cable connection to submersible transducer. Relief device to have threaded connection to transducer.

J. Where electrical equipment submitted does not fit location shown on plans, Contractor shall adjust locations of other equipment as required for total installation to fit available space. Otherwise, submit only equipment that is specifically fabricated to fit space shown on plans.

K. All devices, fittings, connectors, supports, brackets, and miscellaneous hardware normally used for installation of electrical equipment may not be shown in detail. Contractor shall provide all these items and included them in bid price.

L. Coordinate location of motor terminal box to match location of conduit stub up, drop or connection on same side of motor.
M. Provide 48 inches minimum workspace in front of electrical equipment.

N. Provide a minimum of 8 inches between all wall or rack mounted enclosure boxes, switches, or equipment. Do not extend past edge of building wall and maintain 6 inches from edge of wall.

O. Paint all conduits mounted on walls or ceilings to match wall or ceiling color. Coordinate with Engineer for exceptions before painting.

P. Do not use nylon or plastic tie wraps or straps for attaching or supporting seal-tight or cables to conduits or structures. Use aluminum straps made for that purpose.

3.02 EXCAVATION AND BACKFILL

A. All underground conduits shall be buried to a minimum depth of 24-inches below finished grade. All trenches shall be uniform width and shall be backfilled and compacted to 95 percent that of original density. Any damage to underground conduits caused by other Contractor’s shall be repaired by this Contractor and shall be compensated accordingly by the party or parties responsible for the damage. Concrete shall be poured evenly on all sides of ductbanks. Do not over pour and do not dump spoils on site.

B. Do not cut paved driveways, sidewalks, etc., unless otherwise noted by Engineer. Bore under such construction, maintaining a minimum of 24 inches below the underside of the pavement or concrete.

3.03 AS-BUILT DRAWINGS

A. Contractor shall maintain complete set of original legibly marked up drawings showing all deviations from contract drawings. In addition, after mark-ups have been approved, provide one (1) set of AutoCAD as-built drawings on CD for Engineer’s records. This shall include conduit routing and sizes, wire sizes, detail changes, diagram changes, etc. As built drawings are to be maintained on site during construction and changes shall be marked as work progresses. Markup shall be in red pencil on black line or blue line plan sheets.

Plans shall be available for Engineer and/or Owner’s review during the course of construction. When work is complete, transfer all changes and data from field drawings to mylar drawings in latest release AutoCAD format. Contact Engineer for base AutoCAD files. Follow layering and other format already being used for base files. Include requirements of the following paragraph on an additional drawing sheet.

As-built drawings shall contain a conduit/conductor schedule that lists all point-to-point wiring that shows origination, destination, conductor quantity and size, and each wire tag number. This list shall include all wiring not specifically shown in O&M manuals, or any Vendor supplied drawings. The intent is to make certain each and every conductor is identified. Coordinate identification of originating terminals and
destination terminals shown in O&M manuals and other drawings to assure accuracy. As-built drawings will be required for use during final inspection and testing in order to verify accuracy and completeness. Provide for Engineer’s review at least 1 week prior to final inspection.

3.04 ELECTRICAL SYSTEM ACCEPTANCE

A. System acceptance upon Substantial Completion shall be defined as that point in time when the following requirements have been fulfilled:

1. When as-built drawings and wiring diagrams have been submitted, reviewed, and approved in writing by Engineer. As-built drawings shall be submitted prior to final inspection.

2. All O&M documentation has been submitted, reviewed, and approved.

3. The complete electrical system has been fully inspected and has successfully been started up, tested and accepted by the Engineer.
   a. Complete electrical system shall be demonstrated to be fully functional. Every alarm and status function shall be exercised and demonstrated.
   b. Complete electrical system shall run continuously for a period of 30 consecutive days without failure. In event of failure, repairs shall be made, and test period started over again.
   c. There is no “Substantial Completion” for electrical systems that cannot demonstrate satisfactory performance of its intended function.

4. All Owners’ staff personnel training programs have been completed.

5. Owner/Engineer sign a document indicating electrical installation has formally been accepted.

6. Warranty certificates for electrical equipment have been properly submitted.

7. All spare parts have been delivered to Owner.

8. All punch list items have been corrected, acknowledged by Contractor in writing and accepted by Engineer.

3.05 TESTING / SYSTEM STARTUP

A. All elements of each electrical control system shall be set up, calibrated, and tested by Manufacturer’s Technician to demonstrate that the total system satisfies all of the requirements of this Specification. All special testing of materials and equipment shall be provided by the Contractor. The Contractor shall coordinate and schedule all of his testing and startup work with the Owner and Systems Integration Engineer. As a minimum, the testing shall include both a factory test and a field test. Testing
requirements are as follows:

1. Factory Tests: The electrical controls and all other associated hardware shall be tested via a full simulation at the factory, prior to shipment, to demonstrate that each component is operational and meets the requirements of these specifications. Manufacturer shall provide test routine program for shop testing of I/O wiring. Where solid-state controller programs are furnished by a specified Systems Integration Programmer, a copy of the program will be provided on CD for Manufacturer’s use in factory testing. Test results shall be certified, with written documentation provided to the Engineer upon test completion. Factory testing may be witnessed by the Engineer and/or Programmer.

2. Field Tests: All electrical control system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Contractor shall provide a checklist for all electrical, control, and instrumentation functions and send to Engineer for approval. Each function shall be demonstrated to the satisfaction of the Owner and Engineer on a paragraph-by-paragraph basis. Each test shall be witnessed and signed off by the Contractor and the Engineer upon satisfactory completion. The Manufacturer’s Representative shall be present for all testing, setup, demonstrations, and training. The Contractor shall notify the Owner at least two (2) weeks prior to the commencement date of the field tests. After tests are completed and with system fully operational, system shall run continuously for a period of 30 days without failure. Any failures shall be repaired and test shall start over again.

3. A state licensed Electrician shall be present at all scheduled inspections.

3.06 CLEANING

A. The Contractor shall upon completion of the work, remove all materials, empty containers, and any other materials that are not incorporated into the work.

B. Concrete spoils shall not be dumped on site without approval by Engineer or Owner.

3.07 MAINTENANCE

A. Provide the following spare parts for all equipment provided on this project.

1. Maintenance Stock, Fuses: For types, voltage, and ampere ratings required furnish 10% spare fuses, but not less than one (1) set of three (3) of each kind.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT
A. ELECTRICAL WORK shall be measured per Lump Sum for all work indicated on the drawings and the measurement shall include all equipment, labor and materials required to provide a complete and serviceable electrical installation.

4.02 PAYMENT

A. The work performed and the materials furnished as prescribed by this item and measured as provided under “MEASUREMENT” shall be paid for at the contract unit price bid as presented in the bid form. The unit price bid item shall be full compensation for furnishing and placing all materials, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work in accordance with the drawings and specifications.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section includes:

1. Solid grounding of electrical systems and equipment.
2. Basic requirements for grounding for protection of life, equipment, circuits, and systems.
3. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.01 REFERENCES

A. American Society for Testing Manufacturing (ASTM)

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

C. Underwriters Laboratories (UL)
   1. UL 467 - Standard for Safety Grounding and Bonding Equipment.

D. National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electric Code (NEC)
2. NFPA 780 – Standard for the Installation of Lightning Protection Systems

1.02 SUBMITTAL

A. Product Data

1. Submit all products covered under this specification for Engineer’s approval. Any items not submitted are the total responsibility of the Contractor.

B. Shop Drawings

1. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.

C. Test and Evaluation Results

1. Report of field tests and observations certified by Contractor.

1.03 QUALITY ASSURANCE

A. Certifications

1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

B. Regulatory Requirements

1. Items provided under this section shall be listed OR labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

   a. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.

   b. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING PRODUCTS

A. Products: Of types indicated and of sizes and ratings to comply with current NEC. Where types, sizes, ratings, and quantities indicated are in excess of current NEC requirements, more stringent requirements and greater size, rating, and quantity indications govern.

B. Conductor Materials: Copper.

2.02 WIRE AND CABLE CONDUCTORS

A. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.
B. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

C. Bonding strap conductors/connectors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper, except as indicated. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

D. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

E. Equipment Grounding Conductor: Green insulated.

F. Grounding Electrode Conductor: Stranded cable.

G. Bare Copper Conductors:
   3. Tin-Coated Conductors: ASTM B33.

2.03 GROUND RODS

A. Copper clad steel with high strength steel core and electrolytic grade copper outer sheath, molten welded to core.
   1. Size: 3/4 inch by 10 feet unless otherwise indicated.

B. Plate Electrodes: Copper plates, minimum 0.10 in. thick, size as indicated.

2.04 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 0.25 inch thick x 2.00 inch wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

2.05 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with S.S. bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.06 GROUNDING BUS BAR

A. Pre-drilled 1/4” x 4” rectangular copper bar with stand-off insulators. Provide insulators and mounting brackets.
2.07 CONNECTOR PRODUCTS

A. General: Listed and labeled as grounding connectors for materials used.
B. Pressure Connectors: High conductivity plated units.
C. Bolted Clamps: Heavy duty units listed for application.
D. Exothermic Welded Connections: Provide in kit form and select for specific types, sizes, and combinations of conductors and other items to be connected.

PART 3 EXECUTION

3.01 APPLICATION

A. Equipment Grounding Conductor Application:
   1. Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
      a. Install separate insulated equipment grounding conductors with circuit conductors.
         (i) Raceway may be used as equipment ground conductor where feasible in non-hazardous areas and permitted by current NEC for lighting circuits and receptacle circuits.
         (ii) Install insulated equipment ground conductor in nonmetallic raceways unless designated for telephone or data cables.

B. Underground Conductors:
   1. Bare, tin-coated, stranded copper except as otherwise indicated.

C. Signal and Communications:
   1. For telephone, alarm, instrumentation and communication systems, provide #4 AWG minimum green insulated copper conductor in raceway from grounding electrode system to each terminal cabinet or central equipment location.

D. Ground separately derived systems required by NEC to be grounded in accordance with NEC Paragraph 250.

E. Metal Poles Supporting Outdoor Lighting Fixtures:
   1. Ground pole to grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.

F. Connections to Lightning Protection System:
   1. Bond grounding conductors or grounding conductor conduits to lightning
G. Common Ground Bonding With Lightning Protection System:

1. Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode, using exothermic welded connection.

2. Use bonding conductor sized same as system ground conductor and installed in conduit.

H. At all water, wastewater and industrial facilities, install UFER grounding at all equipment structures and buildings unless specifically deleted.

I. Bond all metallic fences, gates, posts, steel structural columns, and other exposed steel structures.

J. Install ground rod at all outdoor control panel, service rack, equipment racks, radio tower, steel canopy structures, and other steel structures where electrical equipment is installed.

3.02 INSTALLATION

A. General: Ground electrical systems and equipment in accordance with current NEC requirements except where Drawings or Specifications exceed NEC requirements.

B. Ground Rods:

1. Locate minimum of one rod length from each other and at least same distance from any other grounding electrode.

2. Interconnect ground rods with bare conductors buried at least 24 in. below grade.

3. Connect bare cable ground conductors to ground rods by means of exothermic welds.

4. Make connections without damaging copper coating or exposing steel.

5. Use 3/4 inch by 10 ft. ground rods except as otherwise indicated.

6. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.

C. Braided Type Bonding Jumpers:

1. Use elsewhere for flexible bonding and grounding connections.

D. Route grounding conductors along shortest and straightest paths possible without protection down conductors or grounding conductors in compliance with NFPA 780.
obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

1. Test Wells:
   a. Locate as indicated and fabricate in accordance with details indicated.

E. UFER Ground:

1. Fabricate with 20 feet of bare 2/0 (minimum) copper conductor laid lengthwise in excavation for foundation or footings.
2. Install so conductor is within 2 in. of bottom of concrete.
3. Where base of foundation is less than 20 feet in length, coil excess conductor at base of foundation.
4. Bond conductor to reinforcing steel at four locations, minimum. Bond to all electrical equipment.
5. Extend conductor below grade and connect to building grounding grid or grounding electrode.
6. Extend to all steel support columns for buildings, equipment structures or roof columns.
7. Alternate UFER Grounding: Install 2/0 (minimum) bare copper conductor in 24” deep trench around perimeter of structures, buildings, slabs, and foundations where electrical or mechanical equipment is located. Install 4 ft. from edge of structure. Bond to all steel structure and equipment and to grounding system, using exothermic welded connections.
8. Do not install ground grid conductors in or under existing concrete adjacent to generators electrical equipment without written approval from Engineer.

3.03 CONNECTIONS

A. General: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot tin coated materials to assure high conductivity and make contact points closer in order of galvanic series.
2. Make connections with clean bare metal at points of contact.
3. Aluminum to steel connections: stainless steel separators and mechanical clamps.
4. Aluminum to galvanized steel connections: tin plated copper jumpers and
mechanical clamps.

5. Coat and seal connections involving dissimilar metals with inert material such as red paint to prevent future penetration of moisture to contact surfaces.

B. Exothermic Welded Connections:

1. Use for connections to structural steel, water tanks, equipment, generators and enclosures, and for underground connections except those at test wells.

2. Install at connections to ground rods and plate electrodes.

3. Comply with manufacturer's written recommendations. Use CAD-Weld or approved equal.

4. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Terminations:

1. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure type grounding lugs.

2. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to housing, terminate each conduit with grounding bushing.

3. Connect grounding bushings with bare grounding conductor to ground bus in housing.

4. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A-486B.

E. Connections at Test Wells:

1. Use compression type connectors on conductors and make bolted and clamped type connections between conductors and ground rods.

F. Compression Type Connections:

1. Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of
connectors. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on ground conductor.

G. Moisture Protection:

1. Where insulated ground conductors are connected to ground rods or ground buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 OVERHEAD LINE GROUNDING

A. General:


B. Ground Rod Connections:

1. Use exothermic welds for underground connections and connections to rods.

C. Lightning Arresters:

1. Separate arrester grounds from other ground conductors.

D. Secondary Neutral and Tank of Transformer:

1. Interconnect and connect to ground.

E. Grounding Conductor Protection:

1. Protect grounding conductors running on surface of wood poles with molding of a type manufactured for this purpose. Extend from grade level up to and through communications and transformer spaces.

3.05 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes:

1. Install 3/4 inch by 10 ft. driven ground rod close to wall and set rod depth such that 4 inches will extend above finished floor.

2. Where necessary, install ground rod before manhole is placed and provide No. 1/0 bare tin-coated copper conductor from ground rod into manhole through waterproof sleeve in manhole wall.

3. Protect ground rods passing through concrete floor with double wrapping of pressure sensitive tape or heat shrunk insulating sleeve from 2 in. above to 6 in. below concrete.
4. Seal floor opening with waterproof non-shrink grout.

B. Connections at Manholes:

1. Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole to ground rod or ground conductor.

2. Make connections with minimum No. 4 AWG stranded hard drawn copper wire.

3. Train conductors plumb or level around corners and fasten to manhole walls.

4. Connect to cable armor and cable shields by means of tinned terminals soldered to armor or shield, or as recommended by manufacturer of splicing and termination kits.

C. Grounding System:

1. Ground noncurrent carrying metallic items associated with manholes, substations, and pad mounted equipment by connecting them to bare underground cable and grounding electrodes arranged as indicated.

3.06 FIELD QUALITY CONTROL / TESTING

A. Test:

1. Subject completed grounding system to megger test at each location where maximum ground resistance level is specified, at service disconnect enclosure ground terminal, and at ground test wells.

2. Measure ground resistance without soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

3. Perform tests by 3-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."

B. Ground/resistance maximum values shall be as follows:

1. Equipment rated 500 kVA and less: 10 Ohms.

2. Equipment rated 500 kVA to 1000 kVA: 5 Ohms.

3. Equipment rated over 1000 kVA: 3 Ohms.

4. Unfenced substations and pad mounted equipment: 5 Ohms.

5. Manhole grounds: 10 Ohms.
C. Deficiencies:

1. Where ground resistances exceed specified values, notify Engineer, and if directed by Engineer, modify grounding system to reduce resistance values. Where measures are directed that exceed those indicated, provisions of Contract covering changes will apply.

D. Report:

1. Prepare test reports, certified by testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.07 RESTORATION

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated.

B. Where sod has been removed, replace it as soon as possible after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition.

D. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

E. Restore disturbed paving as indicated.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section includes

1. Conduit and equipment supports
2. Anchors and fasteners
3. Strut
4. Fittings
5. Hangers
6. Hanger rod
7. Brackets
8. Cable ties
9. Spring vibration isolators
10. Concrete Equipment Pads

1.01 REFERENCES

A. American Society for Testing Manufacturing (ASTM)


B. Federal Specification (FF)

1. Federal Specification W-C-528A – Conduit, Raceway, Metal, and Fittings; Surface.
1.02 SUBMITTALS

A. Product Data
   1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

B. Shop Drawings
   1. Shop drawings indicating details of fabricated products and materials.
   2. Submittals in this section shall be sealed by a licensed Structural Engineer in the State

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications
   1. Electrical components shall be listed and labeled by UL, ETL, or CSA.
   2. Company specializing in manufacturing Products specified in this section with minimum three years’ experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
   3. Accept products on site in factory containers and verify damage.
   4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the Work, include, but are not limited to, the following:
   1. Slotted Metal Angle and U Channel Systems:
      a. Eaton, B-Line
      b. Unistrut Corporation
      c. Thomas & Betts Corporation
d. Or approved equal

2. Brackets, Hangers, and Cable Ties:
   a. Caddy, Erico International Corporation
   b. Eaton, B-Line
   c. Thomas & Betts Corporation.
   d. Unistrut Corporation
   e. Hubbell
   f. Or approved equal

3. Vibration Isolators:
   a. Kinetics Noise Control, Inc.
   b. Isotech, Inc.
   c. Mason Industries
   d. Eaton, B-Line
   e. Or approved equal

2.02 COATINGS

A. Coating: Strut, fittings, hangers, and hanger rod shall be ASTM A123 hot dip galvanized after fabrication. Hardware fasteners and clamps shall have ASTM B633 Type III SCI electroplated zinc coatings.

2.03 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports:

1. Clevis hangers, riser clamps, conduit straps, threaded C clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps. Purlin hangers shall mount to the vertical member of the purlin or as otherwise required by building manufacturer and/or structural engineer.

B. Fasteners:

1. Types, materials, and construction features as follows:
   a. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using beam clamps.
   b. Use steel springhead type toggle bolts or hollow wall fasteners in hollow
masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

c. Fasteners for Damp or Wet Locations:
   (i) Stainless steel screws and hardware.

d. Do not use powder-actuated anchors.

e. Do not drill structural steel members.

C. Cable Ties:

   1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for color-coding.

D. Cable Supports for Vertical Conduit:

   1. Factory fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable iron casting with hot dip-galvanized finish.

E. U Channel Systems (Strut):

   1. 12 gage steel 1-5/8 inch x 1-5/8 inch minimum channels, with 9/16 inch x 1-1/8 inch maximum short slots at 2 inch on center maximum. Strut shall be cold formed per ASTM A570 GR33. Joints in strut system shall be made with four bolt accessories as a minimum. Conduit clamps to strut shall be bolt using Unistrut 1100, 1200, or 1400 Series, or approved substitution.

   2. Provide approved cap on end of all exposed strut pieces. Assure tight fit.

F. Recessed Box Supports Brackets:

   1. Mount boxes with Erico/Caddy SGB Series, FBS Series, Hubbell or approved substitution.
1. Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
   a. 3 inches and smaller: 20 gauge.
   b. 4 inches to 6 inch: 16 gauge.
   c. Over 6 inches: 14 gauge.

2. Steel Pipe:
   a. Fabricate from Schedule 40 galvanized steel pipe.

D. All Thread Rod:
   1. Hot dip galvanized 1/4 of an inch minimum.

2.05 VIBRATION ISOLATORS

A. Hangers:
   1. Spring steel hangers shall be Amber/Booth BS Series or approved substitution.

B. Pads:
   1. Provide ribbed neoprene pads Amber/Booth Type NR or approved substitution.

PART 3 EXECUTION

3.01 GENERAL

A. Install supporting devices to fasten electric components securely and permanently in accordance with NEC, NECA, and manufacturers requirements.

B. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw type nails on wood, toggle bolts on hollow masonry units, concrete inserts, or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal
screws.

2. Holes cut to a depth of more than 1 1/2 inches in reinforced concrete beams, or to a depth of more than 3/4 of an inch in concrete, shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-resistant and shock-resistant fasteners for attachments to concrete slabs.

C. Exclusions:

1. Do not fasten supports to ceiling system, pipes, ducts, mechanical equipment, and conduit.

2. Tie wires and perforated pipe straps shall not be used for securing conduits.

3. Do not support loads from the bottom chord member of trusses or open web steel joists.

4. Do not attach conduit to ceiling support wires or ceiling tees.

5. Do not use powder-actuated anchors unless indicated by Architect or Structural Engineer.

6. Do not drill or cut structural members unless directed by Architect or Structural Engineer.

D. Touch up all scratches or cuts on steel components with an approved zinc chromate or 90 percent zinc paint. Use PVC compounds on PVC coated components.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install damming materials to arrest liquid material leakage.

3.03 INSTALLATION

A. Conduit, Raceways, and Sleeves

1. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts unless otherwise noted.

2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four.
3. Install individual and multiple raceway hangers and riser clamps as necessary to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze type hangers. Where conduit is of different sizes, use the same trapeze hanger space supports for the smallest size conduit on the rack.

5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for raceways 1 inch in diameter or smaller, serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use threaded steel with a diameter of 1/4 of an inch or larger. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Branch circuit raceways, which are 1 inch in diameter or smaller, may be attached to wall studs using manufactured clips.

7. Space supports for raceways in accordance with NEC.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

9. Sleeves:
   a. Install in concrete slabs and walls and all other fire rated floors and walls for raceways and cable installations. For sleeves through fire rated wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.

B. Boxes and Wiring Devices

1. Structural Mounting:
   a. They shall be rigidly supported from a structural member of the building either directly or by using a metal brace. Support wires that do not provide rigid support shall not be permitted as the sole support.

2. Outlet or junction boxes in exposed or concealed ceilings, all thread rod, manufactured brackets shall be mounted to building structure, strut suspended from building structure. Do not support boxes with conduit only or with all thread rod.

3. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

4. Support boxes independently of conduit, except for a cast box that is connected to two rigid metal conduits, both of which are supported within 12 inches of the
box.

5. Use stamped steel bridges to fasten flush mounting outlet box between studs.

6. Metal braces shall be protected against corrosion and formed from metal not less than .020 inch (508 micrometers) thick uncoated.

7. Use adjustable steel channel fasteners for hung ceiling outlet box.

8. Do not fasten boxes to ceiling support wires or tees.

C. Wires and Cables

1. Vertical Conductor Supports:
   a. Install simultaneously with installation of conductors.

D. Outdoor Wall Mounted Equipment

1. This shall include but not be limited to cabinets, enclosures, disconnect switches, panelboards, motor controllers, VFD's, small transfer switches, and wireways.

2. All cabinets and panelboards shall be wall mounted unless otherwise indicated.

3. Install surface-mounted cabinets and panelboards with minimum of four anchors.

4. In wet and damp locations use stainless steel channel supports to stand cabinets and panelboard one inch off wall.

5. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

E. Outdoor Rack

1. Equipment shall be rack mounted only where indicated or required by installation.

2. Mount on strut bolted to concrete.

3.04 FIELD QUALITY CONTROL / TESTING

A. Protect adjacent surfaces from damage by material installation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.
PART 1 GENERAL

1.00 SUMMARY

A. Section includes
   1. Identification of electrical materials, equipment, and installations.
   2. Nameplate identification on MCC’s and control panels.
   3. Arc Flash Warning Signs
   4. Equipment and High Voltage Warning Signs
   5. Identification of conduit and conductors.

1.01 REFERENCES

A. American National Standards Institute (ANSI)
   1. ANSI/ASME A13.1 – Scheme for the Identification of Piping Systems

B. National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electric Code (NEC)

1.02 SUBMITTALS

A. Product Data
   1. Submit all products covered under this specification for Engineer’s approval.
   2. Provide nameplate designations list and nameplate and text size for Engineer and/or Owner’s approval.

B. Samples
   1. Submit for each color, lettering style, and or graphic representation required for identification materials; samples of labels and signs.

C. Miscellaneous
   1. Schedule of identification nomenclature to be used for identification signs and labels.
1.03 QUALITY ASSURANCE

A. Regulatory Requirements

1. National Electrical Code: Components and installation shall comply with NFPA 70.

2. Comply with ANSI C2.

PART 2 PRODUCTS

2.01 RACEWAY AND CABLE LABELS

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.

B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.

2. Legend: Indicates voltage.

C. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

1. Provide identification wire marker for all power and control conductors.

D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 in. wide for phase and ground conductor identification.

E. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:

1. Size: Not less than 6 in. wide by 4 mils thick.

2. Compounded for permanent direct burial service.

3. Embedded continuous metallic strip or core.

4. Printed Legend: Indicates type of underground line.

F. Tape Markers: Vinyl or vinyl cloth, self-adhesive, wraparound type with preprinted numbers and letters. Limited use for indoor control cabinets.

G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014 in. (0.4 mm) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
H. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

I. Aluminum Faced Card Stock Tags: Wear resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 in. (0.05 mm) thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.

J. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 in. by 0.05 in. for conduit and power conductor identification. Attached with stainless steel bands.

2.02 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.

B. Engraving stock, melamine plastic laminate, 1/16 in. (1.6 mm) minimum thick for signs up to 20 sq. in. (129 sq. cm), 1/8 in. (3.2 mm) thick for larger sizes.

1. Engraved Legend: Black letters on white face.

2. Punched for mechanical fasteners or stainless-steel screws.

3. Use in control panels, MCC's, device housings, boxes, and similar locations.

C. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 in. (6.4 mm) grommets in corners for mounting.

D. Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396 in. (1 mm), galvanized steel backing, with colors, legend, and size appropriate to application. 1/4 in. (6.4 mm) grommets in corners for mounting.

E. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus inert, self-extinguishing, 1 piece, self-locking, Type 6/6 nylon cable ties with following features:

1. Minimum Width: 3/16 inch

2. Tensile Strength: 50-pound minimum.
3. Temperature Range: -40°F to 185°F.

4. Color: As indicated where used for color coding.

B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

2.04 CONTROL PANELS

A. Wire Markers: Provide wire markers on all power and wiring in panels of all types. Identify wire at points of termination at devices and at terminal strips.

B. Provide nameplates on body or housing of all devices.

C. Provide engraved nameplates near base of all relays and similar devices. Adhesive materials not allowed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference of operation and maintenance of equipment.

C. Lettering, Colors, and Graphics:

1. Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.

D. Sequence of Work:

1. Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products:

1. Not allowed. Use stainless steel screws.

F. Identify feeders over 600 V with "DANGER HIGH VOLTAGE" in black letters 2 in. high, stenciled with paint at 10 ft (3 m) intervals over continuous, painted orange background. Identify following:

1. Entire floor area directly above conduits running beneath and within 12 in. of basement or ground floor that is in contact with earth or is framed above un-excavated space.

2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

4. Entire surface of exposed conduits.

G. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime Surfaces:
   a. For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.

3. Apply one intermediate and one finish coat of silicone alkyd enamel.

4. Apply primer and finish materials according to manufacturer's instructions.

H. Install Caution Signs for Enclosures:

1. Use label indicating system voltage in black, preprinted on orange field. Install on exterior of door or cover with stainless screws.

I. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Plastic label on cover.

2. Concealed Boxes: Plasticized card stock tags.

3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

J. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 in. (150 to 200 mm) below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 16 in. (400 mm), use single line marker.

1. Install line marker for underground wiring, both direct buried and in raceway.

K. Color Code Conductors:

1. Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.
   a. Field applied, color coding methods may be used in lieu of factory coded
wire for sizes larger than No. 10 AWG.

(i) Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 in. from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 in. wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

(ii) Colored cable ties applied in groups of three (3) ties of specified color to each wire at each terminal or splice point starting 3 in. from terminal and spaced 3 in. apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/240 Volt 1Ph/3w</td>
<td>Black</td>
<td>Red</td>
<td>-</td>
<td>White</td>
</tr>
<tr>
<td>120/208 Volt 3Ph/4w</td>
<td>Black</td>
<td>Red</td>
<td>Blue</td>
<td>White</td>
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<tr>
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<td>Black</td>
<td>Orange</td>
<td>Blue</td>
<td>White</td>
</tr>
<tr>
<td>277/480 Volt 3Ph/4w</td>
<td>Brown</td>
<td>Purple</td>
<td>Yellow</td>
<td>Grey</td>
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<td>3</td>
<td>Blue</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ground</td>
<td>-</td>
<td>-</td>
<td>Green</td>
<td>-</td>
</tr>
</tbody>
</table>

L. Power Circuit Identification:

1. Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.
   a. Legend: 1/4 in. (6.4 mm) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
   b. Fasten tags with nylon cable ties; fasten bands using integral ears.

M. Apply identification to conductors as follows:

1. Conductors to Be Extended in Future:
   a. Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in Same Enclosure:
   a. Identify each conductor with source, voltage, circuit number, and phase.
Use color coding for voltage and phase indication of secondary circuit.

3. Multiple Control and Communications Circuits in Same Enclosure:
   a. Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.

N. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

2. Install warning signs on the following equipment as a minimum requirement.
   a. Plant Breaker/Disconnect
   b. Control Panels
   c. Where exposed bus bars inside.
   d. Solid-state Starters
   e. Other locations described in No. 1 above.

O. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal control, and alarm systems, unless units are specified with their own self-explanatory identification.

   Except as otherwise indicated, provide single line of text with ½ inch high lettering on 1 ½ inch high label; where two (2) lines of text are required, use ½ inch lettering on 2-inch-high label. For small control panels a smaller text may be used but shall be clearly readable. Use black lettering on white field. Use red lettering on white field where shown on plans or as requested by Engineer or Owner. Apply labels with stainless screws for each unit of following categories of equipment.

   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Control panels.
   d. Motor starters.
e. Push button stations.

f. Contactors.

g. Control devices.

h. Transformers.

i. Conduits at manholes, at junction boxes, and pull boxes.

2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3. For control panels the nameplate designation shall be according to the control, alarm or status function indicated on the control diagrams, one-line diagrams, details as required in other applicable specifications for this project.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section Includes:
   1. Selective electrical demolition.

1.01 REFERENCES

A. National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electrical Code (NEC),

B. OSHA 1926.417 – Lockout and tagging of circuits.

1.02 SUBMITTALS

A. Product Data
   1. Submit all products covered under this specification for Engineer’s approval.

B. Shop Drawings
   1. Provide detailed drawings of equipment and enclosures layout. Show dimensions of device layouts on enclosures. All equipment shall fit available space shown on plans. Special fabrication may be required for electronic system enclosures and other equipment.

C. Record Drawings and Documentation
   1. Annotate existing drawings to sequence the demolition of systems, equipment removal, and temporary hook-ups.

1.03 QUALITY ASSURANCE

A. Installer Qualifications
   1. Contractor shall be responsible for maintaining and adjusting all equipment for safe, damage free operation where equipment must be operated by Owner. This especially pertains to existing equipment and controls that may be modified under this contract but are required to be operated by Owner. Before starting demolition, test installation and verify operating condition of all equipment that
is to remain serviceable. Notify Owner in writing of any equipment that is not operable.

B. Certifications

1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

C. Regulatory Requirements

1. Verify field measurements and circuiting arrangements are as shown on Drawings.
2. Verify that abandoned wiring and equipment serve only abandoned facilities.
3. Demolition drawings are based on casual field observation and existing record documents. Report any discrepancies to Engineer before disturbing existing installation.
4. By beginning demolition, installer accepts existing conditions and warrants that he will maintain service to equipment and items not scheduled or indicated for removal, and that he will return to the Owner all serviceable items and systems in good operating conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials and equipment for patching and extending work: As specified in individual Sections, or as required to complete work intended by plans and specification.

2.02 PERFORMANCE / DESIGN CRITERIA

A. The temporary electrical wiring and facilities shall be designed and constructed in strict compliance with NEC.

PART 3 EXECUTION

3.01 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Utility Company to provide continuous service to operating equipment.

C. Where required, provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is
complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner at least one week before partially or completely disabling system. Minimize outage duration.

E. All existing equipment that is to remain serviceable shall be covered and sealed to prevent dust or water intrusion.

F. Where equipment, motor control centers, panels, and devices are to be removed or relocated and where wiring is to remain or be reused, trace out all wiring and tag conductors. Record data in “As-Built” drawings.

G. Where equipment is to be reused and is disabled without power for a period of over 1 week, the equipment shall be stored in a dry location and a heater shall be installed inside the enclosure and remain activated until equipment is placed back in service.

3.02 DEMOLITION AND EXTENSION OF EXISITING ELECTRICAL WORK

A. Demolish and extend existing electrical work as shown on plans, and as understood from observable conditions noted during the pre-bid site visit.

B. Remove, relocate, and extend existing installations to accommodate new construction. This includes rerouting of underground duct banks and conduits that may not be documented on Owner’s record drawings. Contractor is to allow for these conditions in bid price. Failure to do so is at Contractor’s risk.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, plug conduit, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment servicing utilization equipment that has been removed.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing installations, which remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods as specified for new work.
K. Any existing equipment that is to remain serviceable and is damaged during demolition or during new work shall be repaired or replaced to Owner’s satisfaction in working condition.

3.03 INSTALLATION

A. Install relocated materials and equipment as shown on plans

3.04 DISPOSAL AND SALVAGE

A. Salvage electrical and instrumentation equipment removed from existing facilities for reuse as applicable.

B. Material and equipment, which can be reused or salvaged, remains the property of the Owner unless specifically indicated in the Specifications or Drawings, or as designed by the Owner.

C. Materials and equipment which cannot be reused or salvaged for Owner’s use will be removed and disposed by the Contractor at approved disposal facility.

D. Remove, seal, and store generators, motors, and other large equipment for Owner’s use. Store at designated location wrapped in water and dust tight covering and on skids.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment, which remains or is to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangements.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section includes

1. The work under this section includes underground cast in place concrete ductbanks for electrical power and signal system distribution. The term “signal” is used through this specification as a generic term to include communications, control, security and other low voltage systems.

1.01 REFERENCES

A. American Society for Testing Manufacturing (ASTM)


B. American Concrete Institute (ACI)

1. 318 – Building Code Requirements for Structural Concrete

C. National Electrical Manufacturers Association (NEMA)

1. TC-9 – Fittings for PVC for Underground Installation

D. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code (NEC)

1.02 SUBMITTALS

A. Product Data

1. Submit the following for Engineer’s approval:

   a. Manufacturer’s cut sheets, catalog data, with selected products clearly marked of ducts and spacers.

   b. Instructions for installation.

   c. Dimensions and weight.
B. Should the Contractor determine that a variation from the as-design underground ductbank system be required based on field and/or other conditions, the Contractor is to submit all underground ductbank profile variations in AutoCAD format for review and approval of Engineer prior to actual installations.

1.03 QUALITY ASSURANCE

A. All work, equipment, and materials shall be protected at all times. The Contractor shall make good all damage caused either directly or indirectly by his workers. Work shall be properly protected to prevent obstruction or damage. All equipment shall be tightly covered and protected against dirt, water, chemical and mechanical injury. At the final completion, all work shall be thoroughly cleaned and delivered in perfect condition.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements
   1. Have duct spacers and associated hardware packed and crated to avoid damage during shipment and handling.
   2. Clearly mark packages or crates stating that the material is for electrical duct banks only.
   3. Store pre-cast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
   4. Lift and support pre-cast concrete units only at designated lifting or supporting points.

B. Storage and Handling Requirements
   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
   3. Accept products on site in factory containers and verify damage.
   4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Underground Devices, Inc.
   B. Cantex, Inc.
   C. Thomas and Betts Corporation (Carlon)
D. Or approved equal

2.02 MATERIALS

A. Conduit

1. Construct ducts using schedule 80 rigid PVC conduit, as specified in conduit division of these Specifications. PVC conduit shall be used unless otherwise shown on Drawings.

B. Spacers

1. Secure conduit with non-magnetic, universal, interlocking-type spacers for both horizontal and vertical duct arrangements.

C. Concrete

1. Use steel reinforced, red concrete as duct encasement.

D. Where unprotected service conductors are routed through a pull box with other conductors a divider wall shall be provided in the pull box for separation as required by the NEC.

2.03 MANHOLE/HANDHOLE HARDWARE AND ACCESSORIES

A. Frames and Covers:


B. Sump Frame and Grate:

1. Comply with FS RR F 621, Type VII for frame, Type I for cover.

C. Pulling Eyes in Walls:

1. Eyebolt with rebar fastening insert. 2-in. diameter eye, 1-in. by 4-in. long bolt. Working load embedded in 6 in, 4,000 psi concrete: 13,000 lbs minimum tension.

D. Pulling and Lifting Irons in Floor:

1. 7/8 in. dia hot dipped galvanized, bent steel rod, stress relieved after forming, and fastened to reinforced rod. Exposed triangular shaped opening. Ultimate yield strength, 40,000 lbs shear, 60,000 lbs tension.

E. Bolting Inserts for Cable Stanchions:

1. Flared, threaded inserts of non-corrosive, chemical resistant, nonconductive
thermoplastic material. 1/2 in. internal dia by 2 3/4 in. deep, flared to 1 1/4 in. minimum at base. Tested ultimate pull out strength: 12,000 lbs, minimum.

F. Expansion Anchors for Installation After Concrete is Cast:

1. Zinc-plated carbon steel wedge type with stainless steel expander clip 1/2 in. bolt size, 5,300 lb rated pull-out strength, and 6,800 lb rated shear strength, minimum.

G. Cable Stanchions:

1. Hot-rolled, hot-dipped galvanized "T" section steel, 2 1/4 in. size, punched with 14 holes on 1 1/2 in. centers for cable arm attachment.

H. Cable Arms:

1. 3/16 ga hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two 12 in. wide by 14 in. long and arranged for secure mounting in horizontal position at any position on cable stanchions.

I. Cable Support Insulators:

1. High glaze, wet process porcelain arranged for mounting on cable arms.

J. Ground Rods:

1. Solid copper clad steel, 3/4 in. dia by 10 ft. length.

K. Ground Wire:

1. Stranded bare copper, No. 6 AWG, minimum.

2.04 PRE-CAST MANHOLES AND HANDHOLES


B. Pre-cast Units: Interlocking, mating sections complete with accessory items, hardware, and features as indicated including concrete knockout panels for conduit entrance and sleeve for ground rod.

C. Joint sealant for joints between pre-cast sections shall be continuous extrusion of asphaltic butyl material compounded for adhesion, cohesion, flexibility, and durability properties required for permanent seal against maximum hydrostatic pressures theoretically attainable at installation location with ground water level at grade.
2.05 RACEWAY/DUCT SEALING COMPOUND

A. Compound:

1. Non-hardening, putty-like consistency workable at temperatures as low as 35°F.

2. Compound shall not slump at temperature of 300°F and shall readily adhere to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify from Drawings and field survey that the location of ductbanks does not interfere with any existing or new underground facilities.

B. Verify that materials are on site in proper condition and that sufficient quantity is on hand for the work.

C. Verify that trenches are in the correct places and prepared with sufficient depth and width to accommodate the duct banks, reinforcing rod, and concrete.

3.02 PREPARATION

A. Be prepared for inspection of the duct banks before reinforcing rod is installed.

B. Coordinate layout and installation of manholes and handholes with final arrangement of ducts as influenced by actual final location of other utilities in field.

C. Coordinate elevations of duct and raceway entrances into manholes and handholes with final profiles of ducts and raceways as determined by coordination with other utilities, underground obstructions, and buildings.

D. Establish locations and elevations to suit field conditions and assure duct banks run drain to manholes, handholes, or as shown on Drawings.

E. Before pouring concrete, verify that the ducts are free of debris and properly installed in the support and spacer systems and that the ducts are properly fitted together and firmly held in place by the hold down hardware.

F. Provide 24-hour notice to Engineer and the Local Code Inspector for cover-up inspection before pouring electrical conduit ductbanks.

3.03 INSTALLATION OF DUCTBANKS

A. Use the size and types of conduit as indicated on the Drawings for the various duct banks required for the project.
B. Make duct bank installations and penetrations through foundation walls watertight.

C. Assemble ductbanks using non-magnetic saddles, spacers, and separators. Position separators to provide 3-inch minimum concrete separation between the outer surfaces of the conduits.

D. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye at the rate of 10 pounds per cubic yard to concrete used for envelopes for easy identification during subsequent excavation.

E. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to ensure filling of spaces between ducts.

F. Make bends with sweeps of radius not less than 6 times the smallest diameter of the raceway.

G. Make a transition from non-metallic to PVC-coated metallic rigid conduit where duct banks enter structures or turn upward for continuation above grade.

H. Make bends of 30 degrees or more using rigid galvanized steel.

I. Reinforce duct banks throughout, where indicated on the Drawings.
   1. Unless otherwise noted on the Drawings, reinforce with No. 5 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 12 inches on centers, and No. 5 tie-bars transversely placed at 24-inch maximum longitudinal intervals.
   2. Maintain a maximum clearance of 2 inches from bars to the edge of the concrete encasement.

J. Where ducts enter structures such as handholes, manholes, pull boxes, or buildings, terminate the ducts in suitable end bells, insulated L-bushings, Myers hubs or couplings on steel conduits. Tag conduit entering pull boxes with stamped, stainless steel tags. Identify as designated in cable and conduit schedule.

K. Pitch ducts to drain towards manholes and handholes and away from buildings and equipment, unless otherwise shown on Drawings. Minimum slope shall be 4 in. in 100 ft. Where necessary to achieve this between manholes, slope ducts from high point in run to drain in both directions.

L. Duct Entrances to Manholes and Handholes: End bells spaced approximately 10 in. center to center for 5 in. ducts and varied proportionately for other duct sizes. Change from regular spacing to end bell spacing shall start 10 ft. from end bell and shall be made without reducing duct line slope and without forming trap in line. Grout end bells into manhole walls from both sides to provide watertight entrances. Provide grounding end bushings on metal ducts and connect to system grounding.
conductor.

M. Make joints in ducts and fittings watertight in accordance with manufacturer’s instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

N. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or prevent adequate compaction of fill.

O. Install a bare stranded copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground to switchgear and MCC ground buses and to steel conduit extensions of the underground duct system.

P. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately one-fourth inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to remove any particles of earth, sand or gravel that may have been left in the duct. Re-pull the rag or sponge swab until the swab emerges clean.

Q. Use hemp rope to pull conductors into PVC conduit. Do not use nylon or wire cable for this purpose.

R. Install a warning ribbon approximately 12 inches below finished grade over underground duct banks.

S. Conduits penetrating underground pull boxes shall be sealed with CSBE seals where equal or larger than 1 ¼-inch diameter and with RTV silicon based sealant where smaller than 1 ¼-inch diameter.

T. Conduits penetrating structural walls of lower levels shall be sealed with CSBE seals where equal or larger than 1 ¼-inch diameter and with RTV silicon based sealant where smaller than 1 ¼-inch diameter.

U. All conduit duct banks penetrating lower level structures and penetrating underground pull boxes shall be sealed watertight between conduit and wall of structure or pull box.

V. Install identification tags on all conduits at manholes, pull boxes, and junction boxes.

W. Conduits shall be separated by means of manufactured interlocking “chairs” spaced at no more than 5 feet apart along the length of the ductbank. Spacing between conduits shall not be less than 3 inches from edge to edge of conduits.

X. Every effort shall be made to minimize the number of bends in all ductbank systems. Field bends shall be made using a “hot box” designed for the size of PVC used. Care shall be given to ductbank routing so that very large radius sweeping turns are designed into the route as opposed to factory made 45° and 90° bends. When
factory 90° bends are used, they shall be a minimum of 36-inch radius for 4 inch and 48-inch radius for 5 inch. Factory 90° bends used in ductbank construction shall be rigid galvanized metal conduit (ferrous) only. These factory made bends shall be protected by corrosion preventing tape such as 3M Scotchrap 50 or approved equal prior to the concrete pour.

Y. The ductbank support “chairs” shall be spaced up from the bottom of the trench using cement brick to insure that the proper amount of concrete is poured under the conduits, as required. Sides of the trench may be used as the form if the width does not exceed 1 ½ times the recommended dimension of the ductbank (width.)

Z. The Electrician shall vacuum, swab, and install pull strings in every conduit of the completed ductbank. The pull string shall be permanently marked in 1-foot increments to aid in wire estimation on future projects. Use Greenlee #435 pull string or approved equal.

AA. Route all electrical ductbanks and conduits below water lines. Maintain minimum of 24 inches between bottom of water line and top of ductbank.

BB. Where ductbanks are routed under existing concrete slabs or pavements, install per plan details. Do not cut rebar in existing conduit except where approved by Engineer. Repair any cut or damaged rebar by welding back together after conduits are installed. Submit detail of intent for cutting or removal of existing concrete for ductbank installation to Engineer for approval.

3.04 INSTALLATION OF MANHOLES/HANDHOLES, GENERAL

A. General:

1. Provide manholes/handholes of sizes, shapes, and locations as indicated.

2. Determine final elevation of ducts as influenced by possible adjustments in other utilities and surface features and discovery of underground obstructions before installing manholes/handholes. Obtain Engineer’s approval for manhole/handhole installation adjustments necessitated by obstructions.

3. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

B. Elevation:

1. Manholes: Install with roof top 15 in. below finished grade, minimum.

2. Manholes: Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1 in. above grade.

C. Drainage: Install drains in bottom of units where indicated. Arrange to coordinate
with drainage provisions indicated or specified.

D. Access: Install access to manhole/handhole through cast iron frame and cover. For manholes, use 30 in. cover except as indicated. Use 30 in. cover for handholes, except use 24 in. covers for 2 ft. by 2 ft. handholes. Install brick chimney to support frame and cover and to connect cover with manhole/handhole roof opening. Provide moisture-tight masonry joints and waterproof grouting of cast iron frame to chimney. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 in. above finished grade.

E. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted in, and prior to backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole/handhole chimneys after brick mortar has cured at least 3 days.

F. Dampproofing: Apply dampproofing to exterior surfaces of units after concrete has cured 3 days, minimum. After ducts have been connected and grouted in, and prior to backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole/handhole chimneys after brick mortar has cured at least 3 days.

G. Hardware: Install removable hardware including pulling eyes, cable stanchions, cable arms, and insulators as required for installation and support of cable and conductors and as indicated.

H. Field Installed Bolting Anchors: Do not drill deeper than 3-7/8 in. for anchor bolts installed in field. Use minimum of 2 anchors for each cable stanchion.

I. Grounding: Install ground rod through floor of each manhole/handhole with top protruding 4 in. above floor. Seal floor opening against water penetration with waterproof non-shrink grout. Ground exposed metal components and hardware with bare copper ground conductor. Train conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors.

3.05 INSTALLATION OF CAST IN PLACE MANHOLES/HANDHOLES

A. Construct manholes/handholes as indicated.

B. Finish interior surfaces with smooth troweled finish.

C. Windows for future duct connections shall be concrete knock out panels 1 1/2 to 2 in. thick, located as indicated.

3.06 INSTALLATION OF PRECAST MANHOLES/HANDHOLES

A. Install in accordance with ASTM C891 and manufacturer's instructions.

B. Support units on level bed of crushed stone or gravel, graded from 1-in. sieve to No.
4 sieve and compacted to same density as adjacent undisturbed earth.

3.07 RESTORATION

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated.

B. Where sod has been removed, replace it as soon as possible after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work to their original condition.

D. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

E. Restore disturbed paving as indicated.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section Includes

1. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.01 REFERENCES

A. American Society for Testing Manufacturing (ASTM)

1. B3 – Soft or Annealed Copper Wires
2. B8 – Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
3. B33 – Tinned Soft or Annealed Copper Wire for Electrical Purposes

B. National Electrical Manufacturers Association (NEMA)

1. WC5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

C. Underwriters Laboratories (UL)

1. UL 44 – Thermoset Insulated Wires and Cables
2. UL 83 – Thermoplastic Insulated Wires and Cables
3. UL 467 – Grounding and Bonding Equipment
4. UL 493 – Thermoplastic Insulated Underground Feeder and Branch Circuit Cables
5. UL 1063 – Machine Tool Wires and Cables

D. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code (NEC)
   a. Article 310 – Conductors for General Wiring
   b. Article 200 – Use and Identification of Grounded Conductors
1.02 SUBMITTALS

A. Product Data
   1. Submit the following for Engineer’s approval:
      a. Manufacturer’s cut sheets and catalog data.
      b. Instructions for handling and storage.
      c. Dimensions and weights.

B. Shop Drawings
   1. Submit sufficient information to demonstrate compliance with drawings and specifications.
   2. Submit complete electrical ratings.

C. Test and Evaluation Results
   1. Certified reports of manufacturers’ factory production and final tests indicating compliance of cable and accessories with referenced standards.

D. Operation and Maintenance Data
   1. Maintenance data for cables and accessories.

1.03 QUALITY ASSURANCE

A. Installer Qualifications
   1. Previous experience with installation and termination of low-voltage electrical cable as specified in this section.

B. Certifications
   1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor
   2. Regulatory Requirements
      a. Cable shall meet all the requirements of Part 6 of ICEA S-61-402.
      b. Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.
1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Ship wire and cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by using manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

B. Storage and Handling Requirements

1. Cable stored and/or cut on site shall have the ends turned down, and sealed with cable manufacturer’s standard cable end seals, or field-installed heat-shrink cable end seals.

PART 2 PRODUCTS

2.00 MANUFACTURERS

A. Southwire
B. General Cable
C. Okonite Company
D. Service Wire Company
E. Cerro Wire Inc
F. Or Approved Equal

2.01 PERFORMANCE / DESIGN CRITERIA

A. Low-Voltage Cable

1. Design

a. Provide cable designated as THWN/THHN or XHHW single conductor type and UL 83 and UL 1063 listed, rated 600 volts and certified for continuous operation at maximum conductor temperature of 90° C in dry locations and 75° C in wet locations while installed in underground duct, conduit or in control panels (MTW). Use XHHW, 90° rated conductors for main service or feeders. Cables shall be single-conductor or multi-conductor (with ground) as specified on the Plan Sheets.

2. Conductors

a. Provide conductors, which are Class B, concentric stranded, annealed un-
coated copper with physical and electrical properties complying with ASTM B3 and B8 and Part 2 of ICEA S-61-402.

3. Insulation
   a. Each conductor shall be PVC insulated and nylon jacketed to meet the requirements of Part 3 of ICEA S-61-402. The insulation thickness shall match the dimensions listed in NEC Table 310-13 for type THHN and THWN wire.

4. Wire Marking
   a. Wire marking shall be in accordance with NEC Article 310-11 and shall be printed on the wire insulation at 2-foot intervals.
   b. The printing method used shall be permanent and the color shall sharply contrast with the jacket color.

5. The single conductor color-coding shall be as follows:

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/240 Volt 1Ph/3w</td>
<td>Black</td>
<td>Red</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>120/208 Volt 3Ph/4w</td>
<td>Black</td>
<td>Red</td>
<td>Blue</td>
<td>White</td>
</tr>
<tr>
<td>120/240 Volt 3Ph/4w</td>
<td>Black</td>
<td>Orange</td>
<td>Blue</td>
<td>White</td>
</tr>
<tr>
<td>277/480 Volt 3Ph/4w</td>
<td>Brown</td>
<td>Purple</td>
<td>Yellow</td>
<td>Grey</td>
</tr>
</tbody>
</table>

Motor Control
   1. Black
   2. Red
   3. Blue

Ground
   Green

6. All service and feeder conductors to be XHHW-2.

B. Control Wiring
   1. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.
   2. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

C. Terminating Products
   1. Mechanical type of high conductivity and corrosion resistant material listed for use with copper conductors.
2. Long barrel compression type of high conductivity and corrosion resistant material, with minimum of two compression indents per wire, listed for use with copper conductors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine raceways, cable trays, pull boxes, manholes, handholes, junction boxes, and other cable installation locations for cleanliness of raceways, minimum bending radii of cables, and conditions affecting performance of cable. Pull mandrel through raceways to check for suitable conditions. Do not proceed with cable installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.

B. Complete the cable raceway systems and underground duct banks before installing cables.

C. Verify sizing of raceways and pull boxes to ensure proper accommodation for the cables.

D. Check the length of the cable raceway system against the length of cable on the selected reel.

E. Clean conduits of foreign matter before cables are pulled.

3.03 INSTALLATION

A. Wiring Methods

1. Use wiring methods indicated on the Drawings

2. In general, use THHN/THWN or XHHW building wire for lighting, power and control wiring where conductors are enclosed in raceways such as above ground conduit system, underground duct banks, or inside control panels. Use XHHW, 90° rated conductors for main service or feeders.

3. Do not use solid conductors.

4. Use conductors no smaller than No. 12 AWG stranded for lighting circuits indoors and no smaller than No. 10 AWG stranded for outdoors. Use No. 10 AWG (minimum) for outdoor receptacles on structures or poles.

5. In general, do not splice conductors unless approved by the Engineer.

6. Splices associated with taps for lighting and control circuits are allowed without
7. Make splices in accessible junction boxes located above ground. Do not splice power and control conductors in underground pull boxes or manholes. Exceptions are as noted.

8. Use wire nuts with insulated caps for lighting wiring splices. Splice control circuit with insulated crimp connectors.

B. Single Conductor in Conduit and Ductbank

1. Clean conduits of foreign matter before cables are pulled.

2. Install cables in accordance with the manufacturer's instructions and NEC Chapter 3 - Wiring Methods and Materials. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

3. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation.

4. Splices are not allowed in manholes.

C. Preparation for Termination

1. Make 600-volt power cable terminations and splices with heat shrinkable sleeves and seals.

2. Terminal lugs and connectors for all sizes of conductors shall be crimp-on type.

3. For size 1/0 AWG and larger, crimp-on lugs shall have the long barrel with 2-hole tongues except in places where termination space is limited.

3.04 FIELD QUALITY CONTROL / TESTING

A. In general, test insulation integrity of the wiring system before terminating.

B. Make sure to disconnect sensitive electronic equipment before testing insulation.

C. Use a 500 VDC megohmmeter and perform the wire system insulation test in accordance with the operating instructions.

D. Termination: After the 600-volt wiring system has been tested with satisfactory results, reconnect wire.

E. All conductors shall be inspected for damage after pulled in conduit. Where damage is deemed excessive by Engineer, conductors shall be replaced for entire length of run.

F. Where damage is due to condition of conduits, Contractor may be requested to provide a televised inspection of conduits at no additional cost to Owner and where
deemed necessary by Engineer, any damaged conduits shall be replaced at no additional cost to Owner.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY
A. Section Includes:
   1. Specifications for instrumentation cable.

1.01 REFERENCES
A. American Society for Testing Manufacturing (ASTM)
   1. B3 – Soft or Annealed Copper Wires
   2. B8 – Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
   3. B33 – Tinned Soft or Annealed Copper Wire for Electrical Purposes
B. Underwriters Laboratories (UL)
   1. 44 – Thermoset Insulated Wires and Cables
   2. 83 – Thermoplastic Insulated Wires and Cables
   3. 467 – Grounding and Bonding Equipment
C. National Fire Protection Association (NFPA) – NFPA 70, National Electric Code (NEC)
   1. NFPA 70 – National Electric Code (NEC)
      a. Article 310 – Conductors for General Wiring
      b. Article 200 – Use and Identification of Grounded Conductors
      c. Article 725 – Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits

1.02 SUBMITTALS
A. Product Data
   1. Submit the following for Engineer’s approval:
      a. Manufacturer’s cut sheets, catalog data, with selected products clearly
b. Installation, terminating and splicing procedure (including bending radius and pulling tension data).

c. Dimensions and weight.

1.03 QUALITY ASSURANCE

A. Certifications

1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor.

B. Regulatory Requirements

1. Cable shall be tested at the factory to confirm that the cable complies with requirements of ICEA Section 7.7.9 of S-66-524 or 7.5.9 of S-68-516.

2. Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Ship cable on manufacturer’s standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer’s standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

B. Storage and Handling Requirements

1. Deliver products to site in acceptable condition and in protective wrappings.

2. Store and protect products from damage.

3. Accept products on site in factory containers and verify damage.

4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Alpha Wire Corporation

B. Belden, Inc.
2.02 MATERIALS AND EQUIPMENT

A. Design

1. Provide cable with the following design characteristics. The cable shall consist of multiple conductors. The cable assembly shall be UL listed, flame, oil, and sunlight resistant, and certified for continuous operation at the temperature specified in wet or dry locations while installed in underground duct, conduit, or cable tray. The number and size of conductors supplied in each cable shall correspond to the quantities specified. Each conductor shall be individually insulated. Pairs and triads shall have conductors, which are twisted together with a drain wire, shielded, and covered with a jacket. Multi-pair/triad cables shall consist of the required number of electrically isolated, shielded pairs or triads, which are bundled together and covered by an overall jacket as specified.

2. Provide composite multi-conductor, shielded pair or triad, outer sheathed cables where shown on plans.

B. Conductors

1. Provide conductors, which are Class B, concentric stranded, annealed tinned copper whose physical and electrical properties comply with ASTM B3, B8 or B33 and Part 2 of ICEA S-61-402, S-66-524, or S-68-516, unless otherwise specified.

C. Insulation

1. Each conductor shall be insulated as specified in compliance the requirements of Part 3 of ICEA S-61-402, S-66-524, or S 68-516. The average insulation thickness shall not be less than the dimensions shown in Table 7-32 or 7.5.1 of ICEA S-66-524 or S-68-516 for 600-volt insulation unless otherwise specified. The minimum insulation thickness shall not be less than 90 percent of the value given in the table.

D. Drain Wire

1. Provide drain wire which is Class B, seven-stranded, tin-coated copper in accordance with ASTM B3, B8, or B33 and as specified. The drain wire shall not be less than two AWG sizes smaller than the insulated conductor's size, except for multiple pair triad drain wires, which shall not be less than the insulated conductor size.
E. Shielding
   1. Provide shielding consisting of laminated, non-burning, mylar-backed aluminum tape applied helically around a twisted pair or triad with the aluminum side in continuous contact with the drain wire unless otherwise specified. Wrap the tape around each twisted pair or triad with a 25 percent minimum overlap unless otherwise specified.

F. Jacket
   1. The physical and electrical properties of the jacket used to cover single or multi-pair or triad cables shall meet the requirements of section 7.7.7 or ICEA S-66-524 or section 7.5.6 of ICEA S-68-516. Jacket material as specified. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516.

G. Armor
   1. Where requested, use instrumentation cables protected by an interlocked metal tape armor coating made of galvanized steel, which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524, unless otherwise specified.

H. Conductor Identification
   1. Use individual conductors in single-pair and single-triad cables, which are, color coded black and white; and black, white and red, respectively. Multi-pair triad cables shall have one conductor in each pair or triad colored white, and all other conductors are color coded in sequence according to Table L-2 of Appendix 2 of ICEA S 66-524, and as specified.

I. Cable Marking
   1. Print cable marking information on the jacket of each cable at 2-foot intervals. Use a permanent printing method with color sharply contrasting the jacket color.

PART 3 EXECUTION

3.01 PREPARATION

A. Complete cable raceway systems, underground duct banks, and cable support systems before installing cables.

B. Verify sizing of raceways and pull boxes to ensure proper accommodation for the cables.

C. Check the length of the cable raceway system against the length of cable on the selected reel.

D. Do not install or work on PVC insulated or jacketed cables in temperatures below 32°F.
E. Clean conduits of foreign matter before cables are pulled.
F. Provide at least 30 percent spare conductors or pairs.

3.02 INSTALLATION

A. Cable in Conduit and Ductbank

1. Install cables in accordance with the manufacturer’s instructions and NEC Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling and Power Limited Circuits. Do not exceed maximum wire tension, maximum insulation pressure, and minimum bending radius.

2. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation or cable jacket.

3. Conduits carrying low level signal cables shall be PVC-coated rigid steel.

B. Termination

1. Do not splice conductors. For termination use crimp-on type ring tongue non-insulated tin-plated copper lugs.

2. For shielded control cable, terminate the shield and ground it at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables.

3. If splicing is required, maintain shield continuity by jumping the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.

4. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring tongue terminal has been installed. Extend the marker over the crimp or base of the terminal.

3.03 FIELD QUALITY CONTROL / TESTING

A. Tests

1. Before connecting the cables, test insulation integrity and conductor continuity.

2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.

B. Termination

1. After the cable has been tested with satisfactory results, the cable can be terminated at both ends to their designated terminal points.
PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section includes

1. This section specifies the furnishing, installation, and connection of conduit, fittings, and bodies.

1.01 REFERENCES

A. American National Standards Institute (ANSI)

1. C80.1 – Rigid Steel Conduit, Zinc Coated.
2. C80.3 – Specification for Electrical Metallic Tubing, Zinc Coated.
3. C80.4 – Fittings for Rigid Metal Conduit.
4. C80.5 – Electrical Rigid Aluminum Conduit.

B. National Electrical Manufacturers Association (NEMA)

1. FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
2. RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
3. TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
4. TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

C. Underwriters Laboratories (UL)

1. 1 – Flexible Metal Electrical Conduit.
2. 6 – Rigid Metal Electrical Conduit.
3. 514B – Standard for Conduit, Tubing, and Cable Fittings.
4. 651 – Schedule 40 and 80 Rigid PVC Conduit.
5. 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit.

D. National Fire Protection Association (NFPA)

E. Federal Specifications
1. W-C-58C – Conduit Outlet Boxes, Bodies Aluminum, and Malleable Iron.
3. WW-C-566C – Flexible Metal Conduit.
4. WW-C-581E – Coatings on Steel Conduit.

1.02 SUBMITTALS

A. Product Data
1. Submit the following for Engineer’s approval:
   a. Manufacturer’s cut sheets, catalog data, with selected products clearly marked.
   b. Installation, terminating and splicing procedure.
   c. Instruction for handling and storage.
   d. Dimensions and weight.

B. Shop Drawings

1.03 QUALITY ASSURANCE

A. Certifications
1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

B. Regulatory Requirements
1. Rigid steel conduit shall pass the bending, ductility, and thickness of zinc coating tests described by ANSI C80.1.
2. Flexible conduit shall pass the tension, flexibility, impact, and zinc coating test described by UL 1.
3. Nonmetallic conduit and fittings shall pass the test requirements of NEMA TC2, UL 651 and 651A and Federal Specification W-C-1094A.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Delivery and Acceptance Requirements

1. Package conduit in 10-foot bundles maximum with conduit and coupling thread protectors suitable for indoor and outdoor storage. Package fittings in manufacturer's standard quantities and packaging suitable for indoor storage. Package plastic-coated rigid conduit, fittings, and bodies in such a manner as to protect the coating from damage during shipment and storage.

B. Storage and Handling Requirements

1. Deliver products to site in acceptable condition and in protective wrappings.
2. Accept products on site in factory containers and verify damage.
3. Store products in clean, dry area.
4. Protect conduit from corrosion and entrance of debris by storing above grade on racks. Provide appropriate covering.
5. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Rigid Steel Conduit

1. Allied Tube and Conduit
2. Nucor Tubular Products
3. Calpipe Industries, Inc. (Calconduit)
4. Wheatland Tube Company
5. Western Tube

B. PVC Coated Steel Conduit

1. Robroy Industries, Inc. (Plasti-Bond)
2. Thomas and Betts (Ocal)
3. Calpipe Industries, Inc. (Calbond)

C. PVC Rigid Conduit

1. Cantex
2. Thomas and Betts (Carlon)
3. Allied Tube & Conduit
D. Conduit Fittings and Bodies
   1. Cantex
   2. Thomas and Betts (Carlon)
   3. Thomas and Betts (Ocal)
   4. Allied Tube and Conduit
   5. Emerson (Appleton Electric)
   6. Emerson (O-Z/Gedney)
   7. Eaton (Crouse-Hinds)
   8. Hubbell, Inc.

E. Liquidtight Flexible Conduit
   1. Thomas and Betts (Carlon)
   2. AFC Cable Systems
   3. Anamet Electrical, Inc.
   4. Electri-flex Company
   5. Superflex, Ltd

F. Aluminum Conduit
   1. Allied Tube and Conduit
   2. Wheatland Tube Company
   3. Or approved equal

2.02 PERFORMANCE / DESIGN CRITERIA

A. Design Conditions
   1. Use electrical conduit, fittings, and bodies designed for service in areas as specified within this section and plan set to form a continuous support system for power, control, and instrument cables.

B. Conduit and Fittings
   1. Rigid Steel Conduit and Fittings:
      a. Rigid steel conduit, rigid steel conduit bends, nipples, and bodies shall be hot-dipped galvanized and shall comply with the latest ANSI C80.1, UL 6,
Federal Specification WW-C-581E, and NEC Article 344.

b. Mild steel tubing shall be used for conduit, nipples, and couplings, and shall be free of defects on both the inner and outer surfaces.

c. Fittings, bodies, and covers for rigid steel conduit shall be steel or cast-iron and shall comply with ANSI C80.4, UL 514B, and Federal Specification W-C-58C.

d. Rigid Steel Conduit shall be threaded on both ends. Taper of conduit threads shall be ¾” per foot (1 in 16) per ANSI/ASME B.1.20.1.

e. Conduit threads shall be hot galvanized after cutting.

2. PVC-Coated Rigid Steel Conduit and Fittings.


b. PVC-coated couplings shall be of the ribbed type.

c. Condulet covers shall have encapsulated stainless steel thumbscrews.

d. Condulets and covers shall be of malleable iron or ferroalloy material before coating.

e. PVC coating shall be a minimum of 2-mil thickness on the interior of the conduit and the interior of fittings, condulets, covers, and bodies.

f. Conduit clamps, strut, and devices shall be PVC coated when used with PVC-coated conduit.

3. Flexible and Liquidtight Flexible Metal Conduit and Fittings.

a. Use liquidtight flexible metal conduit manufactured in accordance with UL 1 and Federal Specification WW-C-566C.

b. Fittings used with liquidtight flexible metal conduit shall be the PVC-coated type and of such design as to thoroughly ground the conduit to the fittings and through it to the box or enclosure to which it is attached.

c. Liquidtight flexible couplings and fittings for use in hazardous areas shall comply with UL 886, NEC Article 501-10 (A&B), and Federal Specification W-C-586C.
d. Do not use flexible metal conduit or liquidtight flexible metal conduit for light fixtures or receptacles unless shown on plans or approved by Engineer.

4. PVC Conduit and Fittings. Use PVC conduit, bends, and fittings, which comply with NEMA TC2, W-C-1094A, and NEC Article 352-III for above ground and underground installation. Conduit shall be Schedule 80, unless shown or noted otherwise on drawings or in other specifications.

5. Use PVC Schedule 80 conduits, fittings, and boxes for all chemical areas and provide conduit seals per NEC.

6. Aluminum RMC conduit may be used indoors and outdoors where not subject to damage by vehicular traffic or where exposed to chemicals or corrosive fumes and approved by engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceways prior to rough-in.

3.02 PREPARATION

A. Confirm submittal of shop drawing with conduit and conduit fitting, sizes, types, and routing shown.

B. Ensure that the conduit system to be installed is sized properly for the cable and wire requirements following NEC rules.

C. Verify the actual physical conduit route from the conduit plan drawings and prepare the conduit support system.

D. Verify the equipment locations to which the conduit will be connected and determine detail requirements for connections.

E. Submit layout of all conduit stub-ups for Engineers review before installing conduits.

3.03 INSTALLATION

A. Install PVC-coated conduits in all outdoor locations at wastewater facilities, inside valve vaults, in wet well slabs, in corrosive and wet environments in chemical rooms (Schedule 80 required) and, where specifically noted on drawings. Aluminum PVC-coated conduit may be used where specifically shown on plans, where specifically noted in specifications or where approved in writing.

B. Install rigid galvanized steel (RGS) conduits in dry inside locations and in all outdoor locations for water facilities and, where specifically noted otherwise on drawings. Aluminum RMC may be used where specifically shown on plans, where
specifically noted in specifications or where approved in writing. Where aluminum conduit is approved, use all aluminum condulets and fittings.

C. Install Schedule 40 PVC conduits in duct banks. For stub-ups, use PVC-coated rigid steel elbows or rigid steel elbows as applicable in A and B above and other specifically noted locations on drawings. Rigid steel stub-up shall have minimum three (3) layers of mylar tape up to 1" above slab where conduit is in contact with concrete. Stub-ups inside MCC’s, panels, equipment and/or enclosures shall have threads with grounding bushings installed.

D. Run exposed conduit parallel or perpendicular to walls, ceilings, or main structural members. Group multiple conduits together where possible. Do not install conduit where it interferes with the use of passageways, doorways, overhead cranes, monorails, equipment removal areas or working areas. In no case shall conduit routing present a safety hazard or interfere with normal plant operating and maintenance procedures. Maintain a minimum overhead clearance of 8'-0" in passageways. Except where absolutely impossible, all conduits are to be installed in or under concrete slab, in walls and ceilings. Any exposed conduit installed otherwise may be relocated at Contractor’s expense where directed by Engineer or Owner. Exceptions, where specifically noted otherwise on plans.

E. Installation and support of conduit shall be from steel or concrete structures in accordance with the standard detail drawings. Furnish necessary conduit straps, clamps, fittings and support for the conduit in accordance with the standard details and consistent with the grade and type of conduit being installed.

F. Identify conduit at termination points like MCC, light fixtures, control panels, receptacles, and junction boxes. Tag all conduits per Section 16075 – “Identification for Electrical Systems.”

G. Not more than three (3) equivalent 90 degree bends will be permitted between pull boxes. Provide bonded expansion fittings at building expansion joints.

H. Install conduit runs so that they are mechanically secure, mechanically protected from physical harm, electrically continuous, and neat in appearance. The interiors of conduit shall provide clean, smooth raceways through which conductors may be drawn without damage to the insulation. Make threaded connections wrench tight.

I. Cut conduit square with a power saw or a rotary type conduit cutter designed to leave a flat face. Do not use plumbing pipe cutters for cutting conduit. Ream the cut ends of conduit with a reamer, designed for the purpose to eliminate rough edges and burrs. Cut threads with standard conduit dies providing 3/4-inch taper per foot, allowing the proper length so that joints and terminals may be made up tight and the ends of the conduit not deformed. Keep dies sharp and use a good quality threading oil continuously during the threading operation. Remove metal cuttings and oil from the conduit ends after the threads are cut and paint threads before connections are made. Use zinc rich, brush-on compound on the threads of steel conduit before connections are made. Use only tools specifically made for
bending and installing PVC-coated or PVC conduit when installing these materials.

J. Use strap wrenches only to tighten joints in plastic coated rigid steel conduit. Replace all conduit and fittings with damage to the plastic coating, such as cuts, nicks and threader chuck jaw marks.

K. Make up changes in direction of exposed conduit using elbows or fittings. Do not use pull boxes to make direction changes unless specifically designated otherwise. Do not use elbow bends for change in direction of exposed conduit.

L. Field fabricated bends shall be free of indentations or elliptical sections. The radius of the bend shall not be less than 6 times the smallest diameter of the raceway.

M. Protect all conduit terminations from mechanical injury. Prevent the entry of moisture and foreign matter into the conduit system by properly capping terminations.

N. Avoid trapped runs of conduit, if possible. When they are necessary, provide drainage using a "tee" condulet equipped with a drain. Conduit is likely to pass through areas with a temperature differential of 20 degrees F or more. Seal penetrations with a proper seal fitting at the wall or barrier between such areas. For conduit passing through walls separating pressurized areas from non-pressurized areas, install sealing fittings at the wall on the non-pressurized side.

O. Fit conduit crossing building or structure expansion joints with approved expansion fittings, except that fittings will not be required when conduit crossing an expansion joint is supported on trapeze hangers in such a way that at no time will the conduit be under stress due to expansion. Install bonding jumpers around expansion joint fittings.

P. Where conduit terminates in sheet metal enclosures, threaded hubs are required. Conduit entries with double locknuts and bushings are prohibited. Sheet metal enclosures located outside or in any other wet, damp, or corrosive areas shall be furnished with threaded hubs. Restrict side penetrations to the lower one third of the enclosure.

Q. Provide liquid tight flexible metallic conduit only where necessary to allow for movement or to localize sound or vibration, at transformers, motors, solenoid valves, motor operated valves, and any other rotating equipment unless shown otherwise on Drawings. Limit length to less than 2 feet. Do not use flexible metallic conduit for light fixture circuits or for devices and do not use as a substitute for rigid conduit.

R. Seal openings or holes where conduits pass through walls or floors. When conduits are passing through a firewall or fire-rated floor into different rooms, cabinets, or enclosures, use a fire-rated seal as shown in the typical detail included in the Drawings. Certain walls, where indicated on the Drawings, require environmental (airtight) seals; seal as shown.
S. Install explosion-proof seals in conduit runs crossing or entering a hazardous classified area, where shown on Drawings. Install type CSBE removable sealing fittings to seal pump cables in the wet well and at the first junction box outside the well. Install EYS seals in all conduits leaving chemical rooms or chemical storage spaces. There shall be no unions, couplings, boxes, or fittings in conduit run between seal and point at which conduit leaves the room.

T. Unless otherwise indicated on the Drawings, install expansion fittings every 300 feet within a straight conduit run and where conduit crosses building expansion joints, using bonding straps to ensure ground continuity.

U. Parallel runs of conduit may be supported by structural steel racks. When two or more racks are arranged one above the other, provide vertical separation of not less than 12 inches between racks, unless otherwise indicated on the Drawings. Space conduits on the racks at least enough to provide 1/4-inch clearance between hubs on adjacent conduits at terminations and to allow room for fittings.

V. Fill conduit racks no more than 75 percent of their capacity, providing usable space for future conduit. To ensure this, conduits leaving the rack horizontally shall be offset up or down so that future conduits may be installed in the space remaining. Construct conduit racks to permit access for wire or cable pulling at all pull points, even when future conduits are added to fill the racks.

W. Where conduit racks are supported on rods from beam clamps or by some other non-rigid suspension system, install rigid supports at no more than 50-foot intervals to give lateral stability to the rack.

X. Conduit racks or hangers must in no way interfere with machinery (or its operation), piping, structural members, process equipment, or access to anticipated future equipment. Refer to architectural, structural, equipment layout and piping drawings to ensure that this requirement is met.

Y. Label high voltage conduit with the circuit phase-to-phase voltage by means of a firmly attached tag or label of approved design at each conduit termination, on each side of walls or barriers pierced and at intervals not exceeding 200 feet along the entire length of the conduit.

Z. Support conduit sizes 2 inches and larger at spacings not exceeding 10 feet and conduit sizes 1-1/2 inches and smaller at spacings not exceeding 8 feet.

AA. The means of fastening conduit to supports shall be: by one-hole malleable iron conduit straps secured by wood screws to wood and by bolts with expansion anchors to concrete or masonry; by "Korn" clamps or U-bolts to other surfaces. Use "clamp backs" when strapping conduits to walls, column faces, or other such surfaces.

BB. Support conduit runs with conduit clamps, hangers, straps, and metal framing channel attached to structural steel members. Conduits of 1-1/2-inch size or less
may be supported by one-hole conduit straps on concrete, tile or steel work, but for larger size conduit, use 2-hole straps. Use clamps of galvanized malleable iron for rigid galvanized conduit and PVC-coated or stainless steel for PVC-coated conduit. Metal framing channel straps used for PVC-coated conduit shall be Type 316 stainless steel.

CC. Install conduits supported from building walls with at least 1/4-inch clearance from the wall to prevent the accumulation of dirt and moisture behind conduit. All conduits shall be routed below concrete floor slabs on grade and shall have sand fill and cover. Set depth to account for radius of turn-up to prevent exposure of elbow bend.

DD. Where specifically shown on plans, size and space embedded conduits in structural slabs in accordance with the Uniform Building Code. Conduits should occupy no more than one-third the thickness of the slab and should not be closer than 3 times the largest diameter on center without additional reinforcement.

EE. Do not cut paved driveways, sidewalks, concrete foundations, etc. to install conduits unless specifically noted on plans. Bore under such construction and maintain a minimum of 24 inches below underside of paving or concrete. Repair any cutting or damage to original condition and to satisfaction of Engineer and Owner.

FF. All conduits for fiber optic cables are to have wide tube radius compatible with cable manufacturer's requirements.

GG. Damaged conduits shall be replaced at no additional cost to Owner where Engineer deems necessary because of extent of damage or, where conductors are damaged by defective conduit installation.

HH. Seal all conduits entering motor control centers, control panels, equipment, enclosures, valve actuators, etc. with CSBE seals or, install EYS at locations permissible. Sealing glands shall be selected specifically for each conduit and conductor. Install seals at all equipment located at elevation lower than U.G. conduit route.

II. Conduits penetrating underground pull boxes shall be sealed with CSBE seals where larger than 1 ¼-inch diameter and with RTV silicon-based sealant where smaller than 1 ¼-inch diameter.

JJ. Conduits penetrating structural walls of lower levels shall be sealed with CSBE seals where larger than 1 ¼-inch diameter and with RTV silicon-based sealant where smaller than 1 ¼-inch diameter.

KK. All conduit duct banks penetrating lower level structures and penetrating underground pull boxes shall be sealed watertight between conduit and wall of structure or pull box.
LL. Where conduits are stubbed out from building for future use, extend conduits 5 feet past building wall or past edge of pavement, whichever is applicable. Do not leave under pavement. Cap ends of conduits.

MM. All conduits shown entering outside walls of buildings shall stub-up immediately adjacent to wall and penetrate low on wall. Where not shown entering wall, all conduits shall be routed up through building floor by excavating below foundation, core drill through floor, and stub-up conduits then backfill with cement stabilized sand, compacted in place.

NN. Apply a conductive coating to field-cut threads of aluminum conduits to ensure continuity and ease of joining. Noalox and Kopr-Shield are acceptable coatings.

OO. Avoid excessive force when tightening threaded fittings for aluminum conduit, both between conduits and at threaded box entries. Generally, the correct force is hand-tight plus one full turn with a wrench. At least three (3) full threads should be engaged.

PP. Do not use conduit bushings to secure threaded aluminum RMC to a box or enclosure. Install a locknut between a conduit bushing and the inside of the box or enclosure.

QQ. Threadless fittings shall not be used with threaded aluminum conduit.

RR. Install expansion fittings in outdoor runs of aluminum RMC.

SS. Do not install aluminum conduit in concrete or underground.

TT. Use special tools for installing aluminum conduit. All damaged conduits shall be replaced.

UU. In chemical rooms, enclosures, and portable/prefab buildings used for chemical storage or chemical equipment operation, use Schedule 80 PVC conduit and fittings only. Use PVC boxes and enclosures. There are no exceptions for this requirement unless specifically noted on drawings as an exception to this section.

VV. Provide minimum one (1) additional spare 2-inch, two (2) spare 1-inch conduits from MCC to U.G. pull box and between all U.G. pull boxes on site.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
SS SECTION 16135
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.00 SUMMARY

A. Section includes

1. This section specifies the furnishing, installation, and connection of device, pull, and junction boxes.

1.01 REFERENCES

A. National Electrical Manufacturers Association (NEMA)
   1. FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
   2. 250 – Enclosures for Electrical Equipment (1000 volts maximum)

B. Underwriters Laboratories (UL)
   1. 50 – Safety Cabinets and Boxes
   2. 508 – Safety Industrial Control Equipment
   3. 514B – Safety Fittings for Conduit and Outlet Boxes
   4. 886 – Safety Outlet Boxes and Fittings for Use in Hazardous Areas

C. National Fire Protection Association (NFPA)
   1. 70 – National Electric Code (NEC)

1.02 SUBMITTALS

A. Product Data

1. Submit the following for Engineer's approval:
   a. Manufacturer's cut sheets, catalog data, with selected products clearly marked.
   b. Installation, terminating and splicing procedure.
   c. Instruction for handling and storage.
d. Dimensions and weight.

B. Shop Drawings

1.03 QUALITY ASSURANCE

A. Manufacturers Qualifications

1. Products shall be free from defects in material and workmanship.

B. Certifications

1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

C. Regulatory Requirements

1. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

   a. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.

   b. Terms "listed" and "labeled" shall be as defined in NEC.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Deliver products to site in acceptable condition and in protective wrappings.

2. Accept products on site in factory containers and verify damage.

3. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sheet Metal and Cast Device Boxes

1. Appleton Electric Company

2. Hoffman Industrial Products

3. Raco

4. Eaton Crouse-Hinds

5. Thomas & Betts

6. Hubbell, Inc.
7. Or approved equal

B. Junction and Pull Boxes:
   2. Hubbell, Inc.
   3. Thomas and Betts (Carlon)
   4. Or approved equal

2.02 PERFORMANCE / DESIGN CRITERIA

A. Sheet Metal Boxes
   1. Provide UL-approved junction boxes and pull boxes manufactured from stainless steel sheet metal with rating of NEMA 4X for corrosive and wet areas, meeting requirements of NEMA 250. Enclosures located outdoors or in environmentally harsh or wet locations shall be NEMA 4X 316 stainless steel.
   2. Provide boxes with a stainless-steel continuous hinge, closure hasps and all stainless-steel hardware.
   3. Furnish the door with neoprene gasket and provisions for padlock.

B. Device Boxes
   1. Provide UL-approved boxes designed and manufactured to house electrical devices like receptacles and switches, and in conformance with NEMA FB 1.
   2. Supply boxes that are hot-dip galvanized on cast iron suitable for corrosive and wet atmosphere.
   3. All boxes located in environmentally harsh or wet or outdoor locations shall be NEMA 4X 316 stainless steel.
   4. All boxes located in chemical rooms shall be H.D. PVC only.
   5. Where unprotected service conductors are routed through a pull box with other conductors a divider wall shall be provided in the pull box for separation as required by the NEC.

C. Pull and Junction Boxes
   1. General:
      a. Comply with UL 50 for boxes over 100 cu in. volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
2. Galvanized Steel Boxes:
   a. Flat rolled, code gauge, sheet steel with welded seams. Where necessary to provide rigid assembly, construct with internal structural steel bracing. Hot dip galvanized after fabrication. Cover shall be gasketed.

3. Stainless Steel Boxes:
   a. Fabricate of 316 stainless steel conforming to ASTM A167. Where necessary to provide rigid assembly, construct with internal structural stainless-steel bracing. Cover shall be gasketed.

D. Hardware
   1. Mounting Hardware
      a. Stainless steel.
   2. Conduit Connectors
      a. Watertight as manufactured by Myers Hubs, or equal.

PART 3 EXECUTION

3.01 PREPARATION
   A. Review the drawings and determine how many boxes of each kind are required and check if supplied quantity is sufficient.

3.02 INSTALLATION, GENERAL
   A. Boxes described in this specification shall be used both in dry and wet, corrosive areas, both inside and outside locations.
   B. Install boxes in locations as indicated on the Drawings in accordance with NEC.
   C. Install junction and pull boxes in readily accessible places to facilitate wire pulls, maintenance, and repair.
   D. Plug unused conduit openings.
   E. Make conduit connections to sheet metal boxes with watertight conduit connectors.

3.03 INSTALLATION OF PULL AND JUNCTION BOXES
   A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8-in. square by 4-in. deep. Do not exceed six (6) entering and six (6) leaving raceways in single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed following:
1. Cable Supports: Install clamps, grips, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 in. inside boxes.

2. Size: Provide pull and junction boxes for telephone, signal, instrumentation, control, and other systems at least 50% larger than would be required by NEC, or as indicated. Locate boxes strategically and provide means to permit easy pulling of future wires or cables of types normal for such systems.

### PART 4 - MEASUREMENT AND PAYMENT

#### 4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
SS SECTION 16136
ELECTRICAL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.00 SUMMARY

A. Section includes:
   1. Cabinets.
   2. Hinged door enclosures.

B. Definitions:
   1. Cabinets: Enclosure designed either for surface or for flush mounting and having frame or trim in which door or doors may be mounted.
   2. Enclosure: Box, case, cabinet, or housing for electrical wiring or components.
   3. Hinged Door Enclosure: Enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with walls of box.

1.01 REFERENCES

A. American Society for Testing Manufacturing (ASTM)

B. National Electrical Manufacturers Association (NEMA)
   1. ICS 6 – Industrial Control and Systems Enclosures.
   2. 250 – Enclosures for Electrical Equipment (1,000V Maximum).

C. Underwriters Laboratories (UL)
   1. 50 – Enclosures for Electrical Equipment

D. National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electric Code (NEC)
1.02 SUBMITTALS

A. Product Data
   1. Submit the following for Engineer's approval:
      a. Manufacturer's cut sheets, catalog data, with selected products clearly marked.
      b. Instructions for installation.
      c. Dimensions and weight.

B. Shop Drawings
   1. Dimensioned plans, sections, and elevations.

1.03 QUALITY ASSURANCE

A. Certifications
   1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

B. Regulatory Requirements
   1. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
      a. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
      b. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
   3. Accept products on site in factory containers and verify damage.
   4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hoffman Engineering.
B. The EMF Company.
C. Rose Enclosure.
D. Weigmann Company; Hubbell, Inc.
E. NEMA Enclosure Manufacturing Corporation

2.02 GENERAL

A. Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for use and location. Provide items complete with covers and accessories required for intended use. Provide gaskets for units in damp or wet locations.

B. Cabinet and Enclosures Heights: Cabinet, panel, and enclosure heights shall not exceed 6 feet – 6 inches from floor to top fastening devices to allow access by Operator without use of ladders or steps to open enclosure doors.

2.03 MISCELLANEOUS MATERIALS AND FINISHES

A. Fasteners for General Use:
   1. Stainless steel screws and hardware.

B. Fasteners for Damp or Wet Locations:
   1. Stainless steel screws and hardware.

C. Finishes:
   1. Exterior Finish:
      a. Gray baked enamel for items exposed in finished locations except as otherwise indicated.
   2. Interior Finish:
      a. Where indicated, white baked enamel.

2.04 CABINETS

A. Outdoor Control Cabinets
   1. Enclosures:
      a. NEMA 4X 316 stainless steel.
   2. Enclosure Size:
      a. As indicated on Drawings, or if not indicated, as required to accommodate equipment and as indicated in UL standards.
3. Material:
   a. Exterior and interior enclosure doors, shelves and component enclosures:
      Fabricate of 14-gauge type 316 stainless steel.

4. Doors:
   a. Stainless steel pan-type construction, with full-length stainless-steel piano
      hinge (for stainless steel or aluminum). Equip exterior door with locking
      hasp, padlock, heavy-duty locking pistol-grip handles, door restraint and 3-
      point latching mechanism of the draw roller type (3/4-inch minimum
      diameter rollers). Handles shall be 3/4-inch minimum diameter stainless
      steel. Equip interior doors with flush quarter-turn closure devices. Equip
      interior and exterior doors with neoprene gaskets. Provide restraints on all
      outer doors.

5. Space Heaters:
   a. Provide minimum 150-watt strip-type space heaters with an individual
      thermostat in each section. Use heaters rated for 240V, producing the
      required wattage when operated at 120V.

6. Provide rain shield with 1-inch drip lip for outdoor cabinets to protect against
   direct sun radiation and rainfall. Design shield to provide 1 foot of cover front
   and back and 2 inches of cover on the sides. Design shield to provide no more
   than 1-foot peak height above the top of the panel with 1-inch airflow clearance
   from the top of the control panel. Shielding material: Type 316 stainless steel.

7. Nameplates:
   a. On the outside of each cabinet’s inner door, provide motor data nameplate
      information for each pump motor; copy all information exactly as shown on
      each motor nameplate. Provide engraved laminated plastic nameplates;
      black letters with white background; fasten to outside of cabinet door of
      each motor starter section with stainless steel screws.

8. In each cabinet section, provide a 120V convenience outlet and a switched 40-
   watt minimum fluorescent light fixture, with 0 degrees F ballast in each section
   (where shown on plans.)

9. Inside and outside of cabinet shall be smooth and free from burrs.

10. NEMA 4X enclosures shall have gasketed bolt holes.

11. A divider of same material and thickness as the cabinet shall be added to divide
    electrical components and wiring from instrumentation and pneumatic
    components and wiring.

12. No control devices are allowed on outer door of outdoor enclosures.
B. Clear plastic outer or inner doors are not acceptable unless specifically noted on plans.

PART 3 EXECUTION

3.01 INSTALLATION

A. Locations:
   1. Install items where indicated and where required to suit code requirements and installation conditions.

B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

C. Sizes shall be adequate to meet current NEC volume requirements, but in no case smaller than sizes indicated.

D. Remove sharp edges where they may come in contact with wiring or personnel.

3.02 GROUNDING

A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes grounding conductor, provide grounding terminal in interior of cabinet, box, or enclosure.

3.03 CLEANING AND FINISH REPAIR

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions, and weld marks.

B. Galvanized Finish: Repair damage using zinc rich paint recommended by manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch up coating.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1  GENERAL

1.00  CONDITIONS

A. The purpose of this specification section is to assure quality construction and fabrication of control panels for this project. Any Manufacturer that cannot meet the requirements of this specification section will not be considered.

B. All equipment and devices shall be NEMA rated. IEC rated equipment and devices are not acceptable.

C. Only control panels fabricated by shops listed in Section 16050 are acceptable, unless control panel is off-the-shelf product provided as part of process equipment installation and is manufactured by the Equipment Supplier, or where control panel is specified as part of equipment specified by Engineer of Record in other Specification Sections.

D. All software or programs provided by any Vendor or Contractor shall be open activation without undisclosed passwords, keys, and/or means or devices that prevent Owners access to programs. All software shall be new copies for Owner with no cost attachments. No exceptions.

1.01  SUMMARY

A. Section Includes:

1. Control switches, relays, transformers, alarm panels, terminal blocks, power suppliers, and accessories.

2. Panel fabrication and assembly requirements.

1.02  REFERENCES

A. American National Standards Institute (ANSI)

B. Institute of Electrical and Electronic Engineers, Inc. (IEEE)

C. National Electrical Manufacturers Association (NEMA)

1. NEMA ICS 1 – General Standards for Industrial Control and Systems.

2. NEMA ICS 2 – Standards for Industrial Control Devices, Controllers, and Assemblies.
3. NEMA ICS 3 – Industrial Systems.

4. NEMA ICS 6 – Enclosures for Industrial Controls and Systems.

5. NEMA ST 1 – Standard for Specialty Transformers (Except General Purpose Type).

D. Underwriters Laboratories (UL)

E. Joint Industrial Council (JIC)

F. Instrument Society of America (ISA)

G. National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electric Code (NEC)

1.03 SUBMITTALS

A. Product Data
   1. Submit all products covered under this specification for Engineer’s approval. Any items not submitted are the total responsibility of the Contractor. Requirements of this section apply to all other electrical, communications, and control and instrumentation sections.

   2. Submit the following for Engineer’s approval:
      a. Manufacturer's cut sheets, catalog data, with selected products clearly marked.
      b. Instructions for installation.
      c. Dimensions and weight.
      d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
      e. Schedule of features, characteristics, ratings, and factory settings of individual devices.

B. Shop Drawings
   1. Shop drawings indicating layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements. Show available space and proposed equipment dimensions. Provide special fabrication where required to fit available space.

C. Test and Evaluation Results
   1. Manufacturer's certificate that all equipment meets or exceeds specified
requirements.


3. Submit factory-testing procedures proposed to verify all input, output, loop operation, and system logic verification.

D. Operation and Maintenance Data

1. Include bound copies of operating and programming instructions.

2. Include component replacement, adjustments, and preventative maintenance procedures and materials.

3. The O&M manuals shall include the following as a minimum:
   a. Name, address, and telephone number of the control system supplier's local service representative.
   b. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided. Specific, not general, data is required.
   c. Copy of all approved submittal information and system shop drawings with corrections made to reflect actual system as tested and delivered to the site for installation. Half-size black line reproductions shall be provided for all shop drawings larger than 11x17 inches.
   d. Control and loop diagrams, electrical drawings, and system description and operation instructions shall be submitted in a separate binder.

1.04 RECORD DRAWINGS AND DOCUMENTATION

A. Half-size black line prints of wiring diagrams applicable to each control panel shall be placed inside a clear plastic envelope and stored in a suitable print pocket or container inside each control panel.

B. Electronic copies of the following reports shall be submitted to the Engineer:
   1. Factory Test Reports (where specified).
   2. Installation Inspection Report
   3. Field Calibration Report (where applicable)
   4. Field Testing Report(s).

C. Accurately record actual locations of control cabinets and input and output devices
connected to system. Include interconnection wiring and cabling information and terminal block layouts in control cabinets, inserted in an aluminum drawing pocket on inside of door.

D. During drawing submittal phase, submit detailed information consisting of ladder logic and line code, complete input, output, relay and controls identification labels and written description of program operation. Ladder logic diagrams submitted shall contain a written descriptive note for each line, describing the function and logic of that line. Submit all documents electronically.

E. Submit factory-testing procedures proposed to verify all input, output, loop operation, and system logic verification. Testing procedures submitted shall detail, as a minimum, verification of the following required minimum functions:

1. Verify motor start, motor stop, and level or pressure alarm outputs by simulating signals representing levels or pressures.

2. Verification of each discrete input via external manually operated connection.

3. The system shall be tested and verified with all external devices required to simulate field connections connected simultaneously for a full system test.

F. All Shop Drawings shall be bound in three ring binders with complete indexing and tab dividers. All equipment information shall be completely tagged and labeled to correspond with the drawings.

G. Review of Shop Drawings shall be for conformance with Contract Documents and with regard to functions specified to be provided.

H. Panels, Consoles, and Cabinets Information:

1. Layout Drawings include the following:
   a. Front, rear, end, and plan views to scale.
   b. Dimensional information.
   c. Tag number and functional name of components mounted in and on panel, console, or cabinet.
   d. Product information on all panel components.
   e. Nameplate location and legend including text, letter size, and colors to be used.
   f. Location of anchoring connections and holes.
   g. Location of external wiring and/or piping connections.
   h. Mounting and installation details.
i. Proposed layouts and sizes of graphic display panels.

2. Wiring and/or piping diagrams include the following:
   a. Name of panel, console, or cabinet.
   b. Wiring sizes and types.
   c. Piping and tubing sizes and types.
   d. Terminal strip numbers.
   e. Color coding.
   f. Functional name and manufacturer's designation for components to which wiring and piping are connected.

3. Electrical control schematics in accordance with JIC standards.

4. Plan showing equipment layout in each area.

I. Field wiring and piping/tubing diagrams, include the following:
   1. Wiring and piping/tubing sizes and types.
   2. Terminal strip numbers.
   3. Color coding.
   4. Conduits in which wiring is to be located.
   5. Location, functional name and manufacturer's designation of items to which wiring and/or piping are connected.
   6. Point-to-point wiring diagrams.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications

   1. Company specializing in manufacturing the assembled control products specified in this specification section with minimum 3 years documented experience, which maintains service facilities within 200 miles of project, and with proven compatibility with Owner's existing type facilities.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
3. Accept products on site in factory containers and verify damage.
4. Store products in clean, dry area.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature above 32°F and below 104°F during and after installation of products.
B. Maintain area free of dirt and dust during and after installation of products.
C. Provide temporary heating and air conditioning units and equipment required to maintain environmental conditions specified for control panels.

1.08 MAINTENANCE SERVICE

A. Provide manufacturer's Maintenance Services of control systems for one year from Date of Substantial Completion.

1.09 WARRANTY

A. Contractor shall provide full 3-year service warranty on the overall installation and shall include all labor and materials required to repair or replace equipment and/or components that are defective or malfunctioning. Included under this warranty shall be all equipment, devices, hardware, and software.
B. This warranty shall begin on date of written “Final Acceptance” of the electrical systems to be executed as required at no additional cost to the Owner.
C. Contractor's warranty shall also guarantee 24-hour service response time and shall provide labor, work, or materials as necessary to maintain plant operation when replacement parts are on order. In no case shall plant electrical systems be out of service for more than 24 hours from time Owner calls for warranty service. This shall be provided at no additional cost to the Owner. All equipment and materials installed shall have full warranty from Manufacturer that guarantees equipment is rated for harsh industrial electrical/mechanical environment in which it is installed.
D. Where Manufacturer's products fail prematurely, Manufacturer shall be fully responsible for new replacement and shall not have the option of declaring that failures were caused by environmental conditions and its effect on the product.
E. Contractor is fully responsible for assuring that Product Manufacturers are aware of this condition and that warranty statement is included in shop drawing submittals. Failure to do so will be at the Contractor’s expense and at no additional cost to the Owner.
F. All critical warranted repairs shall be made within 24 hours of receipt of required parts from Manufacturer with reasonable delivery time of overnight shipping. Any repairs not completed within 5 working days from date of notice are subject to Owner
making other arrangements for repair and back charging Contractor. This requirement is a condition of this contract.

G. Where equipment or instrument problems remain unresolved by Contractor beyond a reasonable time, a Factory Technician shall be provided on-site to take any corrective actions necessary to put equipment or instruments in operating order. Owner and Engineer reserve the right to determine a reasonable time for corrective action by Contractor.

PART 2 PANEL CONSTRUCTION AND PRODUCTS

2.01 PANEL CONSTRUCTION

A. Wiring Methods:

1. All interconnect wiring inside panel to be stranded copper conductors intended for panel wire use. Thermoplastic covered wire is not to be used.

2. All wiring to be bundled and laced with wax cord or nylon cable ties or, may be installed in Panduit wireways.

3. Cable ties shall be spaced at intervals not to exceed 4 inches. All wiring between device terminals and wireways shall be orderly and tied. Wire markers shall be visible without removing wiring from a wireway.

4. Where wireways are used, they shall be properly sized for wiring contained within and shall not be oversized. Wireway fill shall not exceed 75 percent of wireway capacity and shall not be less than 25 percent of wireway capacity. Wireway width to depth ratio shall not be less than 2 to 1.

5. All cable ties shall be trimmed and loose ends shall not exceed 1/8 inch in length after trimming.

6. Wiring bundles shall be secured in place with nylon cable clamps that are attached to the mounting plate with stainless steel bolts. Cable bundles attached to the back side of a front plate or cover plate shall be via steel studs welded to the plate before painting. Counter sunk head steel bolts may be used in which case the head finish shall match the panel finish in color so as to provide a neat appearance of the front panel. Adhesive type cable tie restraints are not allowed.

7. Wire splices inside panels are prohibited. Wire nuts and similar devices are prohibited. Split, bridged, or extended circuits shall be done via use of terminal strips only except where looped grounds or power circuits may be used where wire is not cut and is attached at each device with proper terminal devices. All circuits shall be continuous and unbroken.

8. Use wire strippers of proper size to avoid wire nicks or cut strands. Trimming strands to make wire fit a terminal is prohibited. Provide proper sized wire and/or terminal device.
B. Device Mounting:

1. All devices mounted on plates or doors shall be installed in holes that are punched with dies that specifically match the device requirements. Holes may be formed with machine tools. No mounting holes are to be cut with saws, nibblers, or similar tools not made for professional panel fabrication. All edges to be smooth and free of burrs.

2. Panels that have scratches or are otherwise damaged when mounting devices shall be touched up with the same identical paint where dried under the same conditions of heat or drying as the original panel finish. Repairs shall not be detectable.

3. All panels to be constructed of 316 stainless steel, minimum 16-gauge painted steel, or 16-gauge aluminum, as noted on plans. All doors to be rigidly constructed to prevent flexing or twisting movement when opened. This is especially of concern when devices are mounted on door. Lightweight doors are not acceptable. Inner panel is to be aluminum or steel. Plexiglas panel is not acceptable. Use fabricated trim that makes neat fit of instrument front match smoothly through front door panel. No raw cut “hole-through-door” extensions allowed for devices mounted on enclosure back plate and extended to door opening without outer trim installed 360 degrees around device at point of penetration through door panel.

4. Where panel is provided by an Equipment Manufacturer as part of the specified equipment package, the Equipment Manufacturer shall be held to these same standards and requirements. Providing panels of less quality than these standards will not be acceptable regardless of Equipment Manufacturer’s standard panel specification described in equipment data sheets. Other specification sections of lesser quality do not supersede the requirements of this specification section.

5. No devices shall be mounted in outer door of panels except where specifically noted on plans.

6. Where instruments are mounted in panel doors or plates, the mounting devices, clips, and brackets shall be type provided by the Instrument Manufacturer or shall be specifically fabricated for the purpose. All panel mounted instruments shall have enclosures that cover any exposed circuit boards or components on the back side of the instrument.

7. Components are to be attached with bolts, washers, and nuts properly sized and made for the purpose applied. Screws or self-tapping screws are not acceptable for mounting components, except self-tapping stainless screws shall be used for mounting nameplates.

8. Do not mount temperature sensitive devices near heat producing components such as resistors or transformers.
9. Arrange all devices for easy identification, removal, and repair. Removal of any device shall not require removal or disturbing other components.

10. Wet devices shall be located in lower part of panel or cabinet with metallic spray shield installed above, separating other electrical devices.

11. DIN rail mounted devices shall be made for purpose and shall be standard sized components. Micro and miniature type components are not acceptable. Provide additional 8-inch DIN rail for future devices for water plant and wastewater plant control panels.

12. All devices shall be of type that is readily available and not special-order type components that are not standard manufactured units.

13. All components, parts, and devices are to be identified at their locations with approved labels or nameplates. Provide 8½ x 11-inch laminated parts list in steel or hard plastic door pocket along with the control diagrams.

14. All over current devices shall be fast acting circuit breakers. Fuses are not allowed except where specifically called for. Where fuses are specified, provide ten (10) each spare fuses in addition to requirements of other specification sections.

15. Fused circuits are not acceptable for power or control devices. Circuit breakers shall be used for all overcurrent protection purposes. Any use of fuses shall be acceptable where specifically approved by Engineer in writing for each specified panel.

16. All display screens or readouts shall be mounted in panel at height of 60 inches above level where operator stands, except where multiple screens or readouts are shown on same panel. This must be accounted for where panels are installed on concrete pads or other elevated structures.

C. Terminals:

1. All terminations for interfacing with external wiring shall be via screw type terminal strips that have numbered markings to identify termination points. All terminals to have compression plates made specifically for the purpose, in addition to the screws. Round washers are not acceptable substitute for the compression plates.

2. All terminals or exposed wiring with more than 120 volts to ground or 300 volts between legs are to be shielded with non-metallic, non-conducting insulating material made for the purpose of avoiding accidental contact. Label all shields and devices in a recognizable manner with warning nameplate or sign.

3. Locate terminal strips in accessible location in panel to allow easy access when making terminations. Provide nameplate for each terminal strip.
D. Miscellaneous:

1. Door fasteners shall be of highest quality, designed to withstand repeated engagement and disengagement without damage to retaining parts, which shall be firmly attached to the panel frame members. Fasteners shall be properly aligned with retainer parts. Lightweight fasteners are not acceptable. Any fasteners failing before warranty period expires shall be replaced with different type fastener that is acceptable to Owner and Engineer.

2. All outdoor panel doors to be NEMA 4X 316 stainless steel unless specifically noted on plans, with three (3) point latching handle and locking hasp and rated to operate in 120-degree Fahrenheit ambient temperatures at 95 percent humidity. Key type handles are not acceptable. No control devices are allowed on outer door of outdoor enclosures.

3. All attachments and studs that are welded to stainless steel panel, enclosure, or plate shall be properly welded in such a manner that does not discolor finish. All welds shall be properly cleaned, buffed, and treated to provide a neat appearing finish. Any discolored plates or enclosures shall be replaced.

4. Panel Manufacturer shall send Engineer color photographs or e-mail color photo files of finished panel where shop inspection has not been conducted before shipping. Photos shall be of quality and clarity to allow evaluation of finished panel quality. No panels shall be delivered to job site without this review and approval in writing by Engineer and, where delivered without this approval may be rejected by Engineer. Any delay in construction schedule due to failure to satisfy this requirement will be at fault of Contractor.

5. Provide 120-volt GFI type receptacle and 12-inch or 24-inch LED, enclosed, weather tight, light fixture in each outdoor panel. Provide door switch to activate light. Provide separate circuit breaker for receptacle and light that is not common to any control circuits.

6. All equipment control panels shall have heaters to remove condensation and shall have satisfactory means of cooling to maintain temperatures below the warranty levels of each device installed inside the enclosure cabinets. Provide 120-volt space heater with thermostat control.

7. Provide thermoelectric cooling units attached to cabinets where cooling is required. Provide cabinet interior insulating and drip panel with drain line routed out of cabinet.

8. Cabinet and Enclosures Heights:

   a. Cabinet, panel, and enclosure heights shall not exceed 6 feet – 6 inches from floor to top fastening devices to allow access by Operator without use of ladders or steps to open enclosure doors.
9. Relocation of panels up to 40 feet from where shown may be required and shall be included in bid cost.

10. All control panels shall have over current protection or disconnect switch for power feeders.

11. All equipment installed on this project shall incorporate all devices and features to protect that equipment from the influence of other equipment, line voltage and phase irregularities, harmonics and other disturbances that may affect the proper and safe operation of that equipment whether these required features are a standard component of that equipment as an off-the-line product. No equipment shall be installed without these features.

12. Controls shall have HOA switch and circuits that allow automatic restart of controls after momentary power interruption, without reset action required. Lock-in push button controls are not allowed. Provide time delay for restart.

13. Provide time delay relays on all motor starters and set at staggered intervals for starting motors sequentially up to largest motor last. This function may optionally be performed by the PLC where shown on plans.

2.02 PUSHBUTTON/SELECTOR SWITCH CONTROL UNITS AND PILOT LIGHTS

A. Manufacturers:
   1. Square D Class 9001, Type K
   2. Cutler-Hammer 10250T
   3. Allen Bradley 800T
   4. Or, pre-approved equal

B. Construction:
   1. Heavy duty
   2. Watertight
   3. Oiltight
   4. Base mounting
   5. Flush panel mounting
   6. Size to mount in 30.5 mm diameter opening without adapter. Smaller units are not acceptable.
   7. Padlock attachments, where required, constructed of metal. Plastic material is not acceptable.
8. Legend plates, as required, for type of operation or as specified elsewhere.

C. Pushbuttons:
   1. Flush head unless specified elsewhere.
   2. Contact Blocks:
      a. Double break silver contacts
      b. AC Ratings: 7,200 VA make, 720 VA break
      c. Single pole, double throw or double pole, single throw
      d. Up to six (6) tandem blocks
   3. Pushbutton “Run/Stop” switches for motor controls not allowed. Use selector switches only.
   4. Maintained contact unless specified elsewhere.
   5. Non-illuminated.
   6. Legend plates, as required, for type of operation or as specified elsewhere.

D. Selector Switches:
   1. Maintained position unless specified elsewhere.
   2. Contact Blocks:
      a. Double break silver contacts
      b. AC Rating: 7,200 VA make, 720 VA break
      c. Single pole, double throw or double pole, single throw
      d. Up to six (6) tandem blocks
   3. Operators:
      a. Number of positions as specified elsewhere
      b. Standard knob type unless specified elsewhere

E. Pilot Lights:
   1. LED, high visibility type
   2. Colored lenses as specified elsewhere
   3. Interchangeable lenses
4. Push to test
5. Legend plates as specified elsewhere

2.03 MOTOR STARTER CONTROL RELAYS

A. Manufacturers
   1. Square D
   2. Cutler Hammer
   3. Or pre-approved equal

B. Construction:
   1. Industrial type
   2. 300 V rated
   3. AC operation
   4. Pressure wire connectors

C. Operating Data:
   1. Pickup Time: 11 ms maximum
   2. Dropout Time: 6 ms maximum

D. Coil:
   1. Molded construction
   2. 120 VAC, 60 Hz
   3. Continuous rated
   4. Color coded to indicate status
   5. Pilot duty
   6. 60A make, 6A break, (120V inductive)

E. Contacts:
   1. Double break
   2. Silver alloy
   3. Convertible
   4. Color coded to indicate status
5. Pilot duty

6. 60A make, 6A break, (120V inductive)

F. Track mounting capability

G. Accessories:

1. Add-on pole attachment
   a. 4 NO and 4 NC contacts
   b. Add-on to 0 to 4 pole relay

2. Latch attachment.

3. Pneumatic Timer Attachment:
   a. Single pole, double throw, double break timed contact
   b. Adjustable 0.2 to 60 sec.
   c. Repeat accuracy of ±15 percent
   d. Convertible timing mode.

4. Transient Timing Mode: Suppress coil transients to 300 V or less.

2.04 CONTROL RELAYS

A. Manufacturers:

1. Potter and Brumfield
2. Struthers Dunn
3. Turck, Inc.

4. Or pre-approved equal, unless shown otherwise on plans.

B. Operating Data:

1. Pickup Time: 13 ms maximum.
2. Dropout Time: 10 ms maximum.
3. Operating Temperature: -45°C to 70°C.

C. AC Coil:

1. 120 or 240 Volts AC
2. Continuous rated
3. 3.5 VA inrush
4. 1.2 VA sealed
5. 50 to 60 Hz
6. Minimum Dropout Voltage: 10% of coil rated voltage.

D. DC Coil:
   1. 24 or 120 Volts DC
   2. Continuous rated
   3. Minimum Coil Resistance
      a. 24 Vdc: 450 ohm
      b. 120 Vdc: 9,000 ohm

E. Contacts:
   1. Silver cadmium oxide for 1 amp or less resistive load
   2. Gold flashed fine silver, gold diffused
   3. 4 Form C
   4. 120 VAC
   5. 20 amp make, 1.5 amp break (inductive)

F. Rated at 10 million operations

G. 11 pin tube socket relay base, external color-coded test button, mechanical and electrical status indications, impact resistant thermoplastic case.

H. Plug-in sockets

I. Enclosed and protected by polycarbonate cover

J. Provide relay retaining clips.

K. All relays to be 4PDT type.

2.05 TIME DELAY RELAYS

A. Description: Control relay as specified above with added Time Cube Module as manufactured by Turck, Inc., series CT3, on or off delay as indicated.

B. Contacts: NEMA ICS 2; three (3) Form C contact sets.
C. Contact Ratings: NEMA ICS 2; DPDT Class 120 volts, 10 amperes inductive.

D. Coil Voltage: 120 volts, 60 Hz, AC, or, as shown on Plans.

E. Features: DIP-switch selectable timing ranges of 0.2-3 sec, 0.8-12 sec, 0.1-1.5 min and 0.8-12 min (unless noted otherwise on plans); externally adjustable graduated time dial; solid-state digital timing system.

2.06 PHASE FAIL PROTECTION DEVICES

A. Manufacture and Model:
   1. Diversified Electronics
      a. Model #SLD-440-ALE, 480 Volt, 3 Phase.
      b. Model #SLD-220-ALE, 240 Volt, 3 Phase.
   2. Macromatic Industrial Controls
      a. Model #PMDU, 208-480 Volt, 3 Phase
   3. Franklin Electric
      a. Submonitor Model #5860005100, 190-600 Volt, 3 Phase, with detachable display
      b. Submonitor Model #D3 Download Tools, with software and USB cable

B. Or pre-approved equal

2.07 CONTROL POWER TRANSFORMERS

A. Transformer: NEMA ST 1; machine tool transformer with isolated secondary winding.

B. Power Rating: 250 VA or 200 percent power requirement (whichever is greater).

C. Voltage Rating: 120/240 volts primary; 120 volts secondary, one-phase.

2.08 TERMINAL BLOCKS

A. Manufacturers:
   1. Entrelec, Inc.
   2. General Electric Company
   3. Bussmann
   4. Or, equal
B. Provide terminal blocks with circuit breaker overcurrent protection.

C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

E. Provide ground bus terminal block, with each connector bonded to enclosure.

2.09 ELAPSED TIME METER

A. Manufacturers:
   1. Cramer #635G/HRS.
      b. Power: 120 VAC, 60 Hz.

2.10 TIMERS

A. 24 Hour Clock Timer (Repeat Cycle):
   1. Manufacturers:
      a. Tork Time Controls
      b. Intermatic
      c. Or pre-approved equal
   2. Mounting: Surface
   3. Display: 24-hr LCD
   4. Contacts: One (1) SPDT rated 20A
   5. Set Points: 288 per 24 hr.
   6. Skip Feature: 1 to 7-day adjustable
   7. Minimum On-Off Time: 5 min.
   8. Time cycle programmable by keypad
   9. Power: 120 VAC, 60 Hz

B. Interval/Duration Timer:
   1. Manufacturers:
2.11 ALTERNATOR

A. Manufacturers:

1. ATC Diversified Electronics:
   a. Two (2) Pump Duplexor:
      (i) 24 VAC/DC, ARA-24-ABA
      (ii) 48 VDC, ARA-48-ABA
      (iii) 120 VAC/DC, ARA-120-ABA
      (iv) 208 VAC, ARA-208-ABA
      (v) 240 VAC, ARA-240-ABA
   
2. Time Mark Corporation:
   a. 120 V, B 471

3. Macromatic Industrial Controls:
   a. Two (2) Pump Duplexor:
      (i) 120 volt, ARP120A6
      (ii) 240 volt, ARP240A6

4. Or equal as pre-approved by Engineer

B. Provide automatic alternation of energizing motor starters.

C. Permit operation of units as single or group operation as called by pilot devices.

D. N.O. auxiliary contacts from motor starters required to operate alternator.

E. Alternator shall provide for operation of standby or lag unit through second pilot device in event of failure of lead unit or first pilot device or alternator coil.
2.12 EXTERIOR MOUNTED ALARM LIGHT
   A. Manufacturers:
      1. Edwards
      2. Appleton Electric Company
      3. Crouse Hinds
      4. Or pre-approved equal
   B. 120 VAC
   C. Suitable for use in wet location, gasketed.
   D. Cabinet mounted, provide mounting lugs. Body to include outlet box.
   E. Aluminum mounting hood.
   F. Red glass globe with guard.
   G. ¾ inch conduit hubs

2.13 EXTERIOR MOUNTED ALARM HORN
   A. Manufacturers:
      1. Edwards
      2. Or pre-approved equal.
   B. 120 VAC
   C. Suitable for use in wet location, gasketed.
   D. Cabinet mounted, provide mounting lugs. Body to include outlet box.
   E. Aluminum mounting hood.
   F. ¾ inch conduit hubs

2.14 ACCESSORIES
   A. Plastic Wireway:
      1. Manufacturers:
         a. Panduit Corp.
         b. Delaware Industries, Inc.
      2. Description: Plastic slotted wireway with snap-on locking covers. White or grey
PART 3 EXECUTION

3.01 PREPARATION

A. Use control diagrams on plans, equipment manufacturer’s data, P&ID’s, Flow Diagrams, electrical plans and all other information in Construction Documents to verify intent of system controls before preparing shop drawing diagrams for Engineers review and acceptance.

B. Where control sequence is not clear or, where not familiar with type of control, consult Engineer for clarification.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and intent of Contract Drawings. Provide sufficient clearance for calibration and maintenance access.

B. Do not install products until major construction is complete and building interior is enclosed and heated.

C. Install control panels, instruments, and motor control centers, to allow a minimum of four (4) feet clearance for access to control devices.

D. Connect input and output devices as shown or, as intended, on Drawings.

E. Provide complete testing.

3.03 FIELD QUALITY CONTROL / TESTING

A. All elements of each electrical control system shall be set up, calibrated, and tested by Manufacturer's Technician to demonstrate that the total system satisfies all the requirements of this Specification. All special testing of materials and equipment shall be provided by the Contractor. At a minimum, the testing shall include both a factory test and a field test.

B. Testing requirements are as follows:

1. Factory Tests: The electrical controls, instrumentation systems, and all other associated hardware shall be tested via a full simulation at the factory, prior to shipment, to demonstrate that each component is operational and meets the requirements of these specifications. Manufacturer shall provide test routine program for shop testing of I/O wiring.

2. Test results shall be certified, with written documentation provided to the Engineer upon test completion. Factory testing may be witnessed by the Engineer.

3. Field Tests: All electrical control system components shall be checked to verify
that they have been installed properly and that all terminations have been made correctly.

4. Witnessed field tests shall be performed on the complete system. Prior to witnessed test, Contractor shall perform a complete test of each and every function, device operation and overall operations of electrical power and control system.

5. Contractor shall provide a checklist for all electrical, control and instrumentation functions and send to Engineer for approval.

6. Each function shall be demonstrated to the satisfaction of the Owner and Engineer on a paragraph-by-paragraph basis. Any equipment, devices or functions that are found not performing properly will be reason for termination of test until repairs are made. Additional testing by Engineer and Owner may be at Contractor’s expense for time and travel of Engineer and Owner’s staff. Each test shall be witnessed and signed off by the Contractor and the Engineer upon satisfactory completion. The equipment Manufacturer’s Representative shall be present for all testing, setup, demonstrations, and training. The Contractor shall notify the Owner at least two (2) weeks prior to the commencement date of the field tests. After tests are completed and with system fully operational, system shall run continuously for a period of 90 days without failure. Any failures shall be repaired and test shall start over again.

3.04 SYSTEM STARTUP

A. Provide systems demonstration in presence of Owner and Engineer.

B. System demonstration to include the following:
   1. Complete verification of all field wiring.
   2. Demonstrate operation of Controls.
   3. Demonstration of functionality of each field device action.
   4. Complete demonstration of each alarm by simulation of actual field device action.

3.05 TRAINING

A. Provide minimum eight (8) hours of “hands-on” instruction each for Owner’s staff. To be conducted at project site by control systems manufacturer’s representative, at no additional cost to Owner. Training is to be conducted after all control systems are fully operational.

B. Provide minimum two (2) week’s notice to Engineer and Owner to schedule training session(s).
3.06 CLEANING
   A. Contractor is to remove all debris and trimmings from control panel.
   B. Wipe down and clean all HMI's and panels to be free of dust and dirt.
   C. Touch up scratches and mars of finish to match original finish.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
   A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section includes

1. This section specifies the furnishing, installation, connection, and testing of wiring devices.

1.01 REFERENCES

A. Federal Specifications

1. W-C-596F

B. Institute of Electrical and Electronic Engineers, Inc. (IEEE)

C. National Electrical Manufacturers Association (NEMA)

1. NEMA WD1 - General Purpose Wiring Devices.
2. NEMA WD6 - Dimensional Requirements.

D. Underwriters Laboratories (UL)

1. UL 20 – General Use Snap Switches
2. UL 231 – Power Outlets
3. UL 467 – Grounding and Bonding Equipment
4. UL 498 – Attachment Plugs and Receptacles
5. UL 943 – Ground Fault Circuit Interrupters
6. UL 1449 – Surge Protective Devices

E. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code (NEC)

1.02 SUBMITTALS

A. Product Data
1. Submit the following for Engineer’s approval:
   a. Manufacturer’s cut sheets, catalog data, with selected products clearly marked.
   b. Installation, terminating and splicing procedures.
   c. Instruction for handling and storage.
   d. Dimensions and weight.

B. Shop Drawings

1.03 QUALITY ASSURANCE

A. General Qualifications
   1. All devices and materials shall be Underwriter’s Laboratories, (UL) listed.
   2. All devices, switches, receptacles, and cover plates shall be specification grade.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
   3. Accept products on site in factory containers and verify damage.
   4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hubbell Inc., Bryant / Wiring Devices Division
B. Eaton / Crouse-Hinds
C. Leviton Manufacturing Company
D. Pass & Seymour; Legrand
E. Or approved equal

2.02 MATERIALS AND EQUIPMENT

A. Standards: Conform to NEMA WD1 for general requirements and NEMA WD6 for dimensional requirements.
B. Manufacture devices to heavy-duty industrial specification grade with brown nylon bodies (orange for isolated-ground receptacles) back and side wiring provisions and green-colored grounding screws.

C. All receptacles shall comply with NEMA, NFPA, UL, and rated as shown on the drawings.

D. Receptacles:
   1. Duplex-type receptacles: Rated 20 amps at 120 volts.
   2. Contacts: Brass or phosphor bronze.
   3. Receptacle grounding system: Extend to the mounting strap unless isolated ground is indicated or required.
   4. GFI or GFCI (ground fault circuit interrupter) receptacles: Provide feed-through type with test and reset button.

E. Wall Switches:
   1. Toggle switches: Rated 20 amps at 120/277 volts AC rated for both resistive and inductive loads.
   2. Contacts: Silver cadmium oxide construction to prevent sticking, welding and excessive pitting.

F. Cover Plates:
   1. In outdoor, corrosive, and wet areas, provide cover plates of cast metal, gasketed with spring-loaded hinged covers and stainless-steel hardware.
   2. All other plates: Type 302 stainless steel.

PART 3 EXECUTION

3.01 PREPARATION
   A. Verify that device boxes are correctly placed.
   B. Verify that the correct quantity, size, and type of wires are pulled to each device box.
   C. Verify that wiring has been checked at both ends.
   D. Prepare wire ends for connection to devices.
   E. Inspect each wiring device for defects.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
B. Install devices plumb and level.
C. Install switches with OFF position down.
D. Install receptacles with grounding pole on top.
E. Connect wiring device grounding terminal to outlet box with bonding jumper.
F. Connect wiring devices by wrapping conductors clockwise around screw terminals.
G. Install cover plates on switch, receptacle, and blank outlets in finished areas.
H. Energize and test devices for proper operation.
I. Use screw connections for wires. No push-in connections allowed.
J. Only two (2) wires per screw terminal allowed. No conductor splices in receptacle box. Use separate box for splicing.
K. Do not connect motor loads of any type to receptacles terminals.
L. For wastewater plant applications, install receptacles at 48 inches AFF.
M. Install GFI receptacles for receptacles in wet areas, pump rooms and all outdoor locations. Provide W.P. in-use covers.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section Includes

1. General Purpose, Dry Type Transformers
2. Control and Signal Transformers
3. Mini Power Zone Packaged Power Supply

1.01 REFERENCES

A. Institute of Electrical and Electronic Engineers, Inc. (IEEE)

2. C57.12.91 – Standard Test Code for Dry-Type Distribution and Power Transformers

B. National Electrical Manufacturers Association (NEMA)

1. LA 1 – Surge Arrestors
2. ST 1 - Specialty Transformers (Except General-Purpose Type)
3. ST 20 – Dry-Type Transformers for General Applications

C. Underwriters Laboratories (UL)

1. 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors
2. 506 – Specialty Transformers

D. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code (NEC)

E. U.S. Department of Energy (DOE)

1. DOE 2016 10 CFR Part 431

1.02 SUBMITTALS
A. Product Data
   1. Submit the following for Engineer's approval:
      a. Manufacturer's cut sheets, catalog data, with selected products clearly marked.
      b. Installation, terminating and splicing procedure.
      c. Instruction for handling and storage.
      d. Dimensions and weight.
      e. Elevations showing minimum clearances.

B. Shop Drawings
   1. Submit the following shop drawings for Engineer's approval:
      a. Dimensional plans and sections
      b. Wiring diagrams
      c. Manufactures nameplate data and electrical ratings

C. Test and Evaluation Results
   1. Certified copies of manufacturer's design and routine factory tests required by reference standards.
   2. Submit after manufacture of transformer and before installation.

D. Operation and Maintenance Data

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications
   1. Manufacturer shall have produced similar electrical equipment for a minimum period of 10 years.

B. Regulatory Requirements

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
1. Handle transformers in accordance with manufacture’s recommendations. Utilize factory provisions for all lifting, rigging, or hoisting.

2. Store transformers prior to installation in a temperature and humidity-controlled space. If such a space is not available, apply temporary heat in accordance with the manufacturer’s instructions within each ventilated type transformer case to exclude moisture and condensation.

3. Deliver products to site in acceptable condition and in protective wrappings.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Square D
   B. General Electric
   C. Eaton
   D. Or approved equal

2.02 TRANSFORMERS, GENERAL
   A. Transformers:
      1. Factory-assembled and tested, air-cooled units of types specified, having characteristics and ratings as indicated.
      2. Design unit for 60 Hz service.
   B. Cores: Grain-oriented, non-aging silicon steel.
   C. Coils: Continuous windings without splices, except for taps.
   D. Internal Coil Connections: Brazed or pressure type.
   E. Bolt coil/core to bottom of enclosure for transformers larger than 15 kVA.
      1. Isolated by rubber, vibration-absorbing mounts.
      2. Metal-to-metal contact between coil/core and enclosure not allowed.
   F. Provide copper windings.
   G. Nameplates: Provide metal nameplate listing manufacturer's name, serial number, type, class, kVA voltage, frequency, and showing internal wiring diagram.
   H. Sound Level: Minimum 3 dB less than sound levels for transformer type and size indicated when factory-tested in accordance with NEMA ST 20.
   I. Enclosures at wastewater treatment plant outdoor or chemical area locations to be
NEMA 4X stainless steel.

2.03 GENERAL PURPOSE, DRY TYPE TRANSFORMERS

A. Comply with NEMA ST 20.

B. Windings: 2-winding type. 3-phase transformers shall use 1 coil/phase in primary and secondary.

C. Transformers shall have following features and ratings.

1. Enclosure: Indoor, ventilated unless otherwise shown on plans, outdoor, weather proof unless shown otherwise on plans.

2. Insulation Class: 185°C or 220°C class for transformers 15 kVA or smaller; 220°C class for transformers larger than 15 kVA.

3. Insulation Temperature Rise: 80°C maximum rise above 40°C for 15 kVA and larger; 115°C maximum rise above 40°C below 15 kVA.

4. Taps: For transformers 3 kVA and larger, full capacity taps in high voltage winding as follows.

   a. 3 through 10 kVA: Two 5% taps below rated high voltage.

   b. 15 through 500 kVA: Six 2-1/2% taps, 2 above and 4 below rated high voltage.

   c. 750 through 1,000 kVA: Four 2-1/2% taps, 2 above and 2 below rated high voltage.

D. Accessories: Following accessory items are required where shown on Drawings.

1. Surge Arresters: Low voltage type, factory-installed and connected to high voltage terminals; complying with NEMA LA 1.

2. Wall Mounting Brackets: Manufacturer's standard brackets for transformers sized up to 75 kVA where wall mounting indicated.

3. Electrostatic Shielding: Insulated metallic shield between primary and secondary windings. Connect to terminal marked "shield" for grounding connection, where applicable.

2.04 CONTROL AND SIGNAL TRANSFORMERS

A. Comply with NEMA ST 1 and UL 506.

B. Ratings:
1. As indicated and for continuous duty.

2. Where rating not indicated, provide 250 percent of load.

C. Type: Self-cooled, 2-winding dry type.

D. Enclosure: Outdoor, except as indicated.

2.05 MINI POWER ZONE PACKAGED POWER SUPPLY

A. Provide with primary breaker, transformer, secondary breaker, and circuit breaker panel as indicated on plans.

B. Enclosure shall be NEMA 4X for outdoor locations. Provide stainless steel enclosure where shown on plans.

C. Unit shall be rated for maximum full load temperature rise of 115°C.

PART 3 EXECUTION

3.01 INSTALLATION

A. Arrange equipment to provide adequate spacing for cooling air circulation.

B. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values not indicated, use those specified in UL 486A and 486B.

C. Install wall-mounted transformers on prefabricated brackets designed for purpose.

D. Install floor-mounted transformers on 4-in. concrete housekeeping pad.

E. Touch up scratched or marred surfaces to match original finish.

F. Identify transformers as specified herein.

G. Install lightning arresters as shown on Drawings.

3.02 GROUNDING

A. Ground in accordance with Section 26 05 26.00 – “Grounding and Bonding for Electrical Systems.”

B. Ground secondary transformers with separate driven ground rod.

3.03 FIELD QUALITY CONTROL / TESTING

A. Test and permanently record as follows.

1. Prior to energization of transformers, test phase-to-phase and phase-to-ground insulation resistance levels.
2. Test transformers for continuity of circuits and short-circuits.

3.04 ADJUSTING
A. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.05 CLEANING
A. Upon completion of installation, inspect interiors and exteriors of accessible components.
   1. Remove paint splatters and other spots, dirt, and construction debris.
   2. Touch up scratches and mars of finish to match original.

3.06 PROTECTION
A. Temporary Heating:
   1. Comply with manufacturer's written recommendations within enclosure of each transformer throughout periods during which equipment is not in a space continuously under normal control of temperature and humidity.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 CONDITIONS

A. Fusible switches are allowed only where specifically shown on Plans for this project, or where approved in writing by Engineer.

1.01 SUMMARY

A. Section includes:

1. The work specified in this Section includes, but shall not be limited to, molded case circuit breakers and disconnect switches as specified herein and as indicated or scheduled on the Drawings, as follows:

   a. Fusible disconnect switches
   b. Non-fusible disconnect switches
   c. Circuit breaker type disconnect switches
   d. Feeder and equipment disconnects
   e. Enclosed circuit breakers
   f. Circuit breakers

B. Definitions:

1. Overcurrent Protective Device (OCPD): Device operative on excessive current that causes and maintains interruption of power in circuit it protects.

2. Ampere-Squared-Seconds: Expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, ampere-squared-seconds during fault current interruption represents energy allowed to flow before fuse or breaker interrupts fault current within its current limiting range.

1.02 REFERENCES

A. American National Standards Institute (ANSI)

1. C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures

2. C37.50 – Low-Voltage AC Power Circuit Breakers Used in Enclosures Test
**Procedures**

**B. Institute of Electrical and Electronic Engineers, Inc. (IEEE)**

**C. National Electrical Manufacturers Association (NEMA)**
1. AB1 – Molded Case Circuit Breakers and Molded Case Switches
2. 250 – Enclosures for Electrical Equipment
3. KS1 – Enclosed Switches
4. FU1 – Low Voltage Cartridge Fuses

**D. Underwriters Laboratories (UL)**
1. 98-87 – Enclosed and Dead Front Switches
2. 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors
3. 489 – Molded Case Circuit Breakers

**E. National Fire Protection Association (NFPA)**
1. NFPA 70 – National Electric Code (NEC)

### 1.03 SUBMITTALS

**A. Product Data**
1. Submit all products covered under this specification for Engineer’s approval. Any items not submitted are the total responsibility of the Contractor. Requirements of this section apply to all other electrical, communications, and control and instrumentation sections.

2. Submit the following for Engineer’s approval:
   a. Product data for fuses, switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for protective devices and let through current curves for those with current limiting characteristics.
   b. Include coordination charts and tables and related data.
   c. Manufacturer's cut sheets, catalog data, with selected products clearly marked.
   d. Instructions for installation.
e. Dimensions and weight.

f. Identification materials.

g. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

B. Shop Drawings

1. Spare fuse cabinet showing dimensions and features including storage provision for fused cartons, where shown on plans.

2. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer installed wiring and field installed wiring.

C. Test and Evaluation Results

1. Certified reports of field tests and observations.

D. Operation and Maintenance Data

1. Include Maintenance data for overcurrent devices, including trip curves.

E. Record Drawings and Documentation

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.

2. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.

3. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.

B. Regulatory Requirements

1. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

   a. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.

   b. Terms "listed" and "labeled" shall be as defined in National Electrical Code.

C. Single-Source Responsibility: Obtain similar enclosed switches, circuit breakers,
and OCPD's from single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
   3. Accept products on site in factory containers and verify damage.
   4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fusible Switches:
   1. Eaton
   2. General Electric (GE)
   3. Square D
   4. Siemens

B. Fused Power Circuit Devices:
   1. Eaton
   2. General Electric (GE)
   3. Square D
   4. Boltswitch

C. Molded Case Circuit Breakers:
   1. Eaton
   2. General Electric (GE)
   3. Square D

D. Insulated Case Circuit Breakers
   1. Eaton
   2. General Electric (GE)
   3. Square D
E. Combination Circuit Breaker and Ground Fault Trip:
   1. Eaton
   2. General Electric (GE)
   3. Square D

F. Molded Case Current Limiting Circuit Breakers:
   1. Eaton
   2. General Electric (GE)
   3. Square D

G. Other Manufacturers that are pre-approved in writing.

2.02 OVERCURRENT PROTECTIVE DEVICES (OCPD’S), GENERAL

A. General:
   1. Provide OCPD’s in indicated types, as integral components of panelboards, switchboards, and motor control centers; and as individually enclosed and mounted single units.

B. Enclosures:
   1. NEMA 1, except that all outdoor areas and indoor environmentally harsh locations such as wastewater process areas shall be NEMA 4X stainless steel.

2.03 FUSIBLE SWITCHES

A. UL 98 and NEMA KS 1 quick-make, quick-break heavy-duty units.

B. Rating:
   1. Load-breaking capacity in excess of normal horsepower rating for switch.

C. Withstand Capability:
   1. In excess of let through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.

D. Operation:
   1. By means of external handle.

E. Interlock:
   1. Prevents access to switch interior except when in “off” position.
F. Fuse Clips:
   1. Rejection type.

G. Padlocking Provisions:
   1. For two (2) padlocks, whether open or closed.

H. Enclosure for Switchboard or Panelboard Mounting:
   1. Suitable for panel mounting where indicated.

I. Enclosure for Switchboard Mounting:
   1. Provide individual mounting where indicated.

J. Enclosure for Independent Mounting:
   1. NEMA Type 12, or as indicated on plan set, or required to suit environment where located, except all outdoor areas and all indoor environmentally harsh locations such as wastewater process areas shall be NEMA 4X stainless steel.

2.04 ENCLOSED SWITCHES

A. Enclosed Non-fusible Switch:
   1. NEMA KS 1, Type HD handle lockable with 2 padlocks

B. Enclosed Fusible Switch, 800 Amperes and Smaller:
   1. NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with two (2) padlocks, and interlocked with cover in CLOSED position.

C. Enclosed Fusible Switch Larger Than 800 Amperes:
   1. Bolted pressure or high pressure contact switch, bus drilled to accommodate specified fuses, enclosure consistent with environment where located.
      2. Minimum Fault Current Rating: 100,000 symmetrical rms amperes.

D. All enclosures located outdoors or where subject to wet or environmentally harsh locations shall be NEMA 4X 316 stainless steel.

E. All switches shall be rated at 600 volts minimum.

F. Handle operator mechanisms shall be on side of enclosure and not on front. Keyed mechanisms that separate handle from breaker mechanism when door is opened are not acceptable.

2.05 FUSED POWER CIRCUIT DEVICES
A. UL 977, with either bolted-pressure-type or high-pressure contact-type switch.

B. Operation:
   1. As indicated.

C. Ground Fault Protection:
   1. Integral, self-powered type with mechanical ground fault indicator, test function, adjustable pick up current and delay time with inverse and constant time characteristics, internal memory arranged to integrate intermittent arcing ground faults, and ground fault current sensor located as indicated.

D. Open Fuse Trip Device:
   1. Arranged to trip switch open if phase fuse opens.

E. Enclosure for Switchboard Mounting:
   1. Suitable for individual mounting.

F. Enclosure for Independent Mounting:
   1. NEMA Type 12, or as indicated on plan set, or required to suit environment where located, except all outdoor areas and all indoor environmentally harsh locations such as wastewater process areas shall be NEMA 4X stainless steel.

G. Minimum Fault Current Rating:
   1. As indicated.

2.06 MOLDED-CASE CIRCUIT BREAKERS

A. UL 489 and NEMA AB 1.

B. Construction:
   1. Bolt in type, except breakers in load-center-type panelboards and breakers 225 ampere frame size and larger may be plug in type if held in place by positive locking device requiring mechanical release for removal.

   2. Handle operator mechanisms shall be on side of enclosure and not on front. Keyed mechanisms that separate handle from breaker mechanism when door is opened are not acceptable.

C. Characteristics:
   1. Indicated frame size, trip rating, number of poles, and short-circuit interrupting capacity rating of 10,000 amperes symmetrical, unless greater rating is indicated on Drawings.
D. Tripping Device:
   1. Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole. All service or feeder breakers to have removable trip plug, to have adjustable overcurrent trip, or to be electronic adjustable type.

E. Adjustable Instantaneous Trip Devices:
   1. Factory adjusted to low-trip-setting current values.

F. Enclosure for Switchboard or Panelboard Mounting:
   1. Suitable for panel mounting in switchboard or panelboards where indicated.

G. Enclosure for Switchboard or Motor Control Center Mounting:
   1. Provide individual mounting where indicated.

H. Enclosure for Independent Mounting:
   1. NEMA Type 12, or as indicated on plan set, or required to suit environment where located, except all outdoor areas and all indoor environmentally harsh locations such as wastewater process areas shall be NEMA 4X stainless steel.

I. Combination Circuit Breakers and Ground-Fault Circuit Interrupters:
   1. UL 943 arranged for sensing and tripping for ground-fault current in addition to overcurrent and short-circuit current.
      (i) Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.
      (ii) Trip Setting for Ground Fault: 4 to 6 milliamperes, listed and labeled as Class A, Type 1 device.
      (iii) Trip Setting for Ground Fault: 30 milliamperes.

J. Current-Limiting Circuit Breakers:
   1. Arranged to limit let through ampere-squared-seconds during fault conditions to value less than ampere-squared-seconds of one-half-cycle wave of prospective symmetrical fault current. Circuit breaker shall use no fusible devices in its operation. Current-limiting characteristic shall be in addition to normal time-delay and instantaneous-trip characteristics and other features as indicated.

K. Circuit Breakers With Solid-State Trip Devices:
   1. Provide indicated circuit breakers with solid-state trip devices having following features:
a. Ambient Compensation: Trip device insensitive to temperature changes between minus 20°C and plus 55°C.

b. Adjustability: Breaker ratings and trip settings shall be changeable by operation of controls on front panel of breaker, by change of plug in element without removing breaker from mounting, or by combination of two methods.

c. Ground-Fault Tripping: Adjustable for pick up and time-delay values. Provide for indicated units.

d. Provide clear plastic shield limiting access to rating plug and adjustments on solid-state trip circuit breaker. Seal by attaching sealing wire through hole in posts provided. With wire seal installed, circuit breaker rating plug and adjustments shall not be "readily accessible."

L. For all electronic breakers requiring programming unit for trip adjustments provide one (1) unit for Owner and Engineers use in setting adjustments after contract ends. This unit to be supplied in new box with all appurtenances included. Submit unit to Engineer for examination prior to final acceptance testing of equipment.

2.07 INSULATED-CASE CIRCUIT BREAKERS

A. UL 489 and NEMA AB 1.

B. Ratings:
   1. Continuous-current, interrupting, and short-time-current ratings, and voltage and frequency ratings as indicated.

C. Operating Mechanism:
   1. Mechanically and electrically trip-free, stored-energy operating mechanism with following features:

D. Moving Contacts Closing Speed:
   1. Independent of both control and operator.

E. Circuit-Breaker Trip Devices: Solid-state overcurrent trip device system that includes one (1) integrally mounted current transformer or sensor per phase, release mechanism, and following features:
   1. Functions:
      a. Long-time-delay, short time delay, and instantaneous-trip functions, which are independent of each other in both action and adjustment.
      2. Temperature compensation to assure accuracy and calibration stability from minus 20°C to plus 55°C.
3. Field-adjustable, time-current characteristics.

4. Current Adjustability:
   a. Effected by operating controls on front panel or by changing plug in elements or current transformers or sensors.

5. Three bands for long-time and short-time delay functions marked "minimum," "intermediate," and "maximum."

6. Five (5) pickup points, minimum, for long-time and short-time trip functions.

7. Six (6) pickup points, minimum, for instantaneous-trip functions.

8. Ground fault protection with at least three (3) short-time-delay settings and thirty-seven (37) trip-time-delay bands. Adjustable current pickup.

9. Trip Indication: Labeled lights or mechanical indicators on trip device shall indicate type of fault causing breaker trip. If lights are used, integral power source shall maintain indication for 60 hours, minimum.

F. Auxiliary Contacts for Remote Indication:
   1. Where remote indication of breaker position is indicated, provide spare auxiliary switch in addition to other auxiliary switches required for normal breaker operation. Spare auxiliary switch shall consist of two (2) Type “a” and two (2) Type “b” stages (contacts), wired to terminal block in breaker housing.

G. Draw Out Features:
   1. Circuit-breaker mounting assembly equipped with racking mechanism that properly positions power circuit breaker and holds it rigidly in connected, test, and fully disconnected positions and includes following features:
      a. Interlock arrangement, preventing movement of circuit breaker to or from connected position when it is in closed position and closure of circuit breaker unless it is in connected, test, or disconnected position.
      b. Construction, permitting racking open circuit breaker to or from connected, test, and disconnected positions with associated compartment door closed or equivalent dead-front barrier protection, and manual withdrawal to position for removal from structure with door open.
      c. Primary disconnecting devices disengaged, and secondary disconnecting devices engaged when breaker is in test position.
      d. Primary and secondary devices disengaged when circuit breaker is in disconnected position.
      e. Ground contact engaged when circuit-breaker element is in connected and
test positions.

H. Circuit-Breaker Features and Accessories: Includes the following:

1. Padlocking Provisions: For installing at least two (2) padlocks on each breaker to secure its enclosure and prevent movement of draw out mechanism.

2. Operating Handle: Provide one (1) for each manually operated breaker. No handle ties are permitted.

3. Electric Close Button: Provide one (1) for each electrically operated breaker.

4. Indicating Lights: Contacts for "Breaker Open" and "Breaker Closed," for main and bus tie circuit breakers, and for other indicated breakers.

2.08 OCPD ACCESSORIES

A. Key Interlocks:

1. Arrange interlocking so keys are held captive at devices indicated. Where future key interlocking provisions are indicated, provide necessary mountings and hardware as required for future installation.

B. Instantaneous Undervoltage Trip Device:

1. For indicated OCPD’s.

C. Adjustable-Time-Delay Undervoltage Trip Devices:

1. For indicated OCPD’s.

D. Shunt-Trip Devices for Circuit Breakers:

1. Where indicated, arrange to trip breaker from external source of power through control switch or relay contacts.

E. For all electronic breakers requiring programming unit for trip adjustments provide one (1) unit for Owner and Engineers use in setting adjustments after contract ends. This unit to be supplied in new box with all appurtenances included. Submit unit to Engineer for examination prior to final acceptance testing of equipment.

F. All service and feeder breakers to have removable trip plug, to have adjustable overcurrent trip, or to be electronic adjustable type.

G. Solid-state breaker requiring programming unit for settings adjustment

1. Provide new programming unit and all accessories for Owner and Engineers use. Turn over to Engineer for review and testing.

2. Original set-up and adjustments shall be performed by the Circuit Breaker Manufacturers Factory Representative.
2.09 ENCLOSURES

A. Where OCPD’s are installed in enclosures. Provide for operating via external lockable three (3) point latching handle without removing a cover or a bolted-on plate. Lockable hinged door access is acceptable where approved by Engineer or where required by enclosure classification. All outdoor enclosures to be NEMA 4X stainless steel unless specifically show otherwise on plans or approved by Engineer in writing.

B. Handle operator mechanisms shall be on side of enclosure and not on front. Keyed mechanisms that separate handle from breaker mechanism when door is opened are not acceptable.

2.10 MOTOR CIRCUIT PROTECTION (MCP)

A. Provide electronic type MCP for motor starters. Unit shall learn inrush current and adjust accordingly.

2.11 LOAD SIZE CONNECTIONS

A. Where OCPD serves as an incoming service main breaker or switch, include provisions for fixture connection of transfer switch conductor lugs. Provide removable bus bars. Provide adequate wiring space inside enclosure.

PART 3 EXECUTION

3.01 COORDINATION

A. Contractor shall determine size, horsepower, voltage and phase of all equipment and motors supplied and shall adjust breaker and fused switch size accordingly and shall note on submittals. Failure to do so will be at expense of Contractor and at no additional cost to Owner.

B. Coordinate OCPD sizes with characteristics of motors supplied for this project. Pay special attention to high efficiency motors.

3.02 INSTALLATION

A. Install enclosed switches and circuit breakers in locations as indicated, according to manufacturer’s written instructions.

B. Fuses: Install fuses in fusible devices indicated.

C. Independently Mounted OCPD’s: Locate as indicated and install in accordance with manufacturer's written installation instructions.

D. Factory install OCPD’s furnished in distribution equipment.

E. Coordinate size overcurrent protective devices with each motor and equipment manufacturer to assure correct size devices and provide accordingly.
F. Install enclosed switches and circuit breakers level and plumb.

G. Install wiring between enclosed switches and circuit breakers and control/indication devices.

H. Connect enclosed switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer’s published torque tightening values for equipment connectors. Where manufacturer’s torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.03 APPLICATION OF FUSES

A. Control Circuits: Class CC, time delay.

B. General Purpose Fusible Switches: Apply following class and types:
   1. 30-600 Amperes: Class J or RK1, time delay.
   2. 601-6,000 Amperes: Class L, time delay.
      a. Size at 125% of motor FLA not to exceed 150%.
      b. For transformers, size per NEC Table 450-3(b).
      c. Size at 100% of load for mains and feeders with non-inductive loads.

C. Combination Starters: Class J or RK1, time delay.

D. Bolted Pressure Switches: Class L, time delay.

3.04 ADJUSTING

A. Set field adjustable enclosed switches and circuit breaker trip ranges as indicated.

3.05 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness.

B. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values. Where manufacturer’s torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.06 GROUNDING

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.
3.07 COORDINATION STUDY

A. Provide coordination study to determine settings for overcurrent protective devices. Where coordination study recommends changes in types, classes, features or ratings of equipment or devices those indicated, make written request for instructions. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed. Make all settings and adjustments according to coordination study results. Provide hard copy records of study for Engineer’s review.

3.08 FIELD QUALITY CONTROL / TESTING

A. Testing:

1. Reports: Prepare certified written reports on tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include complete records of repairs and adjustments made.

2. Labeling: Upon satisfactory completion of tests and related effort, apply label to tested components indicating test results, date, and responsible person.

3. Schedule visual and mechanical inspections and electrical tests with at least one (1) week’s advance notification.

4. Pre-testing: Upon completing installation of system, perform following preparations for tests:
   a. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
   b. Make continuity tests of circuits.
   c. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
   d. Comply with manufacturer's instructions for installation and testing of OCPD’s.

5. Visual and mechanical inspection: Include following inspections and related work.
   a. Overcurrent Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make final system adjustments.
   b. Inspect for defects and physical damage, NRTL labeling, and nameplate
compliance with current single line diagram.

c. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.

d. Check tightness of electrical connections of OCPD’s with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

e. Clean OCPD’s using manufacturer's approved methods and materials.

f. Verify installation of proper fuse types and ratings in fusible OCPD’s.

6. Electrical Tests: Include following items performed in accordance with manufacturer's instructions:

   a. Insulation resistance test of OCPD conducting parts. Insulation resistance less than 100 megohms is not acceptable.

   b. Verify trip unit reset characteristics for insulated-case circuit breakers.

   c. Make adjustments for final settings of adjustable-trip devices.

   d. Activate auxiliary protective devices such as ground fault or undervoltage relays, to verify operation of shunt-trip devices.

   e. Check stored-energy charging motors for proper operation of motor, mechanism, and limit switches.

   f. Check operation of electrically operated OCPD’s in accordance with manufacturer's instructions.

   g. Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on locked-closed devices including moveable barriers and shutters.

7. Retest: Correct deficiencies identified by tests and observations and retest. Verify by system tests that specified requirements are met.

3.09 CLEANING

   A. Upon completion of installation, inspect OCPD’s. After completing system installation including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

3.10 MAINTENANCE

   A. Provide extra materials as follows:

      1. Maintenance Stock, Fuses: For types, voltage, and ampere ratings required
ENCLOSED SWITCHES AND CIRCUIT BREAKERS
METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, TX
100% CONSTRUCTION DOCUMENTS

furnish 10% spare fuses, but not less than one (1) set of three (3) of each kind.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 SUMMARY

A. Section includes:

1. Lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

B. Definitions:

1. Overcurrent Protective Device (OCPD): Device operative on excessive current that causes and maintains interruption of power in circuit it protects.

1.01 REFERENCES

A. Institute of Electrical and Electronic Engineers, Inc. (IEEE)


2. C62.11 - Standard for Metal-Oxide Surge Arrestors for AC Power Circuits

B. National Electrical Manufacturers Association (NEMA)

1. PB1 – Panelboards

2. PB1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 volts or less.

C. Underwriters Laboratories (UL)

1. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

2. 870 - Wireways, Auxiliary Gutters, and Associated Fittings

D. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code (NEC)
1.02 SUBMITTALS

A. Product Data
   1. Submit the following for Engineer’s approval:
      a. Manufacturer’s cut sheets, catalog data, with selected products clearly marked.
      b. Instructions for installation.
      c. Dimensions and weight.
      d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
      e. Identification materials.
      f. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

B. Shop Drawings
   1. Dimensioned plans, sections, and elevations.
   2. Tabulations of installed devices, major features, and voltage rating.
   3. Include:
      a. Enclosure type with details for types other than NEMA Type 1.
      b. Breaker layout drawing with dimensions indicated and nameplate designation
      c. Bus configuration and current ratings.
      d. Short circuit current rating of panelboard.
      e. Wiring diagrams detailing schematic diagram including control wiring and differentiating between manufacturer installed and field-installed wiring.

C. Test and Evaluation Results
   1. Report of field tests and observations in accordance with this section.

D. Operation and Maintenance Data
   1. Include instructions for testing circuit breakers.
1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications
   1. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.
   2. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Certifications
   1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

C. Regulatory Requirements
   1. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
      a. Terms "NRTL" shall be as defined in OSHA Regulation 1910.7.
      b. Terms "listed" and "labeled" shall be as defined in National Electrical Code.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

B. Storage and Handling Requirements
   1. Deliver products to site in acceptable condition and in protective wrappings.
   2. Store and protect products from damage.
   3. Accept products on site in factory containers and verify damage.
   4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. General Electric (GE)
2.02 PANELBOARDS, GENERAL REQUIREMENTS

A. Construction in accordance with NEMA PB1.

B. Overcurrent Protective Devices (OCPD’s):
   1. Provide type, rating, and features as indicated.
   2. Comply with “Low-Voltage Circuit Protective Devices” where provided in the Specifications.
   3. Tandem circuit breakers shall not be used.
   4. Multi-pole breakers shall have common trip.

C. Enclosures:
   1. Cabinets, enclosures, and panels, flush or surface mounted as indicated. NEMA Type 12 enclosure shall be use indoors, except where other enclosure requirements are indicated on drawings. All outdoor enclosures shall be NEMA 4X stainless steel. This includes indoor locations such as wastewater process areas and environmentally harsh locations. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

D. Front:
   1. Secure to box with concealed trim clamps except as indicated.
   2. Front for surface mounted panels shall be same dimensions as box.
   3. Fronts for flush panels shall overlap box except as otherwise specified.

E. Directory Frame:
   1. Metal, mounted inside each panel door.

F. Bus:
   1. Hard drawn copper of 98 percent conductivity.

G. Main and Neutral Lugs:
   1. Mechanical type.
H. Equipment Ground Bus:
   1. Adequate for feeder and branch circuit equipment ground conductors. Bonded to box.

I. Service Equipment Approval:
   1. Listed for use as service equipment for panelboards having main service disconnect.

J. Provision for Future Devices:
   1. Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.

K. Special Features: Provide following features for panelboards as indicated.
   1. Isolated Equipment Ground Bus:
      a. Adequate for branch circuit equipment ground conductors; insulated from box.
   2. Split Bus:
      a. Vertical bus of indicated panels divided into two vertical sections with connections as indicated.
   3. Extra Gutter Space:
      a. Dimensions and arrangement as indicated.
   4. Auxiliary Gutter:
      a. Conform to UL 870.
   5. Column Type Panelboard Configuration:
      a. Narrow cabinet extended as wireway to overhead junction box equipped with ground and neutral terminal buses.
   6. Sub-feed:
      a. OCPD or lug provision as indicated.
   7. Feed Through Lugs:
      a. Sized to accommodate feeders indicated.
   8. Surge Arresters: For panelboards as indicated on Plans.
b. Description: Coordinate impulse sparkover voltage with system circuit voltage and provide factory mounting with UL recognized mounting device.

2.03 LOAD CENTERS

A. Provide load center type panelboards only where specifically indicated.

B. OCPD's:
   1. Plug in full module (nominal 1 in. width) circuit breaker.

C. Circuit Breakers for Switching Lights at Panelboards:
   1. Indicated type SWD.

D. Circuit Breakers for Equipment Marked HCAR Type:
   1. Indicated HCAR type.

E. Interiors:
   1. Provide physical means to prevent installation of more OCPD's than quantity for which enclosure was listed.

2.04 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Branch OCPD's:
   1. Bolt on circuit breakers, replaceable without disturbing adjacent units.

B. Doors:
   1. In panel front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

2.05 DISTRIBUTION PANELBOARDS

A. Branch Circuit Breakers:
   1. Where OCPD's are indicated to be circuit breakers, use bolt on breakers except circuit breakers 225 ampere frame size and greater may be plug in type where individual positive locking device requires mechanical release for removal.

B. Doors:
   1. In panel front, omit single panelboard door in cabinet front for fusible switch panelboards except as indicated.
   2. Secure with vault type with tumbler lock, all keyed alike.

2.06 ACCESSORY COMPONENTS AND FEATURES
A. Accessory Set:
   1. Include tools and miscellaneous items as required for overcurrent protective
device test, inspection, maintenance, and operation.

B. Portable Test Set:
   1. Arranged to permit testing of functions of solid-state trip devices without removal
   from panelboard.

C. Spare Fuse Cabinet:
   1. Identified, compartmented, lockable steel box or cabinet with compartments
   suitable for surface mounting on wall.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install panelboards and accessory items in accordance with NEMA PB 1.1, and
   manufacturers' written installation instructions, and approved submittals.

B. Mounting Heights:
   1. Top of trim 6 ft 2 in. above finished floor, except as indicated.

C. Mounting:
   1. Plumb and rigid without distortion of box.
   2. Mount flush panels uniformly flush with wall finish.

D. Circuit Directory:
   1. Typed and reflective of final circuit changes required to balance panel loads.
   Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards:
   1. Stub four 1-inch empty conduits from panel into accessible ceiling space or
   space designated to be ceiling space in future.
   2. Stub four 1-inch empty conduits into raised floor space or below slab other than
   slabs on grade.

G. Auxiliary Gutter:
1. Install where a panel is tapped to a riser at an intermediate location.

H. Wiring in Panel Gutters:
   1. Train conductors neatly in groups; bundle and wrap with wire ties after completion of load balancing.

3.02 IDENTIFICATION
   A. Identify field-installed wiring and components and provide warning signs.

3.03 GROUNDING
   A. Connections:
      1. Make equipment grounding connections for panelboards as indicated.
   B. Provide ground continuity to main electrical ground bus indicated.
   C. Ground in accordance with Specification 16060 - “Grounding and Bonding for Electrical Systems,” where provided in these Specifications.

3.04 CONNECTIONS
   A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.05 FIELD QUALITY CONTROL / TESTING
   A. Perform tests on low voltage power panelboards and accessories.
   B. Upon completing installation of system, perform following tests:
      1. Make insulation resistance tests of panelboard buses, components, and connecting supply, feeder, and control circuits.
      2. Make continuity tests of circuits.
   C. Quality Control Program.
      1. Procedures:
         a. Make field tests and inspections and prepare panelboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.
      2. Notify Engineer at least one week in advance of testing.
      3. Report Testing:
a. Report written reports of tests and observations.

b. Report defective materials and workmanship and unsatisfactory test results.

c. Include records of repairs and adjustments made.

4. Protective Device Ratings and Settings:

a. Verify indicated ratings and settings to be appropriate for final system configuration and parameters.

b. Where discrepancies are found, recommend final protective device ratings and settings.

c. Use accepted ratings or settings to make final system adjustments.

D. Visual and Mechanical Inspection: Include following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up to date drawings and panelboard schedules.

2. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction.

3. Check panelboard mounting, area clearances, and alignment and fit of components.

4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

5. Perform visual and mechanical inspection and related work for overcurrent protective devices as within this section.

E. Electrical tests: Include following items performed in accordance with manufacturer's instruction:

1. Insulation resistance test of buses and portions of control wiring that disconnected from solid state devices. Insulation resistance less than 100 megohms is not acceptable.

2. Ground resistance test on system and equipment ground connections.

3. Test main and sub-feed overcurrent protective devices in accordance within this section.

F. Retest:

1. Correct deficiencies identified by tests and observations and provide retesting of panelboards. Verify by system tests that total assembly meets specified requirements.
3.06 CLEANING
   A. Upon completion of installation, inspect interior and exterior of panelboards.
   B. Remove paint splatters and other spots, dirt, and debris.
   C. Touch up scratches and mars of finish to match original finish.
   D. Clean interior of panelboard.

3.07 ADJUSTING
   A. Adjust doors and operating mechanisms for free mechanical movement.

3.08 COMMISSIONING
   A. Balancing Loads: After Substantial Completion, but before Final Acceptance, conduct load balancing measurements and circuit changes as follows:
      1. Perform measurements during period of normal working load as advised by Owner.
      2. Recheck loads after circuit changes during normal load period. Record load readings before and after changes and submit test records.
      3. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Re-balance and recheck as required to meet this minimum requirement.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
   A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 CONDITIONS

A. Installation and materials shall comply with local ordinances and illumination requirements.

1.01 SUMMARY

A. Section Includes:
   1. Exterior lighting fixtures, lamps, poles standards, and accessories.

B. Definitions:
   1. Fixture: Complete lighting unit. Fixtures include lamp or lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.
   2. Lighting Unit: Fixture, or assembly of fixtures with common support, including pole or bracket plus mounting and support accessories.

1.02 REFERENCES

A. Illuminating Engineering Society of North America (IESNA)
   2. LM-80 – Measuring Lumen Maintenance of LED Light Sources.
   3. LM-82 – Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature.

B. American National Standards Institute (ANSI):
   1. C78.1 to C78.1502 – Electric Lamps.

C. American Society for Testing and Materials (ASTM)
   1. A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.


D. Institute of Electrical and Electronic Engineers, Inc. (IEEE)

1. C62.41 – Surge Voltages in Low-Voltage AC Power Circuits

E. National Electrical Manufacturers Association (NEMA)

1. C82.4 – High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)

2. C78.x Series – American National Standards for Lamps- exact section as determined by lamp type

3. SSL 1-16 – Electronic Drivers for LED Devices, Arrays, or Systems

F. Underwriters Laboratories (UL)

1. 486A-486B – Wire Connectors

2. 496 – Lampholders

3. 773 – Safety Plug-In, Locking Type Photocontrols for Use with Area Lighting.

4. 844 – Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

5. 8750 – Light Emitting Diode (LED) Light Sources for use in Lighting Products

G. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code (NEC)

1.03 SUBMITTALS

A. Product Data

1. Submit the following for Engineer’s approval:

   a. Manufacturer’s cut sheets, catalog data, with selected products clearly marked.

   b. Instructions for installation.

   c. Dimensions and weight.

   d. Include data on features, poles, accessories, and following:

      (i) Outline drawings of fixtures and poles indicating dimensions and
principal features.

(ii) Electrical ratings and photometric data with certified results of independent laboratory tests.

B. Shop Drawings

1. Detail fixtures and poles and indicating dimensions, weights, methods at field assembly, components, and accessories.

C. Test and Evaluation Results

1. Certified reports of field tests and observations.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. Firms experienced in manufacturing lighting units that are similar to those indicated for this Project and that have record of successful in-service performance.

B. Certifications

1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor

C. Regulatory Requirements

1. Fixtures for Hazardous Locations: Conform to UL 844 or get Factory Mutual Engineering and Research Corporation (FM) certification for the class and division of hazard.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

B. Storage and Handling Requirements

1. Deliver products to site in acceptable condition and in protective wrappings.

2. Store poles on decay-resistant treated skids at least 1 ft above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.

3. Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

4. Accept products on site in factory containers and verify damage.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As shown on plans.

2.02 FIXTURE COMPONENTS, GENERAL

A. Shall be in accordance with NFPA, UL, as shown on drawings, and as specified.

B. Provide lighting fixtures in accordance with the lighting plan Drawings, Lighting Fixture Schedules and this specification.

C. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Division areas as defined in NFPA 70.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

E. Metal Parts:

1. Sheet metal components shall be steel unless otherwise indicated and shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.

2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.

3. When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.

4. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.

F. Ballasts and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts shall not be mounted to removable reflectors or wireway covers unless so specified.

G. Exposed Hardware Material: Stainless steel.

H. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

I. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:

1. White Surfaces: 85%.
2. Specular Surfaces: 83%.

3. Diffusing Specular Surfaces: 75%.

J. Photoelectric Relay: UL 773.

1. Contact Relays: Single-throw, arranged to fail in the "on" position and factory set to turn light unit on at 1.5 to 3 foot-candles and off at 4.5 to 10 foot-candles with 15 sec' minimum time delay.

2. Relay Mounting: In fixture housing.

K. Fixture Support Components:


2. Rod Hangers: 3/16-inch minimum diameter, stainless steel threaded rod.

3. Stainless Steel Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

4. As specified elsewhere.

L. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

2.03 PHOTO CELLS

A. Provide a photo cell to control outdoor fixtures unless otherwise indicated on the lighting plans.

B. Use a photo cell that is either the plug-in twist-locking type or the wire-in swivel-top type, both with similar features and operating characteristics.

C. Provide a photo cell that is enclosed in a UV-resistant rain-tight polypropylene housing with the cell being a 0.75 square inch cadmium sulfide surface passivated and a single pole, single throw normally closed bi-metallic switch.

2.04 LED LIGHTING 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 Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
   a. Minimum efficiency: 85% at full load.
   b. Minimum Operating Ambient Temperature: -20˚ C. (-4˚ F.)
   c. Input Voltage: 120 - 277V (±10%) at 60 Hz unless otherwise indicated. Refer to lighting fixture schedule on plan set.
   d. Integral short circuit, open circuit, and overload protection.
   e. Power Factor: ≥ 0.95.
   f. Total Harmonic Distortion: ≤ 20%.

4. LED modules shall include the following features unless otherwise indicated:
   a. Comply with IES LM-79 and LM-80 requirements.
   b. Minimum CRI 80 and color temperature 4000˚ K unless otherwise indicated. Refer to lighting fixture schedule on plan set.
   c. Minimum Rated Life: 50,000 hours per IES L70.

B. For outdoor application the fixtures shall be of vaporproof NEMA 4X construction with globe, guard and stainless steel hardware.

2.05 FIXTURE SUPPORT COMPONENTS

A. Pole-Mounted Fixtures:
   1. Conform to AASHTO LTS 1.

B. Wind-Load Strength:
   1. 100 mph and 1.3 gust factor for total support assembly, including pole, base, and anchorage, where used, to carry fixtures, supports, and appurtenances at indicated heights above grade without deflection or whipping.

C. Arm, Bracket, and Tenon Mount Materials:
   1. Match the poles.

D. Mountings, Fastenings, and Appurtenances:
   1. Corrosion-resistant components compatible with poles and fixtures that will not cause galvanic action at contact points. Provide mountings that will correctly position luminaire to provide indicated light distribution.

E. Pole Shafts:
1. As shown on Plans.

F. Pole Bases:
   1. Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts, and bolt covers.

G. Anchor Bolts:
   1. Anchor bolt length, orientation, and thread projection shall comply with pole manufacturer recommendations. Plywood (or equal) template shall be used during placement of anchor bolts for correct pole base hole alignment. Finished bolt alignment shall be straight and true.

H. Steel Poles:
   1. Steel tubing conforming to ASTM A500, Grade B, carbon steel with minimum yield of 46,000 psi. Poles are 1-piece construction up to 40 ft in length and have access handhole in wall.

I. Steel Mast Arms:
   1. Fabricated from 2 in. pipe, continuously welded to pole attachment plate and having span and rise as indicated.

J. Metal Pole Brackets:
   1. Designed to match pole metal. Provide cantilever brackets without underbrace, in the sizes and styles indicated, with straight tubular end section to accommodate the fixture.

K. Pole-Top Tenons:
   1. Fabricated to support fixture indicated and securely fastened to the pole top.

L. Metal Pole Grounding Provisions:
   1. Welded 1/2 in. threaded lug, accessible through handhole.

2.06 FINISH

A. Metal Parts:
   1. Manufacturer's standard finish except as otherwise indicated. Finish applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters, and similar defects. Remove poles, fixtures, and accessories showing evidence of corrosion or finish failure during Project warranty period and replace with new items.

B. Other Parts:
1. Manufacturer’s standard finish except as otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set units plumb, square, level, and secure according to manufacturer's written instructions and approved submittals.

3.02 GROUNDING

A. Poles: Install 10 ft driven ground rod in ground well at each pole. Solidly connect ground rod to ground lug in metallic poles.

B. Nonmetallic Poles: Ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor.

3.03 FIELD QUALITY CONTROL

A. Inspect installed units for damage.

B. Provide advance notice of dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:

1. Photometric Tests: Measure light intensities at locations where specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.

2. Check for excessively noisy ballasts.

3. Check for uniformity of illuminations.

4. Written report of tests indicating actual illumination results.

E. Replace or repair damaged and malfunctioning units and retest.

3.04 ADJUSTING AND CLEANING

A. Clean components on completion of installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

3.05 MAINTENANCE

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels
describing contents.

1. Lamps: 10% of each type and rating installed. Furnish at least 1 of each type.

2. Plastic Diffusers and Lenses: 5% of each type and rating installed. Furnish at least 1 of each type.

3. Globes and Guards: 5% of each type and rating installed. Furnish at least 1 of each type.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION
PART 1 GENERAL

1.00 CONDITIONS

A. All equipment and devices shall be NEMA rated. IEC rated equipment and devices are not acceptable.

1.01 SUMMARY

A. Section Includes:
   1. Pilot and control devices for instrumentation and control (I&C) system.
   2. Products listed are applicable where indicated on plans or required in other specifications.

1.02 REFERENCES

A. American Society for Testing Manufacturing (ASTM)
B. Institute of Electrical and Electronic Engineers, Inc. (IEEE)
C. National Electrical Manufacturers Association (NEMA)
   1. NEMA ICS 1 – General Standards for Industrial Control and Systems.
   2. NEMA ICS 2 – Standards for Industrial Control Devices, Controllers, and Assemblies.
   3. NEMA ICS 3 – Industrial Systems.
D. Underwriters Laboratories (UL)
E. National Fire Protection Association (NFPA)
   1. NFPA 70 – National Electric Code (NEC)

1.03 SUBMITTALS

A. Product Data
   1. Submit the following for Engineer’s approval:
      a. Manufacturer’s cut sheets, catalog data, with selected products clearly marked.
b. Instructions for installation.

c. Dimensions and weight.

d. Schedule of features, characteristics, ratings, and factory settings of individual devices.

B. Shop Drawings

C. Test and Evaluation Results

D. Operation and Maintenance Data

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. Company specializing in manufacturing the assembled control products specified in this specification section with minimum 3 years documented experience.

B. Certifications

1. All electrical work shall be performed only by a Texas State Licensed Electrical Contractor.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Deliver products to site in acceptable condition and in protective wrappings.

2. Store and protect products from damage.

3. Accept products on site in factory containers and verify damage.

4. Store products in clean, dry area.

PART 2 PRODUCTS

2.01 UNIVERSAL AC CURRENT SENSOR

A. Manufacturer:

1. Littlefuse, SSAC

2. ABB

3. Or approved equal.

B. TSC, ECS, ECSH, and ECSL Series: Provides relay contact closure when current
reaches pre-set level.

C. Install per Manufacturer’s instructions.

D. Sensor to be rated at 125% of current rating.

2.02 CURRENT TRANSDUCER

A. Manufacturers:
   1. NK Technologies
   2. Ohio Semitronics, Inc.
   3. HCS
   4. Or approved equal

B. AT Series: Current transformer with signal conditioner.
   1. Split or solidcore as applicable.
   2. 420 model with 4–20 MA output.
   3. Self powered.
   4. 0 – 200 amp range.
   5. U.L. listed.

C. CR4170 Series:
   1. Output: 4 – 20 mA or 0 – 5 VDC, as required.
   2. Three (3) element AC current.
   4. Temperature Range: 0 to 50 degrees Celsius.

D. MCT5 Series: 005E or 005E2 (as shown on plans)
   1. With Manufacturer’s recommended CT rated per circuit maximum amps x 1.25.

E. AT/ATR Series:
   1. 0 – 200-amp range or, as required by motor current rating.

F. Transducer to be rated for 125% of voltage rating.

G. Size unit to detect peak inrush current of motor.
2.03 VOLTAGE TRANSDUCER

A. Manufacturer:
   1. Ohio Semitronics, Inc.
   2. Or approved equal

B. AVT series:
   1. Rated per circuit maximum voltage x 1.25.
   2. Select version that matches shown on plans.

C. Transducer to be rated for 125% of current rating.

2.04 FLOAT SWITCH

A. Wastewater / Non-Potable Use:
   1. Manufacturers:
      a. Anchor Scientific
      b. Conery MFG, Inc.
      c. Pre-approved equal

   2. Construction:
      a. Direct acting.
      b. Polypropylene body.
      c. Form C type contact mercury switch.
      d. 10 amps at 230 VAC maximum.
      e. Integral cord weight-zinc plated cast iron.

B. Potable Water Use:
   1. Manufacturer:
      a. Siemens
      b. Pre-approved equal

   2. Construction:
      a. Model 9G-EF, mercury free
2.05 DC INPUT, FIELD CONFIGURABLE ISOLATOR

A. Manufacturer:
   1. Eurotherm/Action Instruments
      a. Model Action I/Q Q406
   2. Or, approved equal.

B. Construction:
   1. Provides one or two fully isolated DC output signals in proportion to one or two DC inputs.
   2. Field Configurable: 4-20 mA, 0-1 mA, 0-20 mA.
   3. 120V power source.

2.06 FLOW-NO-FLOW SWITCH

A. Manufacturer and Model:
   1. Gems Sensors
      a. FS-550
   2. Flow Technology
      a. Uniprobe Flow-No-Flow Switch UP01
   3. Or pre-approved equal.

B. Specifications:
   1. Flow Threshold Switch Point
      a. 0.05 to 0.5 ft/sec (Liquid)
      b. 0.5 to 5.0 ft/sec (Gas)
   2. Maximum No-Damage Flow Velocity
      a. 50 ft/sec (Liquid)
      b. 500 ft/sec (Gas)
   3. Power:
      a. 12 - 24 VDC @ 200 mA
      b. 115 VAC @ 125 mA
c. 220 VAC @ 60 mA

4. Response Time
   a. 3 – 30 seconds (Liquid)
   b. 10 – 60 seconds (Gas)

5. Switch Capacity
   a. 7.5 A, non-inductive load

6. Switch Configuration
   a. DPDT relay contacts

7. Operating Temperature Range
   a. -40°F to 185°F

8. Maximum Operating Pressure
   a. UP01 – 4000 psig with NPT fitting

9. Construction of 316 Stainless Steel

10. NEMA 4X or Explosion-Proof Enclosure

11. Omni-Directional Flow Sensing

12. Operates in corrosive or abrasive liquids and gases.

2.07 DC/DC CONVERTER

A. Manufacturer and Model:
   1. AGM Electronics
      a. Group 4000 or, as pre-approved in writing.

B. Supply Voltage:
   1. 8 – 90 VDC.

C. Load Drive:
   1. 0 – 350 ohms.

D. Outputs:
   1. Multiple, as indicated on plans or as required for circuit application.
E. 2 or 4 wire, as required.
F. 4 - 20 ma or 8 – 10 vdc, as required for inputs and outputs.

G. Accuracy:
   1. Plus/minus 0.1 percent calibration.

H. Adjustable signal offset and span.
I. See Manufacturer’s data sheets for additional requirements.

2.08 POSITION/DISPLACEMENT SENSOR

   1. DC-LVDT Sensor:
      a. Plus/minus 15 VDC input, 0 to plus/minus 10 VDC output.
      b. Non-linearity less than plus/minus 0.25 percent of FRO.
      c. Range: Plus/minus 0.050 inch to plus/minus 10 inches.
      d. Environmentally sealed to IEC IP.68.
   2. Loop Powered LVDT Transmitter:
      a. 4 – 20 mA loop powered I/O.
      b. Non-linearity less than plus/minus 0.5 percent of FRO.
      c. Range: 1 inch to 10 inches.
      d. Hermetically sealed for harsh environments.

B. Macro Sensor DMC-A2-100 Dual Channel Controller: AC-LVDT controller with digital display and with RS232C/Ethernet/analog outputs.

C. Macro Sensor Modular LVDT Signal Conditioner:
   2. DIN rail mounting.
   3. 4 – 20 ma output or 0 – 10 VDC output.
   4. 12 vdc or 24 VDC operating voltage.
5. Temperature Range: 0° F to 160° F.

6. Install per Manufacturer’s instructions.

D. Calibration and Settings:
   1. Calibration to be performed by Factory Representative.
   2. Field settings per Manufacturer’s instructions.

2.09 SUBMERSIBLE PUMP PROTECTION MODULE

A. Manufacturer and Model:
   1. Xylem/Flygt
      a. MiniCAS II:
         (i) 83 58 57 (24 volt)
         (ii) 40-50 10 98 (120 volt)

B. Module shall be capable of monitoring temperature via a thermal switch embedded in motor winding, and capable of detecting leakage via sensor located in pump.

C. Temperature detection to operate Form “C” 10-amp contact, such that when wired into pump controls will shut down pump when over-temperature condition is detected.

D. Leakage detection to operate Form “C” 10-amp contact, such that when wired into pump controls will initiate alarm.

E. Supply Voltage:
   1. 20-30 VDC, 50-60 Hz with 24-volt external power supply.
   2. 120 VAC, 50-60 Hz control power source.

F. LED indicators for over-temperature and leak indications.

G. Manual reset pushbutton to interrupt power supply.

H. Temperature Range:
   1. -25° to 60° C, Max 90% RH

2.10 LIGHTING CONTROL DEVICES

A. Photocells:
   1. Manufacturers:
a. Tork
b. GE
c. Woods
d. Or approved equal.

2. Provide photocell rated at 120-volt, 5 amp minimum.

3. Temperature range -40 to 150-degree F, weatherproof outdoor use.

4. Twist lock base where noted.

B. Lighting Contractors:

1. Manufacturers:
   a. Eaton
   b. GE
   c. Allen Bradley
d. Or approved equal.

   2. Provide multipole, 120/300/600-volt range as applicable with contacts rated at 10 to 100 amps as required by lighting load.

C. Enclosure:

1. Provide NEMA 1 enclosure for indoor use and NEMA 4X for outdoor use, or as indicated on plans. Outdoor enclosures to have no devices on outer door.

D. Selector Switches & Pilot Lights:

1. Provide Hand/Off/Auto selector switch as indicated on plans.

2.11 HYBRID VOLTAGE / CURRENT SENSOR MODULE

A. Provide a solid-state hybrid voltage/current sensor module equal in quality to Potter Brumfield CR Series unit, to control and monitor VFD driven submersible pumps in event of “over temperature” conditions as shown on control diagram sheet of the construction plans. This is a proprietary monitor and control scheme that is designed for this specific project only. It is intended for use with Flygt pumps only and may not provide the protection required with other pump controls.

This control circuit replaces the standard Mini Cas unit provide with Flygt pumps and may not function with other manufactures pumps.
B. The pump shall be ordered without the standard Leak Detector system when this specific method of control is used. The pump shall contain only the temperature sensor switch manufactured by Thermik and installed inside pump by Flygt.

C. The controls shall operate in a manner as follows for VFD operated pumps:

1. Provide solid state hybrid voltage/current sensor module as manufactured by Potter Brumfield or equal for use with 12vdc power to pump motor temperature sensor model SO6-140.05 manufactured by Thermik as supplied installed in Flygt grit pump. Circuit shall operate to sense current flow thru the temperature sensor and output a 4-20 am signal over a calibrated range that allows the SCADA PLC to determine motor temperature based on current flow. In addition, the sensor module shall provide a discrete signal output when sensor current is zero, indicating the sensor switch has opened at the high temperature limit setpoint. The sensor will reset internally when the motor temperature decreases as the motor cools.

2. The control circuit shall Lock Out when the sensor switch opens on high temperature and requires operator manual reset before pump will restart. Contacts will inhibit the motor control circuit and also send an alarm to the control panel indicator light and to the SCADA PLC.

3. The 4-20 ma signal to the SCADA AO module shall be calibrated to temperature of each specific pump sensor. The PLC can inhibit the motor controls at any time before the temperature sensor switch is opened, and shall lock out the PLC pump VFD Call signal until reset at the PLC.

This allows two means to stop the pump in event temperature rise is greater than set at the PLC, or greater than the operating point of the temperature sensor internal switch to assure pump temperature is not ever excessive at any VFD controlled speed.

4. The sensor circuit shall operate in same in Hand or Auto control of the pump. The temperature monitoring circuit will be powered up when the pump HOA switch is turned to the Hand or Auto position. The circuit shall have a settling time after initiation of the activation relay as shown on the pump control diagram. The pump start time delay relay shall be set a value not less than the time it requires for the over temperature circuits to be fully activated to assure the pump Call controls function normally when the HOA switch is set. When the pump HOA is Off or when a specific pump VFD breaker is turned off, the over temperature circuit is to be deactivated.

D. Controls manufacturer shall perform field calibration tests based on test figures from manufacturer and shall confirm temperature readings are accurate based on current flow thru the over temperature sensor/switch provided with each pump. Pump manufacture is to provide certified calibration data for the current flow thru sensor over the range of pump operating temperatures.
2.12 TAGGING
   A. Provide Type 316 stainless steel tag on field-mounted units and permanently affix tag to unit.
   B. Include Engineer’s tag number where listed in Control Diagrams.
   C. See Section 16075 – “Identification for Electrical Devices” for additional requirements.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer’s written instructions, applicable requirements of NEC, NECA “Standard of Installation,” and recognized industry practices.
   B. Control Relay:
      1. Install panel control relays in control panel.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT
   A. No separate payment will be made for work provided under this Section. Include cost in Lump Sum price for ELECTRICAL WORK as described in Section 16050.

END OF SECTION