TECHNICAL SPECIFICATIONS PACKAGE
FOR
WATER SUPPLY PROGRAM
RIVER INTAKE PUMP STATION

VOLUME 2
TECHNICAL SPECIFICATIONS

Atlanta, Georgia

GEORGIA
REGISTERED
No. 26389
PROFESSIONAL
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ENGINEER
GEORGE AJY

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Mayor
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Commissioner
Department of Watershed Management

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Department of Procurement

WATER SUPPLY PROGRAM
RIVER INTAKE PUMP STATION

CITY OF ATLANTA, GEORGIA

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Mayor

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SECTION 02000
SITE WORK

PART 1 GENERAL

1.01 SCOPE

A. This section outlines site work requirements that are applicable to all site work operations. Refer to specification sections for specific product and execution requirements.

B. (Not Used)

1.02 QUALITY ASSURANCE

A. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

B. Obtain and pay for all required inspections, permits and fees. Provide notices required by governmental authorities.

1.03 PROJECT CONDITIONS

A. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services designated to remain. Repair utilities damaged during site work operations at Contractor's expense.

B. Arrange for disconnection or disconnect and seal or cap all utilities and services designated to be removed before start of site work operations. Perform all work in accordance with the requirements of the applicable utility company or agency involved.

C. When uncharted or incorrectly charted underground piping or other utilities and services are encountered during site work operations, notify the Engineer and the applicable utility company immediately to obtain procedure directions. Cooperate with the applicable utility company in maintaining active services in operation.

D. Locate, protect, and maintain bench marks, monuments, control points and project engineering reference points. Reestablish disturbed or destroyed items at Contractor's expense.

E. Perform site work operations and the removal of debris and waste materials to assure minimum interference with streets, walks and other adjacent facilities.

F. Obtain governing authorities' written permission when required to close or obstruct street, walks and adjacent facilities. Provide alternate routes around closed or obstructed traffic ways when required by governing authorities.

G. Control dust caused by work. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

H. Protect existing buildings, paving and other services or facilities on site and adjacent to the site from damage caused by site work operations. Cost of repair and restoration of damaged items at Contractor's expense.

I. Protect and maintain street lights, utility poles and services, traffic signal control boxes, curb boxes, valves and other services, except items designated for removal. Remove or coordinate the removal of traffic signs, parking meters and postal mail boxes with the applicable governmental agency. Provide for temporary relocation when required to maintain facilities and services in operation during construction work.

J. Preserve from injury or defacement all vegetation and objects designated to remain.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment: As selected by the Contractor, except as indicated in contract documents.

B. (Not Used)

PART 3 EXECUTION

3.01 GENERAL

A. Examine the areas and conditions under which site work is performed. Do not proceed with the work until unsatisfactory conditions are corrected.

B. Consult the records and drawings of adjacent work and of existing services and utilities which may affect site work operations.

C. Maintain vehicular access to laboratory building and intake facilities at all times.

+ + + END OF SECTION 02000 + + +

SECTION 02050
DEMOLITION

PART 1 - GENERAL

1.01 SCOPE:

A. The work covered under this Section includes furnishing all labor, equipment and material required to remove asphalt pavements designated for demolition as shown on the Drawings, directed by the Engineer or required for the completion of the Work, including all necessary saw cutting, excavation and backfilling.

B. The work specified herein and shown on the Drawings is intended to show the extent of the scope of this work but must not be construed as covering it entirely. The Contractor shall visit the site and judge the amount of work required and the problems anticipated in the performance of the work.

C. (Not Used)

D. (Not Used)

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. The Contractor shall submit to the Engineer, prior to beginning work, a schedule of demolition and detail the methods to be used.

2. The Contractor shall develop and submit a demolition plan which includes a demolition schedule that covers:

   a. Stationing from and to with start and finish dates.
   b. Proposed method of demolition.
   c. Approved haul routes and permit(s) to and from the site.
   d. Locations of wood piles.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide all materials and equipment in suitable and adequate quantity as required to accomplish the work shown, specified herein, and as required to complete the project.

PART 3 - EXECUTION

3.01 GENERAL

A. Shutdown of Existing Operations and Utilities

1. The existing chemical building & raw water intake facility is required to remain in service during construction.

2. Prior to making any pavement removals, saw cut pavements to full depth.

3. Remove designated trees and stumps to at least 2 feet below grade.

B. PROTECTION

1. Take care to prevent the spread of dust and flying particles. Sprinkle rubbish and debris with water to keep dust to a minimum. Install, operate, and maintain erosion control measures at all times.

PERSONNEL: Perform work by personnel experienced in this type work and in such a manner as to eliminate hazards to persons and property without interference with new work and with use of adjacent areas, public rights-of-way, utilities and structures.

3.02 CONCRETE DEMOLITION

A. According to drawings

3.03 MASONRY DEMOLITION (Not Used)

3.04 REMOVAL OF EXISTING EQUIPMENT AND PIPING (Not Used)

3.05 PROTECTION OF WORK AND EXISTING FACILITY

A. Perform the work in a manner that will not damage parts of the site, or systems not intended to be removed. If in the opinion of the Engineer, the method of demolition or cutting may endanger or damage parts of the structure(s) or affect the operation of the facilities, promptly change the method when so notified by the Engineer. Perform all cutting required regardless whether such cutting is specifically indicated. Examine the existing structures, evaluate conditions to be encountered in accomplishing the work, and accommodate such requirements accordingly in the Bid Proposal.

B. The Contractor shall exercise full care and shall use such methods and equipment during removal as will maintain the usefulness of vehicular access to telecommunications and antennas at the site at all times.

C. Any damage done to structures or equipment during removal and any patching, plugging of holes or repairs necessitated because of removal of equipment and piping shall be repaired to the satisfaction of the Engineer and the cost thereof shall be included in the Contract Price.

3.06 DISPOSAL

A. Disposal: All rubble and waste material shall be hauled off site as it is removed. Stockpiling is not permitted at any time. The Contractor shall be fully responsible for proper disposal of waste materials in accordance with all federal, state and local laws at no additional cost to the City.

B. Contractor shall not dispose of any trash, material, equipment, or litter on the site. Contractor shall be responsible for any damage to any facilities, tanks or equipment which is damaged by any such foreign material.

3.07 DISPOSITION OF SALVAGEABLE MATERIALS (Not Used)

3.08 REHABILITATION (Not Used)

+++ END OF SECTION 02050 +++

SECTION 02110
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for all clearing and grubbing including, but not limited to, the removal from the site of trees, stumps, roots, brush, structures, abandoned utilities, trash, debris and all other materials found on or near the surface of the ground in the construction area and understood by generally accepted engineering practice not to be suitable for construction of the type contemplated.

B. The extent of clearing is that minimum degree of clearing necessary to carry out all construction activities including construction of appurtenances. Areas protected by silt fences, tree save and other fencing shall not be disturbed at any time.

C. Clearing and grubbing operations shall be coordinated with temporary and permanent erosion control requirements.

D. Clearing operations include, but are not limited to, the following:

1. Protection of existing trees and other vegetation
2. Removal of trees and other vegetation

E. Related Work Specified Elsewhere:

1. Division 1 General Requirements
2. Section 02125, Temporary and Permanent Erosion and Sediment Control.
3. Section 02050, Demolition.
4. Section 02200, Earthwork.

1.02 JOB CONDITIONS

A. Protection of Existing Improvements:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements.

2. Protect improvements on adjoining properties as well as those on the project site. Restore improvements damaged by this work to their original condition, as acceptable to the Engineer. Replace property line monuments (such as iron pins) removed or disturbed by clearing operations under the direction of a Land Surveyor licensed in the State of Georgia.

B. Protection of Existing Trees and Vegetation:

1. Protect existing trees and other vegetation to avoid cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip lines, foot or vehicular traffic, and parking of vehicles or equipment within drip line. Provide temporary fences, barricades or guards as required to protect trees and vegetation to be left standing.

2. Provide protection for tree roots over 1-1/2 inches diameter that are cut during any construction operation. Coat the cut faces with emulsified asphalt, or other acceptable coating, especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots of trees with wet burlap to prevent roots from drying out; provide earth cover as soon as possible.

3. Repair or replace damaged trees and vegetation resulting from any construction operation, in a manner acceptable to the Engineer. A qualified arborist approved by the engineer shall perform tree damage repair at no cost to the City. Replace damaged trees that cannot be repaired and restored to full-growth status, as determined by the Engineer.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 EXISTING TREES AND VEGETATION

A. Avoid cutting or injuring trees designated to remain. Other trees cut or injured shall be solely at Contractor expense to obtain permits, approvals, and pay all fees to the City before cutting and hauling off site.

3.02 CLEARING AND GRUBBING

A. Clearing operations shall begin no more than seven days before beginning construction work for any area.

B. Materials to be cleared, grubbed and removed from the project site include but are not limited to vegetation, trees, stumps, roots, lawns, shrubbery, gardens, paving, miscellaneous structures, debris, and abandoned utilities to the minimum practicable extent to complete the work. Limit clearing to a single lane work route without provision for construction vehicles to pass utility operation.

C. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all areas to be graded so that topsoil is free of roots and debris. Topsoil is to be left sufficiently clean so that further picking and raking will not be required.

D. All stumps, roots, foundations and planking embedded in the ground shall be removed and disposed of. Stumps and roots larger than 1 inch shall be grubbed and removed to a depth not less than 4 feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material.

E. Where the tree limbs interfere with utility wires, or where the trees to be felled are in close proximity to utility wires, the tree shall be taken down in sections to eliminate the possibility of damage to the utility.

F. Any work pertaining to utility poles shall comply with the requirements of the appropriate utility.

G. All fences adjoining any excavation or embankment that, in the Contractor's opinion, may be damaged or buried, shall be carefully removed, stored and replaced. Any fencing that is damaged shall be replaced with new fence material of equal or better quality and construction.

H. Stumps and roots shall be grubbed and removed to a depth not less than two feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material

I. Burying of residual materials and organics will not be allowed.

J. The Contractor shall utilize special precautions required for the protection and preservation of trees, cultivated shrubs, sod, fences, etc. situated within the construction area but not directly within excavation and/or fill limits. The Contractor shall be responsible for repair or replacement of any items damaged as a result of its operations.

3.03 HOLES AND DEPRESSIONS

A. Fill holes, depressions and voids created or exposed by clearing operations with non-organic soil material approved by the Engineer.

B. Backfill pavement removal areas with non-organic topsoil in horizontal layers not exceeding six inches loose-depth and compact to 95 per-cent standard Proctor.

3.04 DISPOSAL OF WASTE MATERIALS

A. Disposal General Requirements: Dispose cleared matter daily so as to maintain site in a safe and neat condition throughout the contract period. Owners of the property may remove merchantable timber, buildings or other items from the work site before the Contractor begins operations, and no assurance exists that any such material will be on the work site

when the Contractor begins work.

B. On-Site Disposal:

1. When authorized by the Engineer, cut tree trunks and limbs, over two inches in diameter, into 48-inch lengths and neatly stack within work limits on the same property as that on which the tree originally grew.

C. The debris resulting from the clearing and grubbing operation shall be hauled to a disposal site secured by the Contractor and shall be disposed of in accordance with all requirements of federal, state, county and municipal regulations. No debris of any kind shall be deposited in any stream or body of water, or in any street or alley. No debris shall be deposited upon any private property except with written consent of the property owner. In no case shall any material or debris be left on the project site, shoved onto abutting private properties, or buried on the project site.

3.05 CONSTRUCTION ACCESS ROUTE ON EASEMENT (Not Used)

3.06 TREE REMOVAL ON EASEMENTS (Not Used)

+++ END OF SECTION 02110 +++

SECTION 02125
TEMPORARY AND PERMANENT EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SCOPE

A. Work under this section includes furnishing all labor, materials, equipment and incidentals required to install and maintain temporary and permanent erosion and sedimentation controls as shown on the Drawings and as specified herein.

B. Temporary and permanent erosion and sedimentation controls include mulching and grassing of disturbed areas and structural barriers at those locations which will ensure that erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by the Georgia Environmental Protection Division (EPD) and applicable codes, ordinances, rules, regulations and laws of local and municipal authorities having jurisdiction.

C. The temporary and permanent erosion and sedimentation control measures shown on the Drawings are minimum requirements. The Contractor shall notify the Engineer of any changes and/or additions to the erosion and sedimentation control measures necessary to accommodate the Contractor's means and methods of operation. Any additional erosion and sedimentation control measures required by the Contractor's means and methods of operation will be installed by the Contractor at no additional cost to the City.

D. The Contractor shall be solely responsible for the control of erosion and sediment production within the Project area. The Contractor shall install controls that will ensure that storm water and drainage from the disturbed area of the Project site will be filtered or otherwise managed to minimize impacts on receiving waters and/or existing storm drains. Discharged waters shall be free of soil particles and shall meet all applicable permit turbidity requirements.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1.03 QUALITY ASSURANCE

A. The Contractor shall designate a worksite erosion control supervisor. The supervisor shall have the responsibility and authority to coordinate all equipment, personnel and materials needed to maintain project site erosion and sediment control in accordance with the management practices and standards established in the Manual for Erosion and Sediment Control in Georgia, the Drawings and Specifications.

B. Within 15 days after receipt of the Notice to Proceed, the Contractor shall submit the name and contact data for the designated erosion control supervisor. The supervisor shall be an individual with an active minimum Level 2 certification as issued by the Georgia Soil and Water Conservation Commission.

C. The erosion control supervisor shall execute NPDES sampling after each rain event and collect samples for laboratory testing.

PART 2 PRODUCTS

2.01 MATERIALS

A. Silt fence: Silt fence shall be as detailed on the Drawings and shall meet the requirements of Section 171 – Silt Fence of the GDOT Department of Transportation Standard Specifications.

1. Silt fence fabric shall conform to GDOT Standard Specification Section 881.2.07.

2. Silt fencing shall conform to GDOT Standard Specification Section 894.

3. Silt fence posts and bracing shall conform to GDOT Standard Specification Section 862.

B. Hay bales shall be clean, seed-free cereal hay type, rectangular in shape.

C. Woven wire fence backing shall be ½-inch, galvanized steel, chicken-wire mesh.

D. Filter stone shall be crushed rock conforming to Georgia Department of Transportation Table 800.01, Size Number 57.

E. Concrete block shall be hollow, non load bearing type.

F. Concrete shall be 3000 psi in accordance with Section 03300, Cast-in-Place Concrete.

G. Plywood shall be ¾-inch thick exterior type.

2.02 RIP RAP

A. Use only one method throughout the Project.

B. Stone Rip Rap shall consist of sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Rip rap shall have less than 66 percent wear when tested in accordance with AASHT0 T-96. Unless shown on the Drawings or specified otherwise, stone rip-rap shall be type 3.

1. Type 1 Rip Rap: The largest pieces shall have a maximum approximate volume of two cubic feet. At least 35 percent of the mass shall be comprised of pieces which weigh 125 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Standard Specification Section 805 - Stone Dumped Rip Rap, Type 1.

2. Type 3 Rip Rap: The largest pieces shall have a maximum approximate volume of one cubic foot. At least 35 percent of the mass shall be comprised of pieces which weigh 15 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Standard Specification Section 805 - Stone Dumped Rip Rap, Type 3.

2.03 FILTER FABRIC

A. Filter fabric for use under rip-rap shall meet the requirements of GDOT Standard Specification Section 881.2.05 for plastic filter fabric.

2.04 CONSTRUCTION EXIT STONE

A. Stone shall be sound, tough, durable stone resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Aggregate size shall be in accordance with the National Stone Association Size R-2 (1.5 to 3.5-inch stone) or Type 3 Riprap as specified in paragraph 2.02 of this Section.

2.05 GRASS

A. Permanent grass shall be of the same type that existed prior to construction.

B. Water: Water shall be free of excess and harmful chemicals, organisms and substances which may be harmful to plant growth or obnoxious to traffic. Salt or brackish water shall not be used. Water shall be furnished by the Contractor.

2.06 EROSION CONTROL FABRIC

A. Erosion control fabric shall be equal to Futerra Erosion Control Blanket manufactured by Profile Products LLC. Fabric shall be a non-woven erosion control/vegetation blanket comprised of wood fiber and crimped, interlocking synthetic fibers laminated by accelerated photodegradable polypropylene netting. Fabric shall be 100% bio-degradable and photo-degradable within 10 months of installation.

PART 3 EXECUTION

3.01 GENERAL

A. Basic Principles:

1. Conduct the earthwork and excavation activities in such a manner to fit the topography, soil type and condition.

2. Minimize the disturbed area and the duration of exposure to erosion elements.

3. Stabilize disturbed areas immediately.

4. Safely convey run-off from the site to a stable outlet.

5. Retain sediment on site that is generated on site.

6. Minimize encroachment upon watercourses.

B. Temporary Erosion and Sedimentation Control: Temporary erosion and sedimentation control procedures shall be directed toward:

1. Preventing soil erosion at the source.

2. Preventing silt and sediment from entering any waterway if soil erosion cannot be prevented.

3. Preventing silt and sediment from migrating downstream in the event it cannot be prevented from entering the waterway.

C. Permanent Erosion Control: Permanent erosion control measures shall be implemented to prevent sedimentation of waterways and to prevent erosion of the Project site.

3.02 SEDIMENTATION AND EROSION CONTROL MEASURES

A. Temporary and permanent erosion and sedimentation control measures shall prevent erosion and prevent sediment from exiting the site. If, in the opinion of the Engineer, the Contractor's temporary erosion and sedimentation control measures are inadequate, the Contractor shall provide additional maintenance for existing measures or additional devices to control erosion and sedimentation on the site at no additional cost to the Owner.

B. All erosion and sedimentation control devices and structures shall be inspected by the Contractor at least once a week and immediately prior to and after each rainfall occurrence. Any device or structure found to be damaged shall be repaired or

replaced by the end of the day. Sediment ponds shall be cleaned out prior to the silt reaching the height or elevation shown on the Drawings.

C. All erosion and sedimentation control measures and devices shall be constructed and installed as shown on the Drawings or specified herein and maintained until adequate permanent disturbed area stabilization has been provided or permanent pavement has been installed and accepted by the Engineer. After adequate permanent stabilization has been provided or permanent pavement has been installed and accepted by the Engineer, all temporary erosion and sedimentation control structures and devices shall be removed.

3.03 SEDIMENT CONTROL

A. Construction Exit:

1. Construction exit(s) shall be placed as shown on the Drawings and as directed by the Engineer. A construction exit shall be located at any point traffic will be leaving a disturbed area to a public right-of-way, street, alley, sidewalk or parking area.

2. Placement of Construction Exit Material: The ground surface upon which the construction exit material is to be placed shall be prepared to a smooth condition free from obstructions, depressions or debris. The plastic filter fabric shall be placed to provide a minimum number of overlaps and a minimum width of one foot of overlap at each joint. The stone shall be placed with its top elevation conforming to the surrounding roadway elevations. The stone shall be dropped no more than three feet during construction.

3. Construction Exit Maintenance: The Contractor shall regularly maintain the exit with the top dressing of stone to prevent tracking or flow of soil onto public right-of-way and paved surfaces as directed by the Engineer.

4. Construction Exit Removal: Construction exit(s) shall be removed and properly disposed of when the disturbed area has been properly stabilized, the tracking or flow of soil onto public right-of-way or paved surfaces has ceased and as directed by the Engineer.

B. Sediment Barriers:

1. Sediment barriers shall include, but are not necessarily limited to, silt fences, hay bales, rock check dams and inlet sediment traps and any device which prevents sediment from exiting the disturbed area.

2. Silt fences, hay bales and rock check dams shall not be used in any flowing stream, creek or river.

3. Sediment barriers shall be installed as shown on the Drawings and as directed by the Engineer.

4. Sediment barriers shall be maintained to ensure the depth of impounded sediment is no more than one half of the original height of the barrier or as directed by the Engineer. Torn, damaged, destroyed or washed out barriers shall be repaired, reinforced or replaced with new material and installed as shown on the Drawings and as directed by the Engineer.

5. Sediment Barrier Removal:

   a. Sediment barrier shall be removed once the disturbed area has been stabilized with a permanent vegetative cover or permanent pavement has been installed and the sediment barrier is no longer required as directed by the Engineer.
   b. Accumulated sediment shall be removed from the barrier and removed from the site.
   c. All non-biodegradable parts of the barrier shall be disposed of properly. The hay bales may be spread evenly across disturbed areas as a mulching material.
   d. The disturbed area created by barrier removal shall be permanently stabilized.

3.04 EROSION CONTROL

A. Grassing

1. Grassing shall be as specified in paragraph 3.05 of this Section

2. Temporary Stabilization: Temporary stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Temporary stabilization shall be provided to any area which will not receive permanent stabilization within the next 14 calendar days. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.

3. Permanent Stabilization:

   a. Permanent stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Permanent stabilization shall be provided to all areas of land disturbance within seven calendar days of the completion of land disturbance for any area greater than 0.25 acre. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.
   b. Grass or sod removed or damaged in residential areas shall be replanted with the same variety within seven calendar days of the completion of work

in any area.

c. Where permanent stabilization cannot be immediately established because of an inappropriate season, the Contractor shall provide temporary stabilization. The Contractor shall return to the site at the appropriate season to provide permanent stabilization in areas that received only temporary stabilization.

3.05 GRASSING

A. General:

1. (Not Used).

2. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched in an effort to restore to a protected condition.

3. Specified permanent grassing shall be performed at the first appropriate season following establishment of final grading in each section of the site.

4. All references to grassing, unless noted otherwise, shall relate to establishing permanent vegetative cover as specified herein for seeding, fertilizing, mulching, etc.

5. Permanent grassing shall be of a perennial species.

B. Grassing activities shall comply with the Manual for Erosion and Sediment Control in Georgia, specifically for the selection of species, planting dates and application rates for seeding, fertilizer and mulching. Where permanent vegetative cover (grassing) cannot be immediately established (due to season or other circumstances) the Contractor shall provide temporary vegetative or mulch cover.

3.06 RIP-RAP

A. Unless shown otherwise on the Drawings, rip-rap shall be placed at all points where banks of streams or drainage ditches are disturbed by excavation, or at all points where their natural vegetation is removed. Carefully compact backfill and place rip rap to prevent subsequent settlement and erosion. This requirement applies equally to construction alongside a stream or drainage ditch as well as crossing a stream or drainage ditch.

B. Placement of Filter Fabric

1. The surface to receive fabric shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. The fabric shall be placed with the long

dimension running up the slope and shall be placed to provide a minimum number of overlaps. The strips shall be placed to provide a minimum width of one foot of overlap for each joint. The filter fabric shall be anchored in place with securing pins of the type recommended by the fabric manufacturer. Pins shall be placed on or within 3-inches of the centerline of the overlap. The fabric shall be placed so that the upstream strip overlaps the downstream strip. The fabric shall be placed loosely so as to give and therefore avoid stretching and tearing during placement of the stones.

2. The fabric shall be protected at all times during construction from clogging due to clay, silts, chemicals or other contaminants. Any contaminated fabric or any fabric damaged during its installation or during placement of rip-rap shall be removed and replaced with uncontaminated and undamaged fabric at no expense to the City.

C. Placement of Rip-Rap

1. The rip-rap shall be placed on a 6-inch layer of soil, crushed stone or sand overlaying the filter fabric. This 6-inch layer shall be placed to maximize the contact between the soil beneath the filter fabric and the filter fabric. Rip-rap shall be placed with its top elevation conforming to the finished grades or the natural slope of the stream bank and stream bottom.

2. The stones shall be dropped no more than 3 feet during construction.

3. Stone rip-rap shall be dumped into place to form a uniform surface and to the thickness specified on the Drawings. The thickness tolerance for the course shall be -6-inches and +12-inches. If the Drawings do not specify a thickness, the course shall be placed to a thickness of not less than 18-inches.

3.07 CLEAN-UP

A. Remove and dispose of all excess erosion and sedimentation control devices and materials when no longer needed or at the completion of construction as directed by the Engineer. Clean out sediment control basins to an elevation at least one foot lower than the elevations shown on the Drawings.

+ + + END OF SECTION 02125 + + +

SECTION 02140
DEWATERING

PART 1 - GENERAL

1.01 SCOPE:

A. Construct all permanent Work in areas free from water. Design, construct and maintain all dikes, levees, cofferdams and diversion and drainage channels as necessary to maintain the areas free from water and to protect the areas to be occupied by permanent work from water damage. Remove temporary works after they have served their purpose.

B. The Contractor shall be responsible for the stability of all temporary and permanent slopes, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and sub-surface, to the lines, grades and conditions existing prior to the damage at no additional cost to the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 CARE OF WATER:

A. Except where the excavated materials are designated as materials for permanent work, material from required excavation may be used for dikes, levees, cofferdams and other temporary backfill.

B. Furnish, install, maintain and operate necessary pumping and other equipment for dewatering the various parts of the Work and for maintaining the foundation and other parts free from water as required for constructing each part of the Work.

C. Install all drainage ditches, sumps and pumps to control excessive seepage on excavated slopes, to drain isolated zones with perched water tables, and to drain impervious surfaces at final excavation elevation.

D. After they have served their purpose, remove all temporary protective work at a satisfactory time and in a satisfactory manner. All diversion channels and other temporary excavations in areas where the compacted fill or other structures will be constructed shall be cleaned out, backfilled and processed under the same Specifications as those governing the compacted fill.

E. When the temporary works will not adversely affect any item of permanent work or the planned usage of the Project, the Contractor may be permitted to leave such temporary works in place. In such instances, breeching of dikes, levees and cofferdams may be required.

3.02 DEWATERING

A. By the use of well points, pumps, tile drains or other approved methods, the Contractor shall prevent the accumulation of water in excavated areas. Should water accumulate, it shall be promptly removed.

B. Excavations shall be continuously dewatered to maintain a ground water level no higher than 3 feet below the lowest point in the excavation.

C. Piezometric observation wells shall be required, to monitor the ground water level, to insure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures.

D. No separate payment will be made for dewatering required to accomplish the work.

+++ END OF SECTION 02140 +++

SECTION 02150
SHEETING, SHORING AND BRACING

PART I GENERAL

1.01 SCOPE

A. This section specifies requirements for sheeting, shoring, and bracing of trenches and excavations greater than 5-feet in depth. Where shoring, sheeting, bracing or other supports are necessary, they shall be furnished, placed, maintained, and except as specified otherwise, removed by the Contractor.

B. Design Requirements:

1. The design, planning, installation and removal, if required, of all sheeting, shoring, lagging, and bracing shall be accomplished in such a manner as to maintain the required excavation or trench section and to maintain the undisturbed state of the soils below and adjacent to the excavation.

2. The Contractor shall design sheeting, shoring, and bracing in accordance with the OSHA Safety and Health Standards as well as state and local requirements.

3. Horizontal strutting below the barrel of a pipe and the use of pipe as support are not acceptable.

4. When the construction sequence of structures requires the transfer of bracing to the completed portions of any new structure or to any existing structure, the Contractor shall provide the Engineer with a complete design analysis of the expected impact of that bracing on the structure. This action shall in no way absolve the Contractor of responsibility of damage resulting from said bracing.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
OSHA 2207	OSHA Safety and Health Standards, Revised 1987

B. (Not Used)

1.03 SUBMITTALS

A. Prior to starting any excavation work requiring sheeting, shoring, and bracing, the Contractor shall submit his plans for trench and excavation support systems to the

Engineer as working drawings in accordance with the requirements of the General Conditions. No provisions of the above requirements shall be construed as relieving the Contractor of his overall responsibility and liability for the work.

B. The Contractor shall submit a Certification of Compliance properly identified with the project name and project location. The Certification shall state that the sheeting, shoring and bracing have been designed in accordance with the prevailing codes and standards by a Professional Engineer registered in the State of Georgia with the Engineer's seal and signature appearing on the certification. Calculations shall not be submitted unless specifically requested by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. The construction of sheeting, shoring and bracing shall not disturb the state of soil adjacent to the trench and below the excavation bottom.

B. Trench sheeting below the top of a pipe shall be left in place.

C. Excavation shall not be started until the design for support systems has been accepted by the Engineer.

+ + + END OF SECTION 02150 + + +

SECTION 02200
EXCAVATION AND BACKFILL

PART 1 – GENERAL

1.01 SCOPE

A. The work under this Section includes earthwork and related operations, relating specifically to structural and site work including, but not limited to; excavating all classes of material encountered, including blasting; handling; storage; transportation; and disposal of all excavated and unsuitable material; construction of fills and embankments; backfilling around structures; backfilling all pits; compacting; all sheeting; shoring and bracing; preparation of subgrades; surfacing and grading; and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the Work.

B. The Contractor shall provide all services, labor, materials, and equipment required for all earthwork and related operations necessary or convenient to the Contractor for furnishing complete Work as shown on the Drawings or specified in these Contract Documents.

C. Related Work specified elsewhere:

1. Section 01410 Testing Laboratory Services
2. Section 02125 Erosion and Sedimentation Control
3. Section 02140 Dewatering
4. Section 02700 Removing and Replacing Pavement

1.02 GENERAL

A. Safety: Comply with local regulations and with provisions of the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc. Occupational Safety and Health Act (OSHA) and all other applicable safety regulations.

B. The elevations shown on the Drawings as existing are taken from the best available data and are intended to give reasonable information about the existing elevations. The Contractor shall verify conditions to determine the exact quantities of excavation and fill required.

C. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.

D. All excavated and filled areas for structures, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the City. All damage caused by erosion or other construction operations shall be repaired by the Contractor using material of the same type as the damaged material at no cost to the City.

E. The Contractor shall control grading in a manner to prevent water running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can flow uninterrupted in existing open ditches or channels; other surface drains; or temporary drains.

F. No classification of excavated materials will be made. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the Work, regardless of the type, character, composition or condition thereof.

G. The Contractor shall determine the appropriate means, methods, and techniques to make excavations shown on the drawings, regardless of the type of material encountered. Contractor shall make supplemental geotechnical investigations at no additional cost to the City to determine the character of subsurface materials encountered.

H. The soil testing will be performed by the Contractor's testing laboratory. As a minimum at least one density test shall be performed for every 5,000 square feet of fill area and every two feet of fill lift.

I. Should the Owner choose to conduct its own testing, the Contractor shall make all necessary excavations and shall supply any samples of materials necessary for conducting compaction and density tests. The cost of all retests made necessary by the failure of materials supplied by the Contractor, his agents or subcontractors, to conform to the requirements of these Contract Documents shall be paid by the Contractor. Contractor shall provide at least 24 hours advance notice of earthwork operations to the Testing Laboratory. Testing Laboratory shall provide reports to the Engineer with copies to the Contractor certifying (and sealed by a Registered Georgia Engineer) that earthwork is in conformance with the plans and specifications. The Testing laboratory shall witness the placement of all fill, unless otherwise directed by the Engineer.

J. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations, and shall be conducted in a manner acceptable to the Engineer.

K. Stockpile Areas: Provided there is space available, stockpiling material may be on the Shaft access road site in areas to receive fill in subsequent phases of construction.

1.03 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

A. Copies of permits obtained by the Contractor for the work.

B. Test results, certification of compliance, source and samples for all imported materials.

C. Samples of fill materials to be used. Samples shall be submitted 2 weeks in advance of use and shall consist of 0.5 cubic feet of each type of material.

D. Test reports for compaction.

E. Regulations: Subcontractor shall obtain at least two copies of all applicable federal, state and local codes, laws, regulations and ordinances regarding the use of explosives. One copy of these codes, laws, regulations and ordinances shall be submitted to the Engineer at least 14 days prior to blasting. The second copy shall be maintained on-site in the Subcontractor's office, for review by all Subcontractor personnel involved in blasting.

F. Subcontractor Qualifications and Evidence of Experience: Submit resumes of proposed blasting consultant and blasting supervisors to the Engineer. Resumes shall contain listing of experience, references with phone numbers and copies of all required blasting licenses.

G. Blast Designs and Safety Measures: Submit to the Engineer the following information for initial test blasts and proposed production blast design for each trench and pit as appropriate:

1. Number, location, diameter, depth and orientation of drill holes on a scaled drawing of the excavation or tunnel heading face;
2. Type of explosive and weight of charge in each hole;
3. Type and nomenclature of detonators;
4. Type and distribution of stemming used to fill hole collars for charge confinement;
5. Total amount of explosives in the blast and maximum charge-per-delay;
6. Delay arrangement showing delay period in each hole;
7. Description of the proposed blasting system; and type of firing source;
8. Specific measures taken to protect structures, buried utilities and other facilities that may be potentially affected by blasting operations;
9. Type and methods of shaft covers, matting and containment of blast area to mitigate fly rock;
10. Description of and locations of signage used to announce blast warning signals to any persons that might enter blast areas;
11. Clearing, guarding and communication procedures to confirm that all persons are evacuated to safe areas and that blast areas are secured prior to blasting;

12. Prediction calculations for noise (air-overpressure) and peak particle velocity (PPV) at the closest structure and at other adjacent structures, pipelines or facilities that maybe potentially affected by blasting operations;

13. Any redesign of the blasting program shall be submitted to the Engineer.

H. Blasting Records: Maintain a record of each blast detonated. Submit to the Engineer the following records and information the same day the blasting is performed:

1. Depth of blast holes and the location of the blast point in relation to Project stationing;

2. Type, strength and quantities of all explosives, types and quantities of detonators, powder factor (lb./cy), and actual firing times of all charges;

3. Total explosive loadings per round and maximum charge per delay;

4. Type of rock blasted;

5. Reference to approved blast design submittal noting any modification;

6. Time spent scaling rock and approval of rock scaling by designated individual;

7. On a diagram of the approved blast pattern indicate any holes not drilled, drilled but not loaded, changes in spacing or in pattern of delay charges or in loading of holes. Include notes explaining why changes were made;

8. Submit an evaluation of the blast indicating tights, areas of significant overbreak and any recommended adjustments for future blasts;

9. Comments by the blaster in charge regarding any misfires, unusual results, or unusual effects;

10. Date and exact firing time of blast; name of person in responsible charge of loading and firing and blaster permit number;

11. Signature and title of person making recording entries;

12. Vibration and air overpressure monitoring record: Two copies of all blast vibration monitoring data obtained independent of monitoring performed by the Engineer. Submit hard copies of 4-channel waveforms for each blast;

13. Any other records required by federal, state and local codes, laws, regulations and ordinances.

I. Blasting Safety and Security Plans:

1. A complete description of the clearing and guarding procedures that will be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. This information shall include details regarding visible warning signs or flags, audible warning signals, method of determining blast area zones, access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the blaster-in-charge will communicate with site security guards.

2. Detailed description of how explosives will be safely stored, transported and used at the various work sites. Plans shall explain how storage magazines and explosive transport vehicles will satisfy all applicable regulations. This plan shall also indicate how explosives will be inventoried, secured and guarded to prevent theft or unauthorized use of explosives.

3. If the Georgia State Fire Marshal authorizes overnight storage of the explosives, the Subcontractor must submit a detailed storage plan that includes scaled maps indicating proposed location of detonator and explosives that will be stored overnight, distances to nearest occupied buildings, roadways and oth.er limiting items in the American Table of Distances.

4. Include Material Safety Data Sheets (MSDS) and specific details about hazard communication programs for employees.

5. Equipment that will be used to monitor the approach of lightning storms and in the event of such, evacuation and site safety security plans.

6. Contingency plans for handling of misfires caused by cut-offs or other causes.

7. Fire prevention plan details, including smoking policies, procedures and limitations for work involving any open flames or sparks, description and location of all firefighting equipment, and firefighting and evacuation plans.

8. Initial and ongoing blasting and fire safety training programs.

9. Description of the personal protective equipment that will be used by the Subcontractor's personnel, including but not limited to, safety glasses, hard-toe footwear, hardhats and gloves.

10. Description of blast monitoring equipment and listing of individuals that will operate such equipment. Submittal shall indicate that all equipment meets the standards defined in Article 2.02 of this Section.

11. The Subcontractor's Safety Representative shall ensure that ongoing blasting work complies with all applicable regulations.

12. Submit copies of ATF Employee Possessor questionnaire forms (OMB No. 1140-0072) or ATF letters of clearance for all employees that will possess explosives for this

work as defined ill 27 CFR Part 555. Subcontractor employees, without submitted evidence of satisfactory ATF clearance, must not handle, control or have access to explosive materials.

13. Ground vibration and air-overpressure monitoring records: submit two copies of all 4 channel monitoring records done.

14. Deliver to the Engineer, 14 days prior to the start of blasting at any location, two bound copies of the property condition inspection reports (condition survey) containing all field notes, sketches, diagrams, photos and videos.

J. Notification:

1. For all work sites prior to starting blasting, the Subcontractor shall notify the appropriate local municipal officials, above and below-ground utility owners and the Engineer who will notify the general public expected to be potentially affected, of the Subcontractor's intent to conduct controlled blasting operations. Notice shall be given to all operators of all buried pipes, cables, conduits and overhead utility lines and poles located within a 200-foot radial distance of the blast area.

2. Notification to appropriate local municipal officials and utility owners or operators shall be done in writing, at least 48 hours prior to the start of blasting at a particular site or sooner if so required by any applicable local law or regulation, and shall indicate the expected frequency of blasting, hours that blasting might occur and the expected date that blasting will be completed. Upon completion of blasting at the particular site, utility owners or operators shall be notified that blasting has ceased in the area for the duration of the Project.

3. The Subcontractor shall furnish the Engineer with a list of those parties notified in accordance herewith prior to the start of such blasting. The list shall include names, addresses and telephone numbers.

4. The Subcontractor must submit copies of written notification letters sent to the responsible fire protection agency for any sites where explosives are stored overnight. These letters shall be submitted to the Engineer at least 48 hours before any explosives are stored at the site. These letters must be submitted by the Subcontractor to the responsible fire protection agency, 48 hours before explosives are stored at the site.

1.04 QUALITY ASSURANCE

Reference Standards. Comply with all Federal, State and local laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. ASTM C136-84a, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ASTM D1556-82, Test Method for Density of Soils in Place by the Sand Cone Method.

C. ASTM D1557-78, Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm Drop).

D. ASTM D3107-88, Test Method for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

E. U.S. Department of Justice, Alcohol, Tobacco and Firearms and Explosives Division (ATF27 CFR Part 555, Implementation of the Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule).

F. Institute of Makers of Explosives, Dos and Don'ts - Instructions and Warnings for Consumers in Transporting, Storing, Handling, and Using Explosive Materials

G. Institute of Makers of Explosives, Destruction of Commercial Explosives

H. Institute of Makers of Explosives, Suggested Code of Regulations for the Manufacture, Transportation, Storage, Sale, Possession and Use of Explosive Materials

I. Institute of Makers of Explosives, Safety in the Transportation, Storage, Handling and Use of Explosive Materials

J. Institute of Makers of Explosives, Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Electric Blasting Caps.

K. National Fire Protection Association (NFPA), NFPA 495 - Code for the Manufacture, Transportation, Storage and Use of Explosive Materials, 1985 Edition

L. National Fire Protection Association (NFPA), NFPA 498 - Standard for Explosives, Motor Vehicle Terminals, 1985 Edition

M. US. Department of Labor, Occupational Safety and Health Administration (OSHA), Construction Standards and Interpretations 29 CFR Part 1926, Subpart V, Section 1926.900, "Blasting and Use of Explosives", final rule dated December 16, 1972.

N. Official Code of Georgia (OCGA); Code Section 25 - Georgia Blasting Standards Act of 1978, Code Section 25-9-1, et seq.

O. Vibration Subcommittee of the International Society of Explosive Engineers (ISEE), blast monitoring equipment operation standards (1999).

1.05 QUALITY CONTROL (BLASTING)

A. The design and execution of blasting shall be performed under the on-site supervision of a licensed blaster certified in the State of Georgia.

B. The Subcontractor shall perform blast monitoring as required to satisfy its legal obligation relative to all permits and all applicable federal, state and local codes, laws, regulations and ordinances, and its contractual responsibilities, including safety.

C. The Engineer may perform blast monitoring to verify conformance with regard to air-overpressure (noise) and peak particle velocity criteria defined by this Section.

D. Qualifications and Clearance Status:

1. The blasting supervisors (blasters-in-charge) shall have a minimum of 10 years of experience, directly related to the specific types of blasting they will oversee. All blasting supervisors shall be able to document the completion of at least three projects of similar scope and complexity.

2. All blasters and supervising shift foremen shall be properly qualified and licensed in accordance with applicable federal, state and local government regulations. Necessary permits include an Explosives License issued by the Georgia Safety Fire Commissioner.

3. Subcontractor shall be required to retain the services of an experienced blasting consultant with at least 10 years of experience in monitoring blasting operations (test blasts and production blasts), interpreting ground vibration, air overpressure, and impulse amplitudes for similar construction projects, and to prepare all blasting plans, test-blasting plans, and revisions to any of these plans. All blasting plans, test-blasting plans and revisions shall be reviewed by and covered with a signed review letter by the blasting consultant. The blasting consultant will not be required to sign the individual blast plans provided they are signed by an on-site licensed blaster.

4. All persons that handle explosive materials, have control over them, or access to them, must not be prohibited persons, as defined in Section 555.11 of 27 CFR (ATF Rules).

PART 2 PRODUCTS

2.01 MATERIALS

A. Earthwork Materials

1. Controlled Fill:

a. Proposed fill soils shall be laboratory tested prior to construction use to determine their suitability. All fill material shall be subject to the approval of the Engineer.

b. Notification: For approval of imported fill material, notify the Engineer and Testing Laboratory at least three (3) weeks in advance of intention to import material, designate the proposed borrow area, and permit the Testing Laboratory to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material. Test results shall be submitted to the Engineer for approval. All fill shall be free of organic matter or debris, have a low to moderate plasticity, (PI≤15) uniform composition, and be free of rock fragments greater than three inches in dimension. Soils selected for use as fill material shall also have a standard Proctor (ASTM D 698) maximum dry density of at least 90 pounds per cubic foot.

c. All on-site fill material shall be soil exclusive of organic matter, frozen lumps or other deleterious substances.

d. It shall contain no rocks or earth clumps over 3-inches maximum in dimension.

2. Structural Fill and Structural Backfill:

a. Select on site materials may be suitable. Testing and recommendation of suitability shall be made by the Testing Laboratory and submitted by the Contractor to the Engineer for approval.

b. Imported material shall be sand, uniformly graded crushed rock or other select material recommended by the Testing Laboratory and submitted by the Contractor to the Engineer for approval. Graded aggregate base material as specified in Section 02700, Removing and Replacing Pavement, is acceptable for structural fill and backfill.

c. Crushed Rock: Crushed rock used for bedding and drainage stone shall conform to the Georgia Department of Transportation Standard Specifications for construction of Road and Bridges, Section 800 for No. 57 Stone.

3. Coarse Aggregate: Coarse aggregate shall conform to the Georgia Department of Transportation Standard Specifications of Transportation Systems construction of Road and Bridges, Section 800 for No. 57 Stone, Group II, and shall have the following gradation:

Sieve size	**Percent Passing**	
1-½ inch	100	-
1 inch	95	100
¾ inch	-	-
½ inch	25	60
3/8 inch	-	-
#4	0	10

#8	0	5

4. Top Soil: Dark organic weed free loam.

B. Sheeting, Bracing and Timbering: The Contractor shall furnish, place and maintain all sheeting, bracing and timbering required to properly support trenches and other excavations in open cut and to prevent all movement of the soil, pavement, structures, or utilities outside of the trench or pit.

1. General:

a. All cofferdams, sheeting, bracing and timbering shall be designed, sealed and signed by a registered Professional Engineer in the State of Georgia at the Contractor's expense. A copy of the drawings and design computations shall be submitted to the Engineer for the project files.

b. Sheeting, bracing and timbering shall be so placed as to allow the Work to be constructed to the lines and grades shown on the Drawings.

c. If at any time the method being used by the Contractor for supporting any material or structure in or adjacent to any excavation is not reasonably safe the Engineer may require and the Contractor shall provide additional bracing and support necessary to furnish the added degree of safety. The Contractor shall provide such added bracing and support by such method as Contractor may elect to use, but the taking of such added precautions shall in no way relieve the Contractor of sole and final responsibility for the safety of lives, work and structures.

d. All sheeting and shoring in contact with the concrete or masonry shall remain in place. The sheeting or shoring above the structure may remain in place or be cut off. No sheeting shall be left in place within three feet below the ground surface.

e. There shall be no payment for sheeting, bracing, and timbering left in place.

2. Timber:

a. Timber may be substituted for steel sheet piling when approved by the Engineer. Timber for shoring, sheeting or bracing shall be sound and free of large or loose knots and in good condition. Size and spacing shall be in accordance with OSHA regulations.

b. Remove bracing and sheeting in units when backfill reaches the point necessary to protect the work and adjacent property. Leave sheeting in place when it cannot be safely removed. Cut off sheeting left in place below the finished ground surface by three feet.

3. Steel Sheet Piling:

Steel sheet piling shall be the continuous interlock type. The weight, depth and section modulus of the sheet piling shall be sufficient to restrain the loads of earth pressure and surcharge from existing foundations. Procedure for installation and bracing shall be so scheduled and coordinated with the removal of the earth that the ground under existing structures shall be protected against lateral or vertical movement at all times. In addition to the drawings and computations, the Contractor shall provide closure and sealing details between sheet piling and existing facilities, as well as method of excavation within sheet piling to the Engineer for review before commencing with construction operations. Contractor shall be responsible for all damage to existing utilities and structures resulting from installation of sheet piling. Damage to existing utilities and/or structures resulting from installation of sheet piling shall be repaired at the Contractor's expense.

C. Blasting Materials

1. Only explosive and initiation devices packaged by federally-licensed explosives manufacturing firms shall be used in blasting.

2. Only packaged or cartridge type, non-flowing explosives shall be used in the works. Black powder and nitroglycerine are prohibited for all blasting.

3. Non-electric detonating devices shall be used.

4. Only explosives designed and manufactured for smoothwall (trim) blasting shall be used in perimeter holes for blasting in the shafts, tunnels, trenches, adits, junctions and diversion structure excavations. The linear charge-weight-per-foot of explosives used in shaft perimeter, and tunnel back and rib holes shall not exceed 0.4 lb. /ft. This limitation does not apply to the primer stick, which must not weigh more than 0.5 pounds. Cartridge configurations and detonating cord shall be included in the linear charge weight-per-foot.

5. Explosives, blasting agents, primers, initiators, and ancillary blasting materials shall be kept in original packaging with clearly marked date codes. All explosives and initiating devices used shall be less than one year old.

6. If the Engineer determines that a blasting product appears to be in a damaged or deteriorated condition, the suspect product shall not be used until its condition can be determined. Products found to be damaged or in a deteriorated condition shall be immediately returned to the supplier for safe disposal.

7. Blast Monitoring Equipment

a. Equipment for on-site and off-site particle velocity and air overpressure monitoring shall be 4 channel (one overpressure and three seismic channels) units capable of digitally storing collected data. Equipment must be capable of printing ground motion time histories and summaries of peak motion intensities, frequencies and USBM RI8507 PPV frequency plots. Printed report records must also include date, time of recording, operator name, instrument number and date of last calibration.

b. Instruments shall have a flat frequency response between 2 and 250 Hz for particle velocity and from 2 to 200 Hz for air-overpressure.

c. The digitizing sampling rate for peak particle velocity and air overpressure measurements shall be at least 1,024 samples per second.

d. Seismographs shall be capable of performing a self-test of velocity transducers and printed event records shall indicate whether or not the sensor test was successful.

e. Seismographs used for compliance monitoring shall be capable of recording overpressure from 100 to 148 dB-L, and particle velocity from 0.05 to 5.0 inches/second.

f. Systems shall be capable of providing printed event reports that include all peak measurements, frequencies and complete waveform plots.

g. Seismographs shall have adequate memory to digitally record the entire duration of the blast-induced motion.

h. All seismograph/software systems shall be capable of saving back-up copies of all event files.

i. If the frequency of blast-induced ground motion for close-in blasting is expected to exceed 250 Hz, monitoring shall be done with instruments that measure acceleration with intensities up to 10 gs and at frequencies between 200 and 5,000 Hz.

j. The Subcontractor shall supply the Engineer with four blast monitoring units as described above for the duration of the blasting in addition to any monitoring equipment the Subcontractor uses to meet the requirements herein. The Subcontractor shall provide for annual calibration for each of the blast monitoring units and any repair or maintenance required.

k. Prior to the commencement of any trench blasting operation, perform preconstruction inspections and noise, vibrations and air overpressure surveys.

D. Other Materials: All other materials not specifically described but required for proper completion of the work of this Section, shall be as selected by the Contractor subject to the prior approval of the Engineer.

E. Stockpile area: The stockpile area shown on the drawings, or as directed by the Engineer, shall be used to stockpile soil material for backfilling around structures and to stockpile needed topsoil.

PART 3 – EXECUTION

3.01 GENERAL

A. Benching of Slopes: When the embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when the embankment is to be built ½ width at a time, the slopes that are steeper than 4:1 as measured at right angles to the embankment shall be continuously benched over those areas as the work is brought up in layers. Benching shall be of sufficient width to permit the operation of placing and compacting equipment. Each successive cut shall begin at the intersection of the original ground and the vertical side of the previous cut. Material thus cut shall be recompacted along with the new embankment material. Proof roll subgrade prior to placement of fill material.

B. Topsoil:

1. Remove all topsoil to a depth at which subsoil is encountered, from all areas, which are to be cut to lower grades or filled.

2. Topsoil to be used for finish grading may be stored on the site. It shall be piled properly, sloped to drain and covered.

C. Bracing and Sheeting:

1. Furnish, install, and maintain all sheeting, bracing, and shoring as may be required to properly support the sides of all excavations and to prevent all movement of earth, which could in any way injure the work, adjacent property, or workmen.

2. Properly support all trenches for duct bank installation so as to conform to all pertinent rules and regulations and these Specifications. All trenches deeper than 5 feet shall be shored unless cut to the angle of repose of the excavated soils.

3. Exercise care in the removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of the excavation faces being supported and damage to the work and adjacent property.

4. Do not leave any sheeting or bracing in the trench or excavation after completion of the work, unless approved or instructed by the Engineer. The cost of removing sheeting or bracing shall be at the Contractor's expense.

5. All sheeting and shoring in contact with concrete or masonry shall remain in place. The sheeting and shoring above the structure may remain or be cut off. No sheeting or shoring left in place shall be within three feet below the ground surface.

D. Obstructions:

1. Remove and dispose of all trees, stumps, roots, boulders, pavement, pipes and the like, as required for the performance of the work.

2. Exercise care in excavating around catch basins, inlets, manholes, piping, duct banks, underground vaults, etc.

3. Avoid removing or loosening castings or pushing dirt into structures.

4. Damaged or displaced castings shall be repaired and replaced, and dirt entering the structures during the performance of the work shall be removed at no additional cost to the City.

E. Utilities to be Abandoned:

1. When pipes, conduits, sewers or other structures are removed from the trench leaving dead ends in the ground, such ends shall be fully plugged and sealed as indicated on the Drawings.

2. Abandoned structures such as manholes, catch basins or chambers shall be entirely removed unless otherwise specified or indicated on the Drawings.

3. All materials from abandoned utilities which can be readily salvaged shall be removed from the excavation and stored on the site at a location as directed by the Engineer.

4. All salvageable materials will remain the property of the City unless otherwise indicated by the Engineer.

F. Extra Earth Excavation:

In case soft material, which, in the opinion of the Engineer is not suitable, is encountered in the bottom of a trench or underneath a structure, the soft material shall be removed and replaced with structural fill or coarse aggregate.

G. Cutting Paved Surfaces and Similar Improvements:

1. Remove existing pavement as necessary for installing utilities and appurtenances or as otherwise shown on the Drawings.

2. Before removing any pavement, mark the pavement neatly, paralleling pipe lines and existing street lines. Space the marks to match the width of the trench.

3. Sawcut the asphalt pavement along the marks before breaking away from the part of pavement that should remain.

4. Do not pull pavement with machines until completely broken and separated from pavement to remain.

5. Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement. Refer to Section 02700 for replacement of damaged or removed pavement.

   NOTE: No additional payment will be made for removing and replacing damaged adjacent pavement.

6. Remove and replace sidewalks disturbed by construction for their full width and to the nearest undisturbed joint.

7. The Contractor may tunnel under curbs that are encountered. Remove and replace any curb disturbed by construction to the nearest undisturbed joint.

H. Dewatering:

1. The proposed dewatering plan shall be submitted by the Contractor to the Engineer for approval at least ten (10) working days prior to the beginning of any excavation.

2. Furnish, install, maintain and operate necessary pumping and other equipment for dewatering the various parts of the Work and for maintaining the foundation and other parts free from water as required for constructing each part of the Work.

3. By the use of well points, pumps, tile drains or other approved methods, the Contractor shall prevent the accumulation of water in excavated areas. Should water accumulate, it shall be promptly removed.

4. Excavations shall be continuously dewatered to maintain a ground water level no higher than 3 feet below the lowest point in the excavation.

5. Piezometric observation wells shall be required, to monitor the ground water level, to insure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures and shall be included in the plan.

6. The cost for all dewatering and discharge shall be at the Contractor's expense and shall be considered incidental.

3.02 EXCAVATION

A. Method:

1. All excavations for appurtenances and structures shall be made in such manner and to such depth and width as will give ample room for building the structures and for bracing, sheeting, and supporting the sides of the excavation, for pumping and draining groundwater and wastewater which may be encountered, and for the removal from the trench of all materials excavated.

2. Water shall not be allowed to accumulate in excavations. Contractor shall provide sufficient temporary pumping to assure that surface and ground waters do not saturate foundation soils.

3. Take special care so that soil below the bottom of the structure to be built is left undisturbed.

B. Grades:

1. Excavate to lines and grades indicated on the Drawings.

2. Where excavation grades are not indicated on the Drawings, excavate as required to accommodate installation.

C. Disposal of Excavated Material:

1. Remove and legally dispose of all excavated material not needed to complete filling, backfilling, and grading.

2. Dispose of excess excavated material at locations secured by the Contractor and in accordance with all requirements of federal, state, county and municipal regulations. No debris of any kind shall be deposited in any stream or body of water, or on any street or alley. No debris shall be deposited on any private property except by written consent of the property owner. In no case shall any material be left on the Project site or be buried in embankments or trenches on the Project site. With recommendation of the Testing Laboratory and approval by the Engineer, demolished, crushed concrete may be acceptable for use in fill areas.

3. Excavated materials shall be placed adjacent to the work to be used for backfilling as required.

4. Excavated materials shall be placed sufficiently back from the edge of the excavation to prevent caving of the trench wall, to permit safe access along the trench and to not cause any drainage problem. Excavated material shall be placed so as to not damage existing landscape or man-made improvements. Surcharging of any bank is not allowed.

D. Rock Excavation:

1. Rock excavation shall mean rock requiring drilling and blasting that occupies an original volume of at least one (1) cubic yard. Rock shall be considered as material which cannot be removed with a crawler tractor equal to a D-8 Caterpillar, equipped

with a single-tooth ripper or by an excavator trackhoe equal to a Caterpillar 225 rated with a ¾ cubic yard capacity with a bucket curling pullout capacity of 25,000 pounds.

2. Where rock is encountered, it shall be excavated to the lines and grades indicated on the Drawings or as otherwise directed by the Engineer. The Contractor shall be responsible for obtaining any blasting permits required.

3. If excess excavation is made or the material becomes disturbed so as to require removal below final subgrade elevations or beyond the prescribed limits, the resulting space shall be refilled with Class B concrete in accordance with Section 03300, Cast-in-Place Concrete.

3.03 EXCAVATING FOR STRUCTURES

A. Excavation:

1. All excavation is unclassified and included in the Contractor's Base Bid. No additional payment will be made for rock excavation.

2. Excavation shall include all substances to be excavated. Excavation for structures shall be to limits not less than 2 feet outside wall lines, to allow for formwork and inspection.

3. Where rock excavation is carried below grade the Contractor shall backfill to grade using concrete or structural fill.

4. Where unsuitable material is encountered excavate material to a depth acceptable to the Engineer and fill with compacted structural fill as required.

B. Excavation for Foundations: Footings and slabs on grades shall rest on undisturbed earth, rock or compacted materials to insure proper bearing.

1. Unsuitable Foundation Material

a. Any material in the opinion of the Engineer which is unsuitable for foundation shall be removed and replaced with coarse aggregate or structural fill material as directed by the Engineer.

b. No determination of unsuitability will be made until all requirements for dewatering are satisfactorily met.

2. Foundation in Rock: Foundations for a structure shall be on similar materials. Should excavation for a foundation be partially in rock, the Contractor shall undercut that portion of the rock 12-inches and bring the excavation to grade with compacted crushed stone.

C. Construction Observations:

All excavations should be examined by the Engineer prior to reinforcing steel placement to verify that the design bearing pressure is available. All excavations should be clean, level and free of ponded water, mud and loose, frozen or water-softened soils. If it is necessary for an excavation to remain open overnight, or if rain is imminent, a 3-to 4-inch thick "mud mat" of Class B concrete may be placed in the bottom of the excavation to protect the bearing soils until reinforcing steel and concrete can be placed.

D. Unsuitable Bearing:

If unsuitable bearing for foundations is encountered at the elevations indicated on the Drawings, the Engineer shall be notified immediately.

3.04 EXCAVATION BELOW GRADE AND REFILL

If the bottom of any excavation is taken out below the limits shown on the Drawings or specified, it shall be refilled to the bottom grade, at the Contractor's expense, except where rock or unsuitable soil is encountered. The refill shall be 6-inch layers of structural fill or other material satisfactory to the Engineer. The type of material to be used shall be the Engineer's option.

3.05 BACKFILL AND FILL PLACEMENT

A. Compaction of fill shall be accomplished by placing the fill material in horizontal lifts of eight-inches (8”) maximum loose thickness and mechanically compacting each lift to at least the specified dry density.

B. All fill placement shall be witnessed by an experienced soils technician of the Testing Laboratory and fill density and moisture tests for each lift shall be performed to verify that the specified degree of compaction is being achieved.

C. Prior to placement of any material in embankments, the area within embankment limits shall be stripped of topsoil and all unsuitable materials removed as described under Excavation. Area to receive fill shall then be scarified to a depth of at least 6-inches.

D. The fill shall be brought to the proposed elevation by placing and compacting only approved fill materials upon a subgrade approved by the Engineer.

E. Fill materials shall be placed in continuous approximately horizontal layers extending the full width of the embankment cross-section and the full dimension of the excavation where practicable.

F. The fill shall be placed at a moisture content that corresponds to a +/- 3% of the optimum moisture content, as determined by the standard Proctor moisture-density relationship test.

G. Compaction:

1. The fill shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil.

2. The upper twelve-inches (12") of fill beneath the structures and pavement areas shall be compacted to 98% of the standard Proctor maximum dry density.

3. Scarification and recompacting of the upper fill soils immediately prior to the slab-on-grade and/or pavement construction shall be required.

4. Compaction of embankments shall be by sheepsfoot rollers with staggered uniformly spaced knobs and suitable cleaning devices. The projected area of each knob and the number and spacing of the knobs shall be such that the total weight of the roller and ballast when distributed over the area of one (1) row of knobs shall be 250 psi. Placement and compaction of materials shall extend beyond the final contours sufficiently to insure compaction of the material at the resulting final surface. Final contours shall then be achieved by a tracked bulldozer or grader shaping the face of the embankment.

5. The backfill placement in trenches and behind structures shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil. In confined areas requiring portable compaction equipment the fill material shall be placed in horizontal lifts of four-inches (4") maximum loose thickness.

6. If tests indicate that density of backfill is less than that specified, the area shall be either be recompacted or undercut, filled, and compacted until specified density is achieved.

H. Final Grading: Upon completion of construction operations, the area shall be graded to finished contour elevations and grades shown on the Drawings. Graded areas shall be made to blend with remaining ground surfaces. All surfaces shall be left smooth and free to drain.

I. Moisture:

1. If fill material is too wet, provide and operate approved means to assist the drying of the fill until suitable for compaction.

2. If fill material is too dry, provide and operate approved means to add moisture to the fill layers.

J. Proofrolling:

1. All areas where pavement or structures are to be built on compacted fill and other areas where indicated on the Drawing, shall be proofrolled to detect soft spots prior to the placement of fill material or construction of foundations.

2. Proofrolling shall consist of the moving a 20-30 ton loaded dump truck or pneumatic tire roller over the subgrade after the subgrade is shaped. Proofrolling shall be witnessed by the Engineer.

3. Pneumatic-tired rollers shall have not fewer than four pneumatic tired wheels which shall be of such size and ply that tire pressures can be maintained between 80 and 100 pounds per square inch for 25,000-pound wheel load during rolling operations. Unless otherwise required, rolling shall be done with tires inflated to 90 psi. The roller wheels shall be located abreast in a rigid steel frame. Each wheel shall be loaded with an individual weight box so that each wheel will bear an equal load when traversing uneven ground. The weight boxes shall be suitable for ballast loading such that the load per wheel shall be 25,000 pounds. The spacing of the wheels shall insure that the distance between the nearest edges of adjacent tires shall be not greater than one-half of the tire width of a single tire at the operating pressure for a 25,000-pound wheel load. The roller shall be operated not faster than 5 feet/second.

4. Subgrade shall be proofrolled with 6 passes. Depressions that develop during the proofrolling operation shall be filled with suitable material and those filled areas shall be proofrolled with 6 passes. If, after having been filled and proofrolled, the subgrade still contains depressions, the soil shall be undercut to the full depth of the soft material or 5 feet whichever is less, backfilled, and rolled to achieve a compacted subgrade.

5. After the proofrolled subgrade has been accepted by the Engineer, the surface of the subgrade shall be finish rolled with a smooth steel wheel roller weighing not less than 10 tons. Finished surface of the subgrade shall be within a tolerance of 0.04 feet at every point.

6. Conduits, pipes, culverts and underdrains shall be neither disturbed nor damaged by proofrolling operations. Rollers shall neither pass over, nor approach closer than 5 feet to conduits, pipes, culverts and underdrains unless the tops of those facilities are deeper than 3 feet.

K. During wet or rainy periods, aeration (drying) shall be required to reduce the fill materials to the required moisture condition. During dry periods, water shall be added to achieve the proper moisture content for compaction. Silty soils, which are wet, shall require aeration prior to compaction even during dry periods.

3.06 BACKFILLING AROUND STRUCTURES

A. General:

1. Remove debris from excavations before backfilling.

2. Do not backfill against precast structures until so instructed by the Engineer

3. Wherever possible, backfilling shall be simultaneous on both sides of walls to equalize lateral pressures.

4. Do not backfill on only one (1) side of vertically spanning walls unless walls are adequately shored or permanent construction is in place to furnish lateral support on both top and bottom of wall.

3.07 GRADING

A. General:

1. Perform all rough and finished grading required to attain the elevations indicated on the Drawings.

2. Perform rough grading to an accuracy of plus or minus 0.10 feet.

B. Grading Around Buildings: Control the grading around buildings so the ground is pitched to prevent water from running into the excavated areas of a building or damaging other site features.

C. Treatment After Completion of Grading:

1. After grading is completed, permit no further excavation, filling or grading, except with the approval of the Engineer.

2. Use all means necessary to prevent the erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.08 EXCESS WATER CONTROL

A. Unfavorable Weather:

1. Do not place, spread or roll any fill material during unfavorable weather conditions.

2. Do not resume operations until moisture content and fill density are satisfactory to the Engineer.

3. Any inundated area that freezes shall be removed and refilled at the Contractor's expense.

B. Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collected in depressions.

C. Pumping, Drainage and Dewatering:

1. Provide, maintain and use at all times during construction adequate means and devices to promptly remove and dispose of all water from every source entering the excavations or other parts of the Work.

2. Dewater by means, which will insure dry excavations, preserve final lines and grades, and do not disturb or displace adjacent soil.

3. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the work of other contractors, and in accordance with all pertinent laws, ordinances, and regulations.

4. Do not overload or obstruct existing drainage facilities.

3.09 SETTLEMENT

A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments, which may occur within one (1) year after final acceptance of the Work by the City.

B. The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after receipt of written notice from the Engineer.

3.10 CLEANING

Upon completion of the work of this Section, remove all rubbish, trash and debris resulting from construction operations. Remove surplus equipment and tools. Leave the site in a neat and orderly condition acceptable to the Engineer, and in conformance with the General Conditions of the Contract Documents.

3.11 BLASTING

A. Blasting of and in trenches shall be limited to the hours of 7:00 a.m. to 7:00 p.m., Monday through Friday, and 9:00 a.m. to 5:00 p.m. on Saturdays, or as outlined in any variances obtained by the Owner. Blasting in tunnels at a distance further than 250 feet away from the shaft centerline shall be limited to the hours of 7:00 a.m. to 10:00 p.m., Monday through Friday, and 9:00 a.m. to 5:00 p.m. on Saturdays. Blasting is not allowed on Sundays or Holidays.

B. Blasting vibration and air-over pressure (noise) limitations are defined in Articles 3.05 and 3.06 below.

C. The Subcontractor shall erect signboards of adequate size stating that blasting operations are taking place in the area, and such signs shall be clearly visible at all points of access to the area. These signs shall also clearly display the audible warning signals (horn signals) that will be used to warn all people in the area of the impending blast.

D. An audible blast warning system shall be established, publicized, and operated only during blasting hours.

E. The Subcontractor shall operate a system to ensure that no personnel remain underground during blasting operations and blasting operations shall not be undertaken until it can be demonstrated that all personnel are accounted for and in a safe location.

F. The Engineer shall be notified 24 hours before blasts occur at any specific location. The Subcontractor shall provide the Engineer with a schedule for all blasts and shall notify the Engineer if any blast is delayed for more than one hour. However, the Subcontractor will be allowed to re-shoot missed holes and tights, as they are uncovered without advance notice to the Engineer.

G. Acceptable Controlled Blasting methods will be those utilizing smooth wall blasting, cushion blasting, and line drilling techniques. Use of "pre-splitting" surface excavations is specifically prohibited. Maximum drill round lengths, including subdrilling shall not exceed 0.75 times the minimum dimension of the opening.

H. Holes shall not be charged with explosives at the same time that drilling or other mechanized equipment not needed to charge the round is being operated within 50 feet of the blast area.

I. The first blasting operation shall be conducted by the Subcontractor as a test case. The first test blasts shall be no larger than 25 percent of the planned production design blast sized as measured by charge-weight-per-delay. The second and third test blasts shall be no larger than 60 and 100 percent respectively of the planned production design blast. Alternate test blasting plans may be proposed by Subcontractor with approval of Engineer. After each test blast and review of test blasting data, the Subcontractor and Engineer shall meet to review the program. Modifications to the blasting program may be required as a result of this review. Drilling and delay patterns, amount and type of explosive to be used in subsequent production blasts shall be revised according to the results of the test case.

J. In addition to the monitoring requirements of the Subcontractor as specified herein, monitoring and recording of air-overpressure and vibration will be performed by the Engineer for every blast round. The results will be provided to the Subcontractor within 24 hours of the blast, for review. Changes in drilling and delay patterns and amount of explosives shall be made when tests indicate vibrations and/or overpressures in excess of that specified herein. Any major changes in the production blast design shall be submitted to the Engineer.

K. All blasts in open cut excavations shall be covered with a sufficient number of steel cable mats or other substantial covering device in order to prevent injury to persons and property, including the structure and equipment used in connection with shaft, open cut or tunnel operation, from flying rock or other material.

L. After a blast is fired, all loose and shattered rock or other loose material, which may endanger the structure or the workers shall be removed and the excavation made safe before proceeding with work. The Subcontractor shall install the required initial support prior to commencing drilling for the subsequent blasting round. Before drilling of blast holes for a new round, the face shall be thoroughly cleaned and examined for missed holes and unexploded charges. Blasting techniques shall be developed and improved as work progresses. The fact that the removal of loose or shattered rock or other loose material may enlarge the excavation beyond the required limits shall not relieve the Subcontractor of responsibility for such removal and subsequent additional backfill or concrete, and the Subcontractor shall not be entitled to additional payment for over- excavation or overbreak.

M. No blasting is allowed within 40 feet of freshly placed concrete or grouted rock until 12 hours has elapsed since placement. Shotcrete is exempt from these requirements.

N. All transportation of explosives on the surface and any handling, blast charging or tie- in operations shall be stopped immediately upon the approach of an electrical storm, and all persons shall immediately be evacuated from the blasting area to a place of safety. Persons underground shall be notified of the approach and cessation (all clear) of an electrical storm, each by means of different signals. In shafts, tunnels or other excavation handing explosives, loading of holes, connecting up or firing of charges shall not be performed during an electrical storm and all persons shall withdraw to a safe distance from a partially or totally loaded face. During such storms, explosives on the surface shall be left in OSHA-approved transport containers, delivery vehicles, day-storage boxes or in approved storage magazines. At all times, explosives shall be watch guarded and secured by the Subcontractor's personnel that are in safe locations.

O. All light and power circuits shall be disconnected and/or removed to a point not less than 100 feet from the face while explosives are being transported into the area and while the loading operations are taking place. During the loading operations only OSHA approved lighting may be used.

P. Air- overpressure shall not exceed 130 decibels when monitored with an instrument with a 2 hertz high pass at any occupied structure. Air overpressure monitoring shall take place at the nearest residential or business structures susceptible to damage or claims of annoyance.

Q. All measurements of blast-induced air-overpressure shall be done in accordance with the standards developed by the Vibration Section of the International Society of Explosives Engineers-I999.

R. The maximum intensity of motion in the vertical, longitudinal and transverse directions, measured in the ground near any building or other surface structure shall not exceed 2.0 inches per second at any frequency of motion.

S. The maximum intensity of motion in the vertical, longitudinal and transverse directions, measured on the ground above any buried utility lines or pipes shall not exceed 4 inches per second at any frequency of motion.

T. The Subcontractor shall monitor each blast with four (4) seismographs located, as approved, between the blast area and the closest structures and/or utilities. The seismographs used shall be capable of recording Particle Velocity and frequency for three (3) mutually perpendicular components of vibration in the range generally found with Controlled Blasting.

U. All measurements of blast-induced ground motion shall be performed in accordance with the standards developed by the Vibration Section of the International Society of Explosives, Engineers - 1999.

V. Blasting operations shall not resume until the Engineer has approved the Subcontractor's revised blasting plan with modifications correcting the conditions causing the suspension.

W. When blasting operations damage off-site properties or a portion of the work or material surrounding or supporting the work, promptly repair or replace damaged items to the condition that existed prior to the damage, to the satisfaction of the Engineer and property owner at no additional cost to the Owner.

X. Blasting operations may be suspended by the Engineer for any of the following reasons:

1. The Subcontractor's safety precautions are inadequate.

2. Air overpressure or ground motion levels exceed specified limits.

3. Existing structural conditions on and off site are aggravated and are damaged by blasting.

4. Blasting causes instability of slopes or causes damage to rock outside the prescribed limits of excavation.

5. The results of the blasting, in the opinion of the Engineer, are not satisfactory.

6. Failure of the Contactor to adhere to the submitted and accepted blast plan.

+++END OF SECTION 02200+++

SECTION 02224
LINER PLATE TUNNEL INSTALLATION

PART 1 GENERAL
1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, materials, equipment and incidentals required to construct a tunnel and to complete pipeline construction as described herein and as shown on the Drawings.

B. Supply all materials and perform all work in accordance with applicable American Society for Testing and Materials (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI) or other recognized standards. Latest revisions of all standards are applicable. If requested by the Engineer, submit evidence that manufacturer has consistently produced products of satisfactory quality and performance over a period of at least two years.

1.02 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.

1. AASHTO M190 – Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

2. ASTM A36 – Standard Specification for Carbon Structural Steel

3. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

6. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled Carbon, Structural, High-Strength, Low-Alloy, High-Strength Low-Alloy with Improved Formability and Ultra-High Strength

B. (Not Used)

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

B. Method Submittals: The Contractor shall provide for the Engineer's approval, detailed plans for the methods proposed for construction of the tunnel. These plans shall address the following:

1. Groundwater Control: The Contractor shall control groundwater throughout the construction of the tunnel. The groundwater shall be controlled by dewatering (well points, sumps, or deep wells), grouting, freezing or other methods approved by the Engineer. The Contractor shall prepare a written, detailed plan for controlling the groundwater, citing similar installation conditions and results. This plan shall be submitted to the Engineer prior to any construction of the tunnel.

2. Face Protection: The face of the excavation shall be protected from the collapse of the soil into the tunnel.

3. Pit Design: The design of the access pits and required bearing to resist the jacking force when the carrier pipe is installed is the responsibility of the Contractor. The Contractor shall engage the services of a professional engineer with current registration in the State of Georgia to design all cofferdam and sheeting and bracing systems for the pits. The Contractor’s Engineer shall submit to the Engineer a signed statement that he has been employed by the Contractor to design the cofferdam and sheeting and bracing systems.

4. Submit additional working drawings, written procedures and calculations describing in detail the proposed jack and bore or tunneling method and the entire operation.

    a. Additional submittals shall include, but not be limited to, ground stabilization if proposed, excavation procedures, control of tunnel alignment and grade, support of face, detection of surface movement, procedure for installing carrier pipes and anchors and placement of grout in the annular space around the tunnel.

    b. If, in opinion of the Contractor, modifications to the methods are required during construction, working drawings shall be submitted delineating such modifications, including reasons for the modifications.

C. Material Submittals: The Contractor shall provide for the Engineer's approval, shop drawings, proposed construction drawings and other pertinent specifications and product data as follows:

1. Shop drawings for tunnel liner plate showing sizes and connection details.

2. Design mixes for concrete and grout.

3. Casing Spacers.

C. Experience Submittals: Tunnel construction is considered to be specialty contractor work. If the Contractor elects to perform the work, the Contractor shall provide evidence of experience as required by the General Conditions. A minimum of five continuous years of experience in tunnel construction is required of the Contractor proposed to do the work. Evidence of this experience shall be provided with the shop drawings for review by the Engineer.

1.04 STORAGE AND PROTECTION

A. All materials shall be stored and protected in accordance with the manufacturer's recommendations and as approved by the Engineer.

B. (Not Used)

1.05 PROJECT PERMITS

A. Seen Section 01060 of these specifications.

B. (Not Used)

PART 2 PRODUCTS

2.01 MATERIALS

A. Tunnel Liner Plate

1. Tunnel liner plate shall consist of structural steel liner plates. Each section shall be composed of the number of plates required to produce a clearance around the pipe sufficient to install and properly joint the pipe. The liner plates shall be either 4-flange type or 2-flange lap-joint type.

2. Liner plates shall be a minimum of 12 gage and shall be fabricated from structural quality, hot-rolled carbon steel sheets or plates conforming to ASTM A1011.

3. Liner plates shall be galvanized in accordance with ASTM A123. All other hardware shall be hot dip galvanized in accordance with ASTM A153. Liner plates shall be bituminous coated in accordance with the requirements of AASHTO M190.

4. All liner plates shall be punched for bolting on both longitudinal and circumferential seams or joints and shall be so fabricated as to permit complete erection from inside

the tunnel. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

5. The plates shall be furnished with 2-inch diameter grout holes to facilitate grouting the annular space above and around the tunnel liner. All grout holes shall be equipped with screw type galvanized plugs for final watertight closure of the grout holes. Grout holes shall be provided at the top of the tunnel at a maximum spacing of 10-feet on center. Grout holes shall also be provided at the top quarter points staggered with the holes at the top.

6. Bolts and Nuts:

   a. Bolt spacing shall be as specified by the plate manufacturer and shall be sufficient to develop the full strength of the plates.

   b. Bolts and nuts used with the 2-flange plates shall be a minimum of 5/8-inch in diameter and shall conform to ASTM A307.

   c. Bolts and nuts used with 4-flange plates shall be not less than ½-inch in diameter for plate thicknesses up to and including 0.179-inches (7 gauge) and not less than 5/8-inch in diameter for plates of greater thickness. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A307.

   d. Where required, bolts and nuts shall be hot dipped galvanized in accordance with ASTM A153.

B. Casing Spacers

1. Casing spacers shall meet one of the following requirements:

   a. Casing spacers shall be flanged, bolt-on style with a two-section stainless steel shell lined with a PVC liner, minimum 0.09-inch thick also having a hardness of 85-90 durometer. Runners shall be attached to stainless steel risers which shall be properly welded to the shell. The height of the runners and risers shall be manufactured such that the pipe does not float within the tunnel. Casing spacers shall be manufactured by Cascade Waterworks Manufacturing Company, Advanced Products & Systems, Inc., or approved equal.

   b. Casing spacers shall be a two-section, flanged, bolt on style constructed of heat fused PVC coated steel, minimum 14 gauge band and 10 gauge risers, with 2-inch wide fiberglass reinforced polyester insular duty PVC inner liner, minimum 0.09-inch thick, having a hardness of 85-90 durometer and all stainless steel hardware. Casing spacer shall be manufactured by Pipeline Seal and Insulator, Ltd., or approved equal.

2. Casing spacers shall be designed for the general configuration shown on the Drawings, including provisions for other conduits to be installed within the tunnel in addition to the carrier pipe.

C. Casing End Seals: Casing end seals shall be 1/8-inch thick synthetic rubber secured with stainless steel banding straps. End seals shall be as manufactured by Pipeline Seal and Insulator, Ltd., or approved equal.

D. Grout: Grout shall be used for filling voids outside of the tunnel liner plates. Grout shall have a minimum compressive strength of 100 psi attained within 24 hours.

E. Concrete: Concrete shall be 3000 psi as specified in Section 03300.

F. Carrier Pipe:

1. Carrier pipe shall be Ductile Iron Pipe as specified in Section 02665, Water Mains and Accessories.

2. All joints of carrier pipe within the limits of the tunnel shall be restrained.

G. Surface Settlement Markers: Surface settlement markers within pavement areas shall be P.K. nails. Surface settlement markers within non-paved areas shall be wooden hubs.

2.02 EQUIPMENT

B. Tunnels

1. Other Tunneling Equipment

a. Power machinery and tools within the tunnel shall be operated by either electricity, compressed air, diesel with approved scrubber or other approved power. Electrical tools and equipment shall be grounded in accordance with the latest requirements of the National Electrical Code.

b. All electrical equipment and power receptacles shall have appropriate ground fault protection.

c. Provide temporary electrical lights to properly and safely illuminate all parts of the shafts and tunnel including special illumination at the working face. Lighting circuits shall be thoroughly insulated and separated from power circuits, and lights shall be enclosed in wire cages. Secure electrical permits required for completion of this work.

PART 3 EXECUTION

3.01 GENERAL

A. Interpretation of soil investigation reports and data, investigating the site and determination of the site soil conditions prior to bidding is the sole responsibility of the Contractor. Rock and/or water, if encountered, shall not entitle the Contractor to additional compensation.

B. Tunnel construction shall be performed so as not to interfere with, interrupt or endanger the CSX Railroad and activity thereon, and minimize subsidence of the surface, structures and utilities above and in the vicinity of the work. Support the ground continuously in a manner that will prevent loss of ground and keep the perimeters and face of the tunnel, passages and shafts stable. The Contractor shall be responsible for all settlement resulting from operations and shall repair and restore damaged property to its original or better condition at no cost to the City.

3.02 GROUNDWATER CONTROL

A. The Contractor shall control the groundwater throughout the construction of the tunnel.

B. When water is encountered, provide and maintain a dewatering system of sufficient capacity to remove water on a 24-hour basis keeping excavations free of water until the backfill operation is in progress. Dewatering shall be performed in such a manner that removal of soil particles is held to a minimum. Dewater into a sediment trap and comply with requirements specified in Section 02125, Temporary and Permanent Erosion and Sedimentation Control.

C. Methods of dewatering shall be at the option and responsibility of the Contractor. Maintain close observation to detect settlement or displacement of surface facilities due to dewatering. Should settlement or displacement be detected, notify the Engineer immediately and take such action as necessary to maintain safe conditions and prevent damage.

3.03 SAFETY

A. Provide all necessary bulkheads and shields to ensure complete safety to all traffic, persons and property at all times during the work. Perform the work in such a manner as to not permanently damage the CSX Railroad or interfere with normal traffic over it in those areas immediately adjacent and outside the active project work area.

B. Observe and comply with all requirements of the CSX Railroad Crossing Agreement.

C. Perform all activities in accordance with the Occupational Safety and Health Act of 1970 PL-596), as amended, applicable regulations of the Federal Government, OSHA 29CFR

1926 and applicable criteria of ANSI A10.16-81, "Safety Requirements for Construction of Tunnel Shafts and Caissons".

3.04 RAILROAD CROSSINGS

A. The Contractor shall secure permission from the railroad to schedule work such that it does not interfere with the operation of the railroad.

B. All work on the railroad right-of-way, including necessary support of tracks, safety of operations and other standard and incidental operation procedures may be under the supervision of an authorized representative of the railroad and any decisions of this representative pertaining to construction and/or operations shall be final and construction shall be governed by such decisions.

C. All railroad costs associated with the pipe installation (inspection, flagging, track work, protection of signal cables etc.) shall be reimbursed to the railroad. These funds will be collected by the railroad in advance of any work being done on railroad property.

D. No blasting shall be permitted within the railroad right-of-way, unless otherwise authorized in writing by CSX Railroad.

3.05 SURFACE SETTLEMENT MONITORING

A. The Contractor shall place settlement markers, along the centerline of the tunnel at 20 foot intervals. Markers shall also be placed at each edge of the CSX Right-of-Way, at the centerline of the railroad tracks and at 10 and 25 feet offset in each direction from the centerline of the tunnel. Tie settlement markers to bench marks and indices sufficiently removed as not to be affected by the Contractor’s operations.

B. Make observations of surface settlement markers, placed as required herein, at intervals acceptable to the Engineer. In the event settlement or heave on any marker exceeds 1-inch, the Contractor shall immediately cease work and using a method approved by the Engineer, take immediate action to restore surface elevations to those existing prior to start of Contractor’s operations.

C. Take readings and permanently record surface elevations prior to start of dewatering operations and/or access pit excavation. The following schedule shall be used for obtaining and recording elevation readings: all settlement markers, once a week; all settlement markers within 50 feet of the tunnel heading, at the beginning of each day; more frequently at the Engineer's direction if settlement is identified. Make all elevation measurements to the nearest 0.01 foot.

D. The Contractor shall cooperate fully with jurisdictional personnel. Any settlement shall be corrected by, and at the expense of, the Contractor.

E. Promptly report any settlement and horizontal movement immediately to the Engineer and the designated CSX Railroad representative, and take immediate remedial action, at no cost to the City.

3.08 TUNNELS

A. Shaft/Access Pit Excavation:

1. Excavate in such a manner that over break is held to a minimum. In soil and mixed face conditions, install primary support in continuous and close contact with the excavated surface to control water inflow and prevent ground loss, so that adjacent structures are not affected by ground movements. Excavation in soil shall not be advanced ahead of the previously installed primary support any more than is necessary for the installation of the succeeding section of primary support.

2. Whenever shaft sinking is suspended, complete primary support to the excavated surfaces and maintain continuous dewatering. The Contractor shall have qualified personnel periodically check conditions that might threaten the excavation stability.

3. Remove excavated soil and rock from the site and dispose of properly at a location secured by the Contractor.

4. Remove sheeting used for shoring from the shaft and off the job site. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either new or existing structures, private or public properties and also to avoid cave-ins or sliding in the banks.

B. Tunnel Excavation:

1. Excavate in such a manner that over break is held to a minimum.

2. Where water inflows in the tunnel face are large and increasing, the Engineer may instruct the Contractor to drill probe holes, relief holes and ground treatment holes in the tunnel face, and to carry out consolidation grouting before proceeding.

3. Whenever tunneling is suspended, complete installation of the primary support for that excavation cycle. Have qualified personnel periodically check conditions that might threaten tunnel stability.

4. Remove excavated rock from the excavation and dispose of properly at a location secured by the Contractor.

C. Liner Plate Installation:

1. The liner plates shall be installed progressively as excavation proceeds. Excavation shall not continue more than 24 inches past the end of the liner plate already in place. At this time an additional section of liner shall be installed before excavation shall continue.

2. Grout shall be placed under pressure in the annular space outside the tunnel as the excavation proceeds. Grout should be continuously placed as close to the heading as possible, using grout stops if necessary. Grout shall be injected in the lower holes first, moving upward as the annular space is filled. Screw type plugs shall be installed after filling each grout hole.

3. After an entire ring has been pressure grouted and the grout has taken an initial set, the top row of plugs in the liner plate shall be successively removed and voids arising from incomplete filling or shrinkage shall be filled by re-grouting.

3.09 VENTILATION AND AIR QUALITY

A. Provide, operate and maintain for the duration of project, a ventilation system to meet safety and OSHA requirements.

B. (Not Used)

3.12 INSTALLATION OF CARRIER PIPE IN TUNNEL

A. After the tunnel is complete and has been accepted by the Engineer, install the carrier pipe in accordance with the Drawings and Specifications.

B. Check the alignment and grade of the tunnel and set the carrier pipe at proper alignment, grade and elevation, without any sags or high spots.

C. Care shall be taken to prevent damage to the flanges of the tunnel liner plates.

D. The Contractor shall be responsible for all bad joints including joints disturbed by placing the pipe in the tunnel.

E. 3000 psi concrete shall be used for constructing the tunnel invert.

F. Close the ends of the tunnel with casing end seals.

3.13 SHEETING REMOVAL

A. Remove sheeting used for shoring access pits and remove from the job site. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either new or existing structures, private or public properties and also to avoid cave-ins or sliding in the banks.

B. (Not Used)

3.14 CLEANUP

A. Backfill materials shall be as specified in Section 02225. After completion of the Work, the Contractor shall remove all spoil materials, debris and construction materials and equipment from the site.

B. (Not Used)

+ + + END OF SECTION 02224 + + +

SECTION 02225
TRENCH EXCAVATION AND BACKFILL

PART I GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment, and incidentals required to perform all excavation and backfill required to complete the work as shown on the Drawings and as specified herein. The work shall include, but not be necessarily limited to, excavation and backfill for pipe and appurtenances, manholes and vaults, backfill and compaction, disposal of surplus and unsuitable material and all related work such as sheeting and bracing and dewatering.

B. Work shall also include the removal of trees, stumps, brush, debris or other obstacles which remain after clearing and grubbing operations, which may obstruct the work, and the removal of all other materials, including rock, to the extent necessary to install the pipe and appurtenances in conformance with the lines and grades shown on the Drawings and as specified herein.

C. Backfill shall include the refilling and compaction of the fill in the trenches and excavations up to the surrounding ground surface.

D. The trench is divided into five specific areas:

1. Foundation: The area beneath the bedding, sometimes also referenced to as trench stabilization.

2. Bedding: The area above the trench bottom (or foundation) and below the bottom of the barrel of the pipe.

3. Haunching: The area above the bottom of the barrel of the pipe up to a specified height above the bottom of the barrel of the pipe.

4. Initial Backfill: The area above the haunching material and below a plane 12-inches above the top of the barrel of the pipe.

5. Final Backfill: The area above a plane 12-inches above the top of the barrel of the pipe.

E. The choice of method, means, techniques, and equipment rests with the Contractor. The Contractor shall select the method and equipment for trench excavation and backfill depending upon the: type of material to be excavated and backfilled, the depth of excavation, the amount of space available for operation of equipment, storage of excavated material, proximity of man-made improvements to be protected and available easement or right of way.

1.02 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.

1. ASTM C33 – Standard Specification for Concrete Aggregates
2. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)
4. ASTM D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using A Vibratory Table
5. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
6. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
7. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3)
8. ASTM D2937 – Standard Method for Density of Soil in Place by the Drive-Cylinder Method

B. Density: All references to "maximum dry density" shall mean the maximum dry density defined by ASTM D698, except that for cohesionless, free draining soils "maximum dry density" shall mean the maximum index density as determined by ASTM D4253. Determination of the density of foundation, bedding, haunching, or backfill materials in place shall meet with the requirements of ASTM D1556, ASTM D6938 or ASTM D2937.

C. Sources and Evaluation Testing: Testing of materials to certify conformance with the Specifications shall be performed by an independent testing laboratory.

1.03 SUBMITTALS

A. The Contractor shall submit record documents in accordance with the requirements of the General Conditions. The Contractor shall record locations of all pipelines installed referenced to survey benchmarks. The Contractor shall also include the locations of all underground utilities encountered and/or rerouted. The Contractor shall provide dimensions, materials, elevations, inverts and direction of flow. The Contractor shall use GPS technology or conventional survey methods to locate utilities.

B. (Not Used)

1.04 SAFETY

A. Perform all trench excavation and backfilling activities in accordance with the Occupational Safety and Health Act of 1970 (PL 91-596), as amended. The Contractor shall pay particular

attention to the Safety and Health Regulations Part 1926, Subpart P "Excavations" as described in OSHA publication 2226.

B. (Not Used)

1.05 TESTING

A. Testing shall be performed by an approved independent laboratory.

B. Compaction testing shall be performed in accordance with the requirements of ASTM D1556 or ASTM D6938.

PART 2 PRODUCTS

2.01 TRENCH FOUNDATION MATERIALS

A. Crushed Stone: Crushed stone shall be utilized for trench foundation (trench stabilization) and shall meet the requirements of the Georgia Department of Transportation Specification 800.01, Group I (limestone, marble, or dolomite) or Group II (quartzite, granite, or gneiss). Stone size shall be between No. 57 and No. 4, inclusive.

B. (Not Used)

2.02 BEDDING AND HAUNCHING MATERIALS

A. Water Mains

1. Unless specified otherwise, bedding and haunching materials shall be suitable materials that have been excavated from the trench and have been approved by the Engineer for use as pipe bedding and haunching. Materials shall be clean and free of rock larger than 2-inches at its largest dimension, organics, cinders, stumps, limbs, frozen earth or mud, man-made wastes and other unsuitable materials.

2. Crushed stone, if utilized for bedding and haunching, shall meet the requirements of the Georgia Department of Transportation Specification 800.01, Group I (limestone, marble, or dolomite) or Group II (quartzite, granite, or gneiss). Stone size shall be between No. 57 and No. 4, inclusive.

B. Sewers and Storm Drains: Crushed stone utilized for bedding and haunching shall meet the requirements of the Georgia Department of Transportation Specification 800.01, Group I (limestone, marble, or dolomite) or Group II (quartzite, granite, or gneiss). Stone size shall be between No. 57 and No. 4, inclusive.

C. Filter Fabric - Non-Woven Type

1. Filter fabric associated with bedding shall be a UV stabilized, spunbonded, continuous filament, needle-punched, polypropylene, non-woven geotextile.

2. The fabric shall have an equivalent open size (EOS or AOS) of 120 - 70. The fabric shall also conform to the minimum property values listed in the following table:

Fabric Property	Unit	Test Procedure	Average Value	
			Typical	Minimum
Weight	oz/yd^2	ASTM D 3776	8.3	
Thickness	mils	ASTM D 1777	105	
Grab Strength	lbs.	ASTM D 4632	240	210
Grab Elongation	%	ASTM D 4632	>50	50
Tear Strength	lbs.	ASTM D 4533	100	85
Mullen Burst	psi	ASTM D 3786	350	320
Puncture Resistance	lbs.	ASTM D 4833	115	100
Permittivity	sec^{-1}	ASTM D 4491	1.7	
Water Permeability	cm/sec	ASTM D 4491	0.4	
Water Flow Rate	gpm/ft^2	ASTM D 4491	120	
UV Resistance (500 hrs)	%	ASTM D 4355	>85	
pH			2 - 13	

3. If ordered by the Engineer, the filter fabric manufacturer shall furnish the services of a competent factory representative to supervise and/or inspect the installation of pipe. This service will be furnished for a minimum of 10 days during initial pipe installation.

4. Filter fabric shall be equal to Polyfelt TS 700, Trevira 1125 or SuPac 7-MP.

D. Electrical Ductbanks: Refer to Section 16119

2.03 INITIAL BACKFILL

A. Initial backfill material shall be crushed stone or earth materials as specified for bedding and haunching materials.

B. Earth materials utilized for initial backfill shall be suitable materials selected from materials excavated from the trench. Suitable materials shall be clean and free of rock larger than 2-inches at its largest dimension, organics, cinders, stumps, limbs, frozen earth or mud, man-made wastes and other unsuitable materials. Should the material excavated from the trench be saturated, the saturated material may be used as earth material, provided it is allowed to dry properly and it is capable of meeting the specified compaction requirements.

When necessary, initial backfill materials shall be moistened to facilitate compaction by tamping.

C. If materials excavated from the trench are not suitable for use as initial backfill material, provide select material conforming to the requirements of this Section.

2.04 FINAL BACKFILL

A. Final backfill material shall be general excavated earth materials, shall not contain rock larger than 2-inches at its greatest diameter, cinders, stumps, limbs, man-made wastes and other unsuitable materials.

B. If materials excavated from the trench are not suitable for use as final backfill material, provide select material conforming to the requirements of this Section.

2.05 SELECT BACKFILL

A. Select backfill shall be materials that meet the requirements as specified for bedding, haunching, initial backfill or final backfill materials, including compaction requirements.

B. (Not Used)

2.06 CONCRETE

A. Concrete for bedding, haunching, initial backfill, or encasement shall have a compressive strength of not less than 3,000 psi, with not less than 5.5 bags of cement per cubic yard and a slump between 3 and 5-inches. Ready-mixed concrete shall be mixed and transported in accordance with ASTM C94. Reinforcing steel shall conform to the requirements of ASTM A615, Grade 60.

B. (Not Used)

2.07 FLOWABLE FILL

A. Controlled strength flowable fill shall be used as trench backfill only when authorized, in writing, by the Engineer.

B. Controlled low strength flowable fill shall conform to Section 600 of the Georgia Department of Transportation Standard Specifications for Construction of Roads and Bridges – latest edition.

C. Flowable fill design mix shall be for “excavatable” fill. Design mix shall be submitted to the Engineer for approval in accordance with Section 600.3.03 of the GDOT Standard Specifications.

2.08 GRANULAR MATERIAL

A. Granular material, where required for trench backfill, shall be sand, river sand, crushed stone or aggregate, pond screenings, crusher run, recycled concrete, or other angular material. Granular material shall meet gradation requirements for Size No. 57 or finer.

B. (Not Used)

2.09 GRADED AGGREGATE BASE

A. Graded aggregate base shall be Class "A" meeting the requirements of the Georgia Department of Transportation Specification Section 815.01.

B. (Not Used)

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

A. Topsoil and grass shall be stripped a minimum of 6-inches over the trench excavation site and stockpiled separately for replacement over finished graded areas.

B. Trenches shall be excavated to the lines and grades shown on the Drawings with the centerlines of the trenches on the centerlines of the pipes and to the dimensions which provide the proper support and protection of the pipe and other structures and accessories.

C. Trench Width:

1. The sides of all trenches shall be vertical to a minimum of one foot above the top of the pipe. Unless otherwise indicated on the Drawings, the maximum trench width shall be equal to the sum of the outside diameter of the pipe plus two feet. The minimum trench width shall be that which allows the proper consolidation of the haunching and initial backfill material.

2. Excavate the top portion of the trench to any width within the construction easement or right-of-way which will not cause unnecessary damage to adjoining structures, roadways, pavement, utilities, trees or private property. Where necessary to accomplish this, provide sheeting and shoring.

3. Where rock is encountered in trenches, excavate to remove boulders and stones to provide a minimum of 12-inches clearance between the rock and any part of the pipe, manhole, vault or other structure.

D. Trench Depth:

1. The trenches shall be excavated to the required depth or elevation which allow for the placement of the pipe and bedding to the dimensions and elevations shown on the Drawings.

2. Where rock is encountered in trenches for pipelines, excavate to the minimum depth which will provide a clearance below the pipe barrel of 8-inches for pipe 21-inches in diameter and smaller and 12-inches clearance for larger pipe, manholes and other structures. Remove boulders and stones to provide above minimum clearances between the rock and any part of the pipe, manhole, vault or other structure.

E. Excavated Materials:

1. Excavated materials shall be placed adjacent to the work to be used for backfilling as required. Top soil shall be carefully separated and lastly placed in its original location.

2. Excavated material shall be placed sufficiently back from the edge of the excavation to prevent caving of the trench wall, to permit safe access along the trench and not cause any drainage problems.

3. Excavated material shall be placed so as not to damage existing landscape features or man-made improvements and also allow access to valves and hydrants.

3.02 SHEETING, SHORING AND BRACING

A. Sheeting, shoring and bracing is specified in Section 02150.

B. Protection of the excavation against caving or settling of the banks shall be the sole responsibility of the Contractor. The Contractor shall protect the sides of his excavation by sheeting and bracing as may be necessary. No actions or instructions by the Engineer shall be regarded as the responsibility for security of the trench or the surrounding areas. The full responsibility remains with the Contractor.

C. The Contractor shall furnish, put in place and maintain sheeting and bracing required to support the side of the excavation and prevent loss of ground which could damage or delay the work or endanger adjacent structures or vehicular traffic. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports placed at the expense of the Contractor. Compliance with such order shall not relieve the Contractor from his responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

D. The Contractor shall leave in place to be imbedded in the backfill of the trench, all wood sheeting, bracing and other related items as shown on the Drawings, or which the Engineer may direct him in writing to leave in place at any time during the progress of the work for the purpose of preventing injury to structures, utilities, or property, whether public or private. The Engineer may direct that timber used for sheeting and bracing in

the trench be cut off at any specified elevation, after backfilling and tamping has reached this level.

E. All sheeting and bracing not left in place shall be carefully removed in such manner as not to endanger the construction of other structures, utilities or property, whether public or private.

F. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating any obligation on his part to issue such orders, and his failure to exercise his right to do so shall not relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place in the trench sufficient sheeting and bracing to prevent any caving or moving of the ground adjacent to the sides of the trench.

G. The Contractor shall receive no payment, other than that included in the price to be paid for pipe, for any extra timber used for sheeting, bracing and other related items. The Contractor shall receive no payment for such timber which was used for the convenience of the Contractor.

3.03 TEST PITS

A. Test pits for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work may be excavated by the Contractor. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as hereinafter specified.

B. Excavation and backfill of test pits shall be considered work incidental to the project and the cost shall be included in the appropriate bid item.

C. If, for any reason, a test pit is left open for any period of time, it shall be properly barricaded and lighted by the Contractor.

3.04 ROCK EXCAVATION

A. Definition of Rock: Refer to 02200.3.02.D.1.

B. Blasting:

1. Exhaust other practical means of excavating prior to utilizing blasting as a means of excavation. Provide licensed, experienced workmen to perform blasting. Conduct blasting operations in accordance with all existing ordinances and regulations. Protect all buildings and structures from the effects of the blast. Repair any resulting damage. If the Contractor repeatedly uses excessive blasting charges or blasts in an unsafe or improper manner, the Engineer may direct the Contractor to employ an independent blasting

consultant to supervise the preparation for each blast and approve the quantity of each charge.

2. (Not Used)

C. Removal of Rock: Dispose of rock off site that is surplus or not suitable for use as rip rap or backfill.

D. The Contractor shall notify the Engineer prior to any blasting. Additionally, the Contractor shall notify the City and local fire department before any charge is set.

3.05 DEWATERING EXCAVATIONS

A. Dewater excavation continuously to maintain a water level two feet below the bottom of the trench.

B. Control drainage in the vicinity of excavation so the ground surface is properly pitched to prevent water running into the excavation.

C. There shall be sufficient pumping equipment, in good working order, available at all times, to remove any water that accumulates in excavations. Where the utility crosses natural drainage channels, the work shall be conducted in such a manner that unnecessary damage or delays in the prosecution of the Work will be prevented. Provision shall be made for the satisfactory disposal of surface water to prevent damage to public or private property.

D. In all cases, accumulated water in the trench shall be removed before placing bedding or haunching, laying pipe, placing concrete or backfilling.

E. Where dewatering is performed by pumping the water from a sump, crushed stone shall be used as the medium for conducting the water to the sump. Sump depth shall be at least two feet below the bottom of the trench. Pumping equipment shall be of sufficient quantity and/or capacity to maintain the water level in the sump two feet below the bottom of the trench. Pumps shall be a type such that intermittent flows can be discharged. A standby pump shall be required in the event the operating pump or pumps clog or otherwise stop operation.

F. Dewater by use of a well point system when pumping from sumps does not lower the water level two feet below the trench bottom. Where soil conditions dictate, the Contractor shall construct well points cased in sand wicks. The casing shall be jetted into the ground, followed by the installation of the well point, filling casing with sand and withdrawing the casing.

3.06 TRENCH FOUNDATION AND STABILIZATION

A. The bottom of the trench shall provide a foundation to support the pipe and its specified bedding. The trench bottom shall be graded to support the pipe and bedding uniformly throughout its length and width.

B. If, after dewatering as specified above, the trench bottom is spongy, or if the trench bottom does not provide firm, stable footing and the material at the bottom of the trench will still not adequately support the pipe, the Engineer may determine that the trench bottom is unsuitable and the Engineer may then order trench stabilization by directing the Contractor to over excavate trench bottom and fill with crushed stone.

C. Where the replacement of unsuitable material with crushed stone does not provide an adequate trench foundation, the trench bottom shall be excavated to a depth of at least two feet below the specified trench bottom. Place filter fabric in the bottom of the trench and support the fabric along the trench walls until the trench stabilization, bedding, haunching and pipe have been placed at the proper grade. The ends of the filter fabric shall be overlapped above the pipe.

D. Where trench stabilization is provided, the trench stabilization material shall be compacted to at least 95 percent of the maximum dry density, unless shown or specified otherwise.

3.07 BEDDING AND HAUNCHING

A. Prior to placement of bedding material, the trench bottom shall be free of any water, loose rocks, boulders, or large dirt clods.

B. Bedding material shall be placed to provide uniform support along the bottom of the pipe and to place and maintain the pipe at the proper elevation. The initial layer of bedding placed to receive the pipe shall be brought to the grade and dimensions indicated on the Drawings. All bedding shall extend the full width of the trench bottom. The pipe shall be placed and brought to grade by tamping the bedding material or by removal of the excess amount of the bedding material under the pipe. Adjustment to grade line shall be made by scraping away or filling with bedding material. Wedging or blocking up of pipe shall not be permitted. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade shall not be permitted. Each pipe section shall have a uniform bearing on the bedding for the length of the pipe, except immediately at the joint.

C. At each joint, excavate bell holes of ample depth and width to permit the joint to be assembled properly and to relieve the pipe bell of any load.

D. After the pipe section is properly placed, add the haunching material to the specified depth. The haunching material shall be shovel sliced, tamped, chinked or otherwise consolidated to provide uniform support for the pipe barrel and to fill completely the voids under the pipe, including the bell hole. Prior to placement of the haunching material, the bedding shall be clean and free of any water, loose rocks, boulders, or dirt clods.

E. Pipe Bedding:

1. The Contractor shall furnish and install pipe on the type and thickness of bedding as shown on the Drawings or as specified by the Engineer.

2. Pipe bedding requirements for large water transmission mains shall be as specified in Section 02667.

F. Manholes, Vaults and Other Structures: Excavate to a minimum of 12-inches below the planned elevation of the base of the manhole, vault or structure. Place and compact crushed stone bedding material to the required grade before constructing the manhole, vault or structure.

G. Compaction:

1. Bedding and haunching materials under pipe, manholes, vaults, structures and accessories shall be compacted to a minimum of 95 percent of the maximum dry density, unless shown or specified otherwise.

2. Bedding and haunching materials within the limits of restrained joint pipe shall be compacted to a minimum of 95 percent of the maximum dry density, unless shown or specified otherwise.

3.08 INITIAL BACKFILL

A. Initial backfill shall be placed to anchor the pipe, protect the pipe from damage by subsequent backfill and ensure the uniform distribution of the loads over the top of the pipe.

B. Place initial backfill material carefully around the pipe in uniform layers to a depth of at least 12-inches above the pipe barrel. Layer depths shall be a maximum of 6-inches for pipe 18-inches in diameter and smaller and a maximum of 12-inches for pipe larger than 18-inches in diameter.

C. Backfill on both sides of the pipe simultaneously to prevent side pressures.

D. Compact each layer thoroughly with suitable hand tools or tamping equipment.

E. Initial backfill shall be compacted to a minimum 95 percent of the maximum dry density, unless shown or specified otherwise. Initial backfill within the limits of restrained joint pipe shall be compacted to a minimum 95 percent of the maximum dry density, unless shown or specified otherwise.

F. If materials excavated from the trench are not suitable for use as backfill materials, provide select backfill material conforming to the requirements of this Section for initial backfill.

3.09 CONCRETE ENCASEMENT FOR PIPELINES

A Where concrete encasement is shown on the Drawings for pipelines, excavate the trench to provide a minimum of 12-inches clearance from the barrel of the pipe. Lay the pipe to line and grade on solid concrete blocks or solid bricks. In lieu of bedding, haunching and initial backfill, place concrete to the full width of the trench and to a height of not less than 12-inches above the pipe bell. Do not backfill the trench for a period of at least 24 hours after concrete is placed.

B. (Not Used)

3.10 FINAL BACKFILL

A. Backfill carefully to restore the ground surface to its original condition.

B. The top 6-inches of backfill shall be topsoil or graded aggregate base material, depending upon the trench location.

C. Excavated material which is unsuitable for backfilling, and excess material, shall be disposed of in a manner approved by the Engineer. Surplus soil may be neatly distributed and spread over the site, if approved by the Engineer, except that surplus soil shall not be distributed and spread over the site in areas under Corps of Engineers jurisdiction. If such spreading is allowed, the site shall be left in a clean condition and shall not affect pre-construction drainage patterns. Surplus rock from the trenching operations shall be removed from the site.

D. If materials excavated from the trench are not suitable for use as backfill materials, provide select backfill material conforming to the requirements of this Section.

E. Pipelines: After initial backfill material has been placed and compacted, backfill with final backfill material. Place backfill material in uniform layers, compacting each layer thoroughly as follows:

1. In 6-inch layers, if using light power tamping equipment, such as a "jumping jack"

2. In 12-inch layers, if using heavy tamping equipment, such as hammer with tamping feet

F. Manholes, Vaults and other Structures:

1. Backfilling shall be carried up evenly on all walls of an individual structure simultaneously. A variation of 2-feet in elevation will be the maximum allowable. Backfill shall not be allowed against walls until they and their supporting slabs, if applicable, have attained sufficient strength. Backfill shall be subject to the approval of the Engineer.

2. In locations where pipes pass through walls, the Contractor shall take the following precautions to consolidate the backfill up to an elevation of at least 2-feet above the bottom of the pipe:

a. Place fill in such areas for a distance of not less than 3-feet either side of the centerline of the pipe in level layers not exceeding 6-inches in depth.

b. Thoroughly compact each layer with a power tamper to the satisfaction of the Engineer.

3. Temporary bracing shall be provided as required during construction of all structures to protect partially completed structures against construction loads, hydraulic pressure and earth pressure. The bracing shall be capable of resisting all loads applied to the walls as a result of backfilling.

G. Final backfill shall be compacted to a minimum 95 percent of the maximum dry density, unless specified otherwise. Final backfill underlying pavement and backfill under dirt and gravel roads and within the limits of restrained joint pipe shall be compacted to a minimum 95 percent of the maximum dry density, unless specified otherwise.

H. Concrete or bituminous asphalt removed during construction shall not be placed in backfill.

I. The surface of filled areas shall be graded to smooth true lines in conformance with the grades or elevations shown on the Drawings.

3.11 ADDITIONAL MATERIAL

A. Where final grades above the pre-construction grades are required to maintain minimum cover, additional fill material will be as shown on the Drawings. Utilize excess material excavated from the trench, if the material is suitable. If excess excavated materials are not suitable, or if the quantity available is not sufficient, provide additional suitable fill material.

B. (Not Used)

3.12 BACKFILL WITHIN RIGHT-OF-WAYS

A. Compact backfill within the limits of the any right-of-way including the backfill underlying pavement and sidewalks, and backfill under dirt and gravel roads to a minimum 95 percent of the maximum dry density.

B. (Not Used)

3.14 FLOWABLE FILL

A. Where flowable fill is utilized, excavate the trench to provide a minimum of 6-inches clearance on either side of the pipe barrel. Lay the pipe to line and grade on solid concrete blocks or bricks. In lieu of bedding, haunching and initial backfill, place flowable fill to the full width and depth of the trench.

B. Flowable fill shall be protected from freezing for a period of 36 hours after placement. Minimum temperature of flowable fill at point of delivery shall be 50 degrees F.

3.15 COMPACTED GRANULAR MATERIAL

A. Where compacted granular material is required as initial and final backfill material, it shall be placed after bedding and haunching material specified elsewhere has been placed. Compacted granular material shall be compacted to a minimum 95 percent of the maximum dry density.

B. (Not Used)

3.16 TESTING AND INSPECTION

A. The soils testing laboratory is responsible for compaction tests in accordance with paragraph 1.02 of this Section.

B. Compaction tests:

1. Compaction tests will be required in existing or proposed streets, sidewalks, driveways and other existing or proposed paved areas at varying depths and at intervals as determined by the Engineer.

2. Minimum requirements for compaction testing shall be a minimum of one (1) test for each 400 feet or less of pipeline and one (1) test at each manhole, vault and other structure unless soil conditions or construction practices, in the opinion of the Engineer, warrant the need for additional tests. One (1) complete compaction test shall consist of individual tests in the same vertical plane over the installed pipe, beginning at a depth of 2-feet above the top of the pipe and at successive two feet vertical increments up to the top of the backfill.

3. The Engineer shall direct where additional compaction tests will be performed along the Project route.

C. The soils testing laboratory shall be responsible for inspecting and testing stripped site, sub grades and proposed fill materials.

D. The Contractor's duties relative to testing include:

1. Notifying laboratory of conditions requiring testing.
2 Coordinating with laboratory for field testing.
3. Providing excavation as necessary for laboratory personnel to conduct tests.
4. Paying costs for additional testing performed beyond the required scope.
5. Paying costs for re-testing where initial tests reveal non-conformance with specified requirements.

E. Inspection

1. Earthwork operations, acceptability of excavated materials for bedding or backfill, and placing and compaction of bedding and backfill shall be subject to inspection by the Engineer.

2. Foundations and shallow spread footing foundations shall be inspected by a geotechnical engineer, who shall verify suitable bearing conditions.

F. Contractor shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state and federal authorities having jurisdiction.

+ + + END OF SECTION 02225 + + +

SECTION 02510
ASPHALT PAVING

PART 1 - GENERAL

1.01 SCOPE:

A. The work under this Section includes, but it is not necessarily limited to, the furnishing and installation of all asphalt paving materials and pavement base materials as indicated on the Drawings and as necessary for the proper performance of this work.

B. Related Work Specified Elsewhere:

Section 02200, Earthwork.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Batch design.
2. Density and viscosity tests on each run.
3. Weight slips for pavement base and asphalt paving materials.

1.03 QUALITY ASSURANCE:

A. Unless otherwise indicated on the Drawings or herein specified, all work under this Section shall be performed in accordance with the current Georgia Department of Transportation Standard Specifications.

B. Furnish weight slips for all material incorporated in the Project to verify chat the required tonnage has been applied.

1.04 PRODUCT HANDLING:

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to gain the approval of the Engineer at no additional cost to the City.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General: All materials and products for the work under this Section shall conform to the current Georgia Department of Transportation Standard Specifications except as otherwise specified herein.

B. Graded Aggregate Base: The sub-base shall be a minimum of 6-inches thick and a width equal to the width of the finished paving. Aggregate base shall be Class A meeting the requirements of the Georgia Department of Transportation Specification Section 815.01. Compact to at least 95% Standard Proctor Density. (ASTM D-698)

C. Base: The base for all paved roadways shall conform to the requirements of the Georgia Department of Transportation Specifications for the Hot Mix asphalt Section 828 Type "B".

D. Surface Course: The surface course for all pavement, including paint or tack coat when required by the Engineer, shall conform to the requirements of the Georgia Department of Transportation Specifications for Asphaltic Concrete, Section 828, Type "E".

E. Prime coat shall be in accordance with Section 412 of the DOT Standard Specifications.

F. Tack coat shall conform to Section 413 of the DOT Standard Specifications.

PART 3 - EXECUTION

3.01 EXCAVATING. FILLING AND GRADING:

Perform excavating and filling in accordance with Section 02200 entitled "Earthwork" of these Specifications.

3.02 INSTALLATION:

A. Asphaltic construction shall be performed in accordance with Section 400 of the Georgia Department of Transportation "Standard Specifications, Construction of Roads and Bridges".

B. Place each course in the required quantities so that when compacted, they will conform to the indicated grade, cross section and minimum thickness as specified or as indicated on the Drawings.

3.03 CLEANING:

A. Prior to acceptance of the work of this Section, clean the pavement and related areas in accordance with the requirement s of the General Conditions of the Contract Documents.

+++ END OF SECTION 02510 +++

SECTION 02521
CONCRETE SIDEWALKS, CURBS AND GUTTERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for construction of concrete sidewalks, curb & gutter which shall consist of monolithic curb and gutter respectively, all constructed of Portland cement concrete, at the locations, and to the lines, grades, cross section, form and dimensions indicated on the Drawings at the Quarry site.

B. (Not Used)

C. Related Work Specified Elsewhere:

1. Section 02110, Clearing and Grubbing.
2. Section 02200, Earthwork.
3. Section 02510, Asphalt Paving.
4. Section 03300, Cast-In-Place Concrete.

1.02 PRODUCT HANDLING

A. Protection: Use all means necessary to protect concrete materials before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the City.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 CONCRETE REINFORCEMENT (Not Used)

2.02 CONCRETE AND RELATED MATERIALS

A. General: Concrete and related materials including, but not necessarily limited to, joint materials, membranes and curing compounds shall conform to Section 03300, Cast-In-Place Concrete.

B. Class: All concrete shall be Class B 3,000 psi and conform to requirements of Section

C. Water used in mixing concrete shall be fresh, clean, potable water free from injurious amounts of oil, acid, alkali, vegetable, wastewater and/or organic matter.

D. Admixtures shall meet the following requirements:

1. Except as herein specified, no curative or hardening admixtures shall be used.
2. An air entrainment agent capable of providing 3 to 6 percent air shall be used. Air entraining admixtures which are added to concrete mixtures shall conform to ASTM C 260 for Air Entraining Admixtures for Concrete.

E. Sub-base shall be constructed of durable material such as bank-run gravel. Minimum depth of sub-base shall be 3-inches.

F. Joint filler shall be a non-extruding joint material conforming to AASHTO M21 3 for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (non-extruding and resilient bituminous types). The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the Engineer.

PART 3 - EXECUTION

3.01 EARTHWORK

A. General: All earthwork shall be performed in accordance with Section 02200, Earthwork, and as specified in this Section.

B. Backfilling

1. After the subgrade for sidewalks is compacted and at the proper grade, spread 3 inches or more of sub-base material. Sprinkle with water and compact by rolling or other approved method. Top of the compacted gravel shall be at the proper level to receive the concrete.

2. After the concrete has set sufficiently, the spaces on both sides of the curb, gutter, and combined curb and gutter shall be backfilled, and the materials compacted and left in a neat and workmanlike condition.

3. Curbs to be used in the construction of asphalt pavements shall be backfilled prior to placement of base material for asphalt pavement.

3.02 SUBGRADE PREPARATION

A. The subgrade shall be formed by excavating to the required depth below the finished surface of the respective types, in accordance with the dimensions and designs indicated

on the Drawings or as directed by the Engineer, and shall be of such width as to permit the proper installation and bracing of forms. The subgrade shall be compacted by hand tamping and all soft, yielding or unsuitable material shall be removed and backfilled with satisfactory material and again compacted thoroughly to 98% of dry density per ASTM 698 and finished to a smooth and unyielding surface. The finished grade shall be to the dimensions and design indicated on the Drawings or as directed by the Engineer for the bottom of the proposed construction.

3.03 CONCRETE CURB AND GUTTER CONSTRUCTION

A. Construct curbs to lines and grade shown or established by the Engineer. Curbs shall conform to the details shown on the Drawings.

B. Forming:

1. Forms shall be metal and of an approved section. They shall be straight, free from distortions, and shall show no vertical variation greater than 1/4-inch in 10 feet, and shall show no lateral variation greater than ¼-inch in 10 feet from the true plane surface on the vertical face of the form.

2. Forms shall be of the full depth of the structure and be so constructed as to permit the inside forms to be securely fastened to the outside forms.

3. Securely hold forms in place true to the lines and grades indicated on the Drawings.

4. Wood forms may be used on sharp turns and for special sections as approved by the Engineer.

5. Where wooden forms are used, they shall be free from warp and the nominal depth of the structure.

6. All mortar and dirt shall be removed from forms and all forms shall be thoroughly oiled or wetted before any concrete is deposited.

7. The supply of forms shall be sufficient to permit their remaining in place at least 12 hours after the concrete has been placed.

C. Joints:

1. Joints shall be constructed as indicated on the Drawings and as specified.

2. Construct joints true to line with their faces perpendicular to the surface of the structure and within ¼-inch of their designated position.

3. Thoroughly spade and compact the concrete at the faces of all joints to fill all voids.

4. Install expansion joint materials at the point of curve at all street returns.

5. Install expansion joint material behind the curb at abutment to sidewalks and adjacent structures.

6. Place contraction joints every 10 feet along the length of the curbs and gutters.

7. Form contraction joints using steel templates or division plates which conform to the cross section of the structure. Leave the templates in place until the concrete has set sufficiently to hold its shape, but remove them while the forms are still in place.

8. Contraction joint templates or plates shall not extend below the top of the steel reinforcement or shall be notched to permit the reinforcement to be continuous through the joint.

9. Contraction joints shall be a minimum of 1-1/2-inches deep.

D. Finishing:

1. Strike off the surface with a template, and finish the surface with a wood float using heavy pressure, after which, contraction joints shall be made and the surface finished with a wood float or steel trowel.

2. Finish the face of the curbs at the top and bottom with an approved finishing tool of the radius indicated on the Drawings.

3. Finish edges with an approved finishing tool having a 1/4-inch radius.

4. Provide a final broom finish by lightly combing with a stiff broom after troweling is complete.

5. The finished surface shall not vary more than 1/8-inch in 10 feet from the established grade.

E. Concrete Curing:

1. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the structure shall be completely coated and sealed with a uniform layer of curing compound specified in Section 03300, Cast-In-Place Concrete.

2. The compound shall be applied in one or two applications as directed by the Engineer. When the compound is applied in two (2) increments, the second application shall follow the first application within 30 minutes.

3. The compound shall be applied continuously by means of an automatic self-propelled, pressure sprayer as approved by the Engineer at the rate directed by the Engineer, but not less than 1 gallon per 200 square feet of surface.

4. The equipment shall provide adequate stirring of the compound during

application.

5. Should the method of applying the compound not produce uniform coverage, its use shall be discontinued, and the curing shall be by another method approved by the Engineer.

F. Protection:

1. Provide and use sufficient coverings for the protection of the concrete in case of rain or breakdown of curing equipment.

2. Provide necessary barricades and lights to protect the work and rebuild or repair to the approval of the Engineer. All damage caused by people, vehicles, animals, rain, the Contractor's operations and the like shall be repaired by the Contractor at no additional expense to the City.

3.04 SIDEWALK CONSTRUCTION (Not Used)

3.05 REPLACEMENT CONCRETE CURB AND SIDEWALK (Not Used)

3.06 CLEANING

A. All excess or unsuitable material shall be disposed of as specified in Section 02050, Demolition.

B. All surfaces of the Work and adjacent surfaces shall be broom clean. Contractor shall use pressure washing and other means approved by the Engineer to remove splashed and spilled concrete from the Work and adjacent surfaces.

C. Disturbed seeded areas shall be reseeded per requirements of Section 02933, Seeding.

+++ END OF SECTION 02521 +++

SECTION 02535

REINFORCED CONCRETE STORM DRAIN PIPE

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to install all reinforced concrete storm drain pipe as shown on the Drawings and as specified herein.

B. (Not Used)

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product Data: The Contractor shall submit, for the Engineer's approval, descriptive details and shop drawings covering full details of pipe, fittings, specials, joints and the assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.

2. Manufacturer’s Installation Instructions: The Contractor shall submit special procedures required to install products specified.

3. Manufacturer’s Certificate: The Contractor shall submit a manufacturer’s certificate certifying that products meet or exceed specified requirements.

B. Submit shop drawings to the Engineer for review showing a complete laying plan of all pipe, including all fittings, adapters, and specials along with the manufacturer’s drawings and specifications indicating complete details of all items. The pipe details shall include stationing, pipe class or design and supporting computations; and laying schedule which specifies pipe class, class coding, pipe stationing for all changes in grade or horizontal alignment, transition stations for various pipe classes and the limits of each. The above shall be submitted to the Engineer for review before fabrication and shipment of these items.

1.03 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.

1. ASTM C33 – Specification for Concrete Aggregate

2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

3. ASTM C150 – Standard Specifications for Portland Cement

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes using Rubber gaskets.

5. ASTM C655 – Standard Specifications for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

6. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

7. ASTM C1619 – Standard Specification for Elastomeric Seals for Joining Concrete Structures

B. (Not Used)

1.04 TRANSPORTATION AND HANDLING

A. Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings, valves and accessories. Make equipment available at all times for use in unloading. Do not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification.

B. Handle pipe, fittings and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift or front loader. Do not use material damaged in handling.

1.05 STORAGE AND PROTECTION

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipes, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall be stored per the manufacturer’s recommendations.

D. Store joint gaskets in a cool location, out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

1.06 ACCEPTANCE

A. Acceptance of pipe shall be on the basis of plant load-bearing tests of the pipe, material tests and inspection of manufactured pipe for visual defects and imperfections as described in paragraph 5.1.1 of ASTM C76.

B. All pipe shall be manufactured in accordance with the American Concrete Pipe Association QCast Storm Sewer quality assurance program. If pipe producer is not QCast certified, each length of pipe shall be stamped by a regular employee of an approved testing agency.

C. If producer is not QCast certified, provide results of tests on pipe, pipe materials, joint material and made-up joints by an independent testing laboratory approved by the Engineer. Include materials, absorption, crushing and hydrostatic leakage tests on pipe of each size in accordance with applicable specifications.

D. Inspect pipe after delivery for QCast or laboratory stamp, shape, cracks, uniformity, blisters and imperfect surfaces, hammer test, damaged ends and gasket grooves. Any pipe repaired or patched is subject to rejection if such repairs or patches, in the opinion of the Engineer, are not sound and properly finished.

E. Pipe shall not be shipped until it has attained full specified 28 day compressive strength.

PART 2 PRODUCTS

2.01 GENERAL

A. All reinforced concrete storm drain pipe shall conform to the requirements ASTM C76, except as specifically extended, modified or amended in this section.

B. All reinforced concrete storm drain pipe shall meet the standards for ASTM C76 Class III or as otherwise designated on the Drawings. All reinforced concrete storm drain pipe shall have a minimum of a B wall thickness unless shown otherwise on the Drawings or specified herein.

2.02 CONCRETE PIPE

A. Reinforced concrete storm drain pipe shall be manufactured in accordance with ASTM C76 and shall be furnished in not less than eight (8) foot lengths. Special pieces and closure pieces may be of shorter lengths than specified in this section. Pipe shall be manufactured wet cast, dry cast, or centrifugally cast.

B. No lifting holes shall be provided in the wall of the pipe. Care shall be exercised in handling and transporting the pipe so as to protect the full interior wall of the pipe. No inward projecting hooks or lift bars shall be used in lifting pipe. Extreme care shall be

applied to handling pipe immediately after manufacture to prevent development of "cure" cracks and stress cracks due to transporting pipe before full length of curing time.

C. All reinforced concrete storm drain pipe shall be made with concrete with a twenty eight (28) day minimum compressive strength of 4000 psi and the absorption shall not exceed nine (9) percent. All cement and aggregate shall conform to the requirements of ASTM C76. Coarse aggregate shall meet the requirements of ASTM C33 of a size that provides a workable homogeneous, high quality concrete mixture, considering the particular wall thickness. Cement, for reinforced concrete pipe, shall be Type I/II portland cement. All admixtures shall be approved by the Engineer prior to use. Prior to manufacturing any pipe, including test pipe, the manufacturer shall submit the proposed concrete design mix to the Engineer for approval. The requirements of this article shall apply to all reinforced concrete pipe manufactured under the requirements of ASTM C76 and ASTM C443.

D. Reinforcement shall consist of either wire conforming to the standard specification for deformed steel wire for concrete reinforcement (ASTM A496), welded deformed steel wire fabric for concrete reinforcement (ASTM A497), bars of intermediate grade steel conforming to standard specifications for billet steel bars for concrete reinforcement (ASTM A615, Grade 60) or from fabricated deformed steel mats for concrete reinforcing (ASTM A184). Steel areas shall be in accordance with ASTM C76. Pipe with a diameter of 42-inches and larger shall be reinforced with two (2) full circular steel cages. Elliptical steel cages or quadrant steel cages shall not be allowed. Reinforcing steel shall be positioned in accordance with the clearances specified in ASTM C76. Clearance shall be provided for the full length of the pipe from bell end to spigot end of the pipe. Steel positioning shall not vary within the forms more than +/-10% of the wall thickness or +/- one-half (1/2)-inch, whichever is greater.

E. Variations of the internal diameter of the pipe shall comply with paragraph 12.1 of ASTM C76. The planes of the ends of the pipe shall be perpendicular to the longitudinal axis of the pipe except as specified for beveled end pipe (special pieces below). The ends of the pipe shall be of such a design that the pipe, when laid, shall form a continuous conduit with smooth and uniform interior surface. Minor repairs to the pipe are allowed as outlined in accordance with ASTM C76. Minor repairs made at the point of manufacture or in the field shall be filled with a permanent non-shrinking patching compound. Mortar patching compound shall be similar and equal to Embeco 167 Mortar as manufactured by Master Builders, Thoropatch as manufactured by Thoroseal Products, or approved equal. The Engineer or QCast Inspector shall inspect the lengths of pipe before they are shipped to the project site and shall require the manufacturer to apply the mortar as directed. No mortar shall be applied without prior approval of the Engineer or QCast Inspector.

F. A record of pipe supplied for the project shall be furnished to the Engineer by the manufacturer. All pipe shipped to the site of the Work shall be clearly marked as to type, date of manufacture, and name or trademark of manufacturer. The historical record of pipe supplied shall be in a form approved by the Engineer and shall contain: class, date of

manufacture, dates of inspection, date of shipment, and dates and results of compressive tests on cylinders and cores.

G. The Contractor shall not unload the pipe from trucks at the site of the Work in a manner that might damage the pipe. The method used to unload the pipe shall be subject to the approval of the Engineer. It shall be the responsibility of the Contractor to assure that the pipe is manufactured, loaded, transported, unloaded, stored, and installed in a manner which does not result in damage to the pipe.

H. The Engineer, in accepting the pipe, does not imply that the pipe is acceptable for its intended use. The Engineer reserves the right to reject any and all pipe until it meets all the requirements of these specifications.

2.03 SPECIAL PIECES

A. Special pieces of pipe such as bends shall be manufactured from cut lengths of straight pipe, and shall have carry-over reinforcement across adjoining planes of a design approved by the Engineer.

B. Manhole pieces shall be manufactured in accordance with the details shown the Drawings or as specified on the Detail Drawings.

2.04 JOINTS

A. All joints and gaskets shall meet the requirements of ASTM C443.

B. (Not Used)

2.05 SPECIAL DESIGN PIPE

A. Special designs of reinforced concrete pipe shall be in accordance with the requirements of ASTM C76 Section 7.2 - modified or special designs.

B. The pipe manufacturer shall not manufacture reinforced concrete pipe, test pipe, or produce pipe until approval has been obtained from the Engineer in writing. The manufacture of pipe shall have concrete cover over the inside steel cage and cover over the outside steel cage, in accordance to ASTM C76 standards, shall provide two complete circular mats of steel, and shall provide the strengths of steel as specified in this section. Pipe shall be designed per applicable sections of ASTM C76.

C. The pipe manufacturer shall be required upon receiving the order from the Contractor to submit to the Engineer for the Engineer's review and approval, the design for the classes of pipe to be manufactured. The design shall include drawings to be submitted for stamped approval. The stamped approval drawings shall be furnished to the Engineer for use during the manufacturing of the pipe. Manufacturing drawings shall be required for

each pipe size and pipe class. The drawings shall be working drawings to reflect sizes of steel (circumferential, longitudinal, spacer, and stirrups steel) as well as steel placement.

D. Submission of certified three-edge-bearing tests already made, which are acceptable to the Engineer, may be considered as verification of Special Design in lieu of D-Load tests.

E. The Engineer may select at random two full length joints of each class or size of pipe to be tested to D-loads that would produce applicable (ASTM C76) cracking. Tests shall be in accordance with applicable sections of ASTM C76 or as amended in this section. The test shall be performed in the presence of the Engineer or QCast inspector.

PART 3 EXECUTION

3.01 LAYING CONCRETE PIPE

A. Excavation for the pipe and preparation of the trench bottom, including bedding to receive the pipe, shall be done in accordance with the requirements of Section 02225, Trench Excavation and Backfill. In the preparation of the pipe bedding, the Contractor shall take into consideration any variation in thickness of the pipe wall, and the bed must be prepared to suit the particular piece of pipe to be lowered into place. Preparation of the compacted bed shall be such that when the pipe is lowered in place and pulled to secure full compressive pack of the rubber joint ring, a smooth and uniform flow line on the specified grades will be secured. An interior inspection of the sewer will be made after sufficient time has elapsed for the backfill to attain its settlement in the trench.

B. The pipe interior and joints shall be clean when lowered in the trench and shall be kept clean thereafter. The exposed ends of pipe in the trench shall be closed by suitable bulkheads at all times when pipe laying is not in progress. Each section of pipe shall be securely anchored in place before the next adjoining pipe is laid and the joint between the sections is made.

C. No tools or equipment shall be used in the laying of the pipe that will damage the pipe. The trenching equipment shall not be used to force a joint of pipe into its proper position on grade by application of pressure on top of the pipe along its partial or full length. All pipe joints shall be brought home by use of properly designed equipment for the specific purpose as approved by the Engineer. Pipe lengths that have received damage to wall, spigot, or socket shall be replaced or repaired to the satisfaction of the Engineer. Such replacement or repair shall be at the Contractor's expense.

D. The Contractor shall secure the following results with the pipe and joint used:

1. A tight joint with gasket fully compressed and joint openings completely filled.

2. Pipeline shall have a smooth and uniform interior section free from cracks, pits, voids, or crazing as defined in Sections 13 and 15 of ASTM C76. Longitudinal and transverse cracks with a width less than 0.01-inch shall be considered hairline and

minor. Seal longitudinal and transverse cracks having a width equal to or greater than 0.01-inch and less than 0.10-inch if there is displacement across the crack and the soil pH is less than 5.5. Replace pipes having longitudinal and transverse cracks greater than 0.10-inch.

E. Backfilling shall be in accordance with the requirements of Section 02225, Trench Excavation and Backfill.

3.02 CLEANING

A. At the conclusion of the work, the Contractor shall clean all pipe by flushing with water or other means to remove all dirt, stone wood or other materials which may have entered the pipe during construction.

B. (Not Used)

3.03 TESTING

A. Additional testing and inspection required for acceptability of installed storm sewers is specified in Section 02650, Testing for Acceptance of Sanitary and Storm Sewers.

B. (Not Used)

3.04 CLEANUP

A. After completing each section of storm drain, the Contractor shall remove all debris and construction materials and equipment from the site of the Work; grade and smooth over the surface on both sides of the line; and leave the entire construction area in a clean and neat condition. The Contractor shall restore the site of the Work to its original or better condition.

B. (Not Used)

+ + + END OF SECTION 02535 + + +

SECTION 02645
FIRE HYDRANTS

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials and equipment to install and test fire hydrants as specified herein and as shown on the Drawings.

B. Fire hydrants shall be Mueller Super Centurion 250 A-423, modified to meet the City of Atlanta standard requirements as specified in this section. In order to insure compatibility with the City's existing inventory of hydrants and spare parts and standardized maintenance procedures, no other hydrants shall be acceptable.

1.02 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, unless indicated otherwise on the Drawings or specified herein.

1. ANSI B18-2.1 - Standard specification for Square and Hex Bolt Screws, including Askew Head Bolts, Hex Cap Screws and Lag Screws

2. ANSI/AWWA C110/A21.10 - Ductile Iron and Gray Iron Fittings

3. ANSI/AWWA C111/A21.11 - Rubber Gaskets Joints for Ductile Iron Pressure Pipe and Fittings.

4. ANSI/AWWA C151/A21.51 - Ductile Iron Pipe, Centrifugally Cast

5. ANSI/AWWA C502 - Dry Barrel Fire Hydrants.

6. ANSI/AWWA C550 – Protective Epoxy Interior Coatings for Valves and Hydrants

7. ANSI/AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.

8. AWWA M17 - Installation, Field Testing and Maintenance of Fire Hydrants.

B. Testing and Inspection: The Contractor shall perform all tests and inspections required by this specification unless otherwise stated. The Contractor may use the manufacturer's facility or any independent laboratory acceptable to the Owner. The Owner reserves the right to perform any of the test and inspection requirements where such tests and inspections are needed to further determine compliance with this specification.

C. Samples, visual tests and inspections may be required by the Owner. These shall be performed and witnessed in the presence of the Engineer at no extra cost. Failure to comply with this provision may cause rejection of the hydrants.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Shop Drawings and Product Data

2. Certificate of compliance with the requirements of ANSI/AWWA C502.

3. Records of standard tests.

B. (Not Used)

PART 2 PRODUCTS

2.01 FIRE HYDRANTS

A. Fire hydrant shall be three-way, post type, dry top traffic design model with compression main valve opening against and closing in the direction of normal water flow. Hydrant shall be designed for 250 psi working pressure.

B. Fire hydrants shall conform to the requirements of ANSI/AWWA C502.

C. Manufacture

1. Hydrant shall have the name of the manufacturer, the year of manufacture, operating pressure and valve size in legible raised letters cast on the barrel. Hydrant shall also have the letters “AWB” cast on the barrel for identification purposes.

2. Dry Top Bonnet:

a. Bonnet shall be constructed with a moist proof lubrication chamber which encloses the operating threads and which provides automatic lubrication of the threads and bearing surfaces each time the hydrant is operated.
b. Bonnet assembly shall be comprised of a top O-ring serving as a dirt and moisture barrier and a lower O-ring which will serve as a pressure seal. The O-ring packing shall be included in an oil filled reservoir so that all operating parts are enclosed in a sealed oil bath.
c. O-rings shall be Buna N in accordance with ASTM D2000.

d. An oil filler plug shall be provided in the bonnet to permit checking of the oil level and adding oil when required.

3. Operating Nut

a. Operating nut shall be ASTM B584 bronze, 7/8 - 1 inch tapered square nut with tamper-proof device.
b. The tamper proof device shall be a ductile iron combination hold-down nut and operating nut shield to eliminate operation of hydrant with wrenches other than a special socket-type wrench. Arrow shall be cast on the periphery of the bonnet indicating direction of the operation for opening the hydrant.

4. Nozzles

a. Fire hydrant shall have two (2) 2-1/2 inch hose connections, 120 degrees apart and one (1) 4-1/2 inch pumper connection, with National Standard threads. Nozzles to be made of bronze and have interlocking lugs to prevent blowout.
b. Nozzle caps nuts shall have the same cross section as the operating nut on the bonnet. Nozzle caps shall be secured to the fire hydrant with non-kinking type steel chain with chain loop on cap ends to permit free turning of caps.
c. Outlet Nozzle Threads shall conform to the National Fire Protection Association (NFPA) for National Standard Fire Hose Coupling Screw Threads.

5. Main Valve

a. The internal main valve diameter shall be a minimum of 5 1/4- inches.
b. The valve shall be designed to open against pressure and close with pressure.
c. Valve shall be made of synthetic rubber and formed to fit the valve seat accurately.
d. The valve shall be reversible.

6. Main Valve Seat

a. The main valve seat shall be ASTM B584 bronze and its assembly into the hydrant shall involve bronze to bronze thread engagement.
b. Two (2) O ring seals shall be provided as a positive pressure seal between the bronze seat ring and the shoe.
c. Valve assembly pressure seals shall be obtained without the employment of torque or torque compressed gaskets.
d. The hydrant shall be designed to allow the removal of all operating parts through the hydrant barrel by means of a single disassembly wrench without excavating.

7. Traffic Design

a. Hydrant barrel section shall be connected at the ground line in a manner that will prevent damage to the hydrant when struck by a vehicle.
b. Main valve rod section shall be connected at the ground line by a frangible coupling.
c. The barrel and ground line safety construction shall be such that the hydrant nozzles can be rotated to any desired position without disassembling or removing the top operating components and top section of the hydrant barrel.

8. Drain

a. The drain mechanism shall be designed to operate with the operation of the main valve and shall allow a momentary flushing of the drain ports.
b. A minimum of two (2) internal positive opening drain valves and two (2) external bronze lined drain ports shall be required in the main valve assembly to drain the hydrant barrel.
c. The drain valve facings shall be made of either rubber or polyethylene material and retained in position with stainless steel screws.

9. Shoe

a. Shoe shall be ductile iron, ASTM A536, grade 65-45-12. Interior of shoe shall be epoxy coated in accordance with ANSI/AWWA C550.
b. Main valve travel stop shall be an integral part of the shoe permitting full opening of the hydrant and positive stop without over travel of the stem.

10. Barrel Extension Sections: Barrel extension sections shall be available in six (6) inch increments complete with rod, extension, coupling and necessary flanges gaskets and bolts so that extending the hydrant can be accomplished without excavating.

11. Nuts and Bolts: Nuts and bolts shall be corrosion resistant. Bolt material shall develop the physical strength requirements of ASTM A307 and may have either regular or square heads with dimensions conforming to ANSI B18.2.1 Nuts, bolts and studs shall be cadmium-plated (ASTM A165, grade NS) or zinc-coated (ASTM A153 or ASTM B633), or rust-proofed by a process acceptable to the Engineer.

12. O Rings: O rings shall be rubber and conform to the requirements of ASTM 2000.

13. Markings: Bury mark of fire hydrant shall be cast on the barrel of the hydrant. The bury mark shall provide not less than 18-inches of clearance from the centerline of the lowest nozzle to the ground.

14. Direction of Opening: Hydrant shall be designed to open “right” or clockwise.

15. Joint Assemblies: Complete joint assemblies consisting of glands, gaskets, bolts and nuts shall be furnished.

16. Coating and Painting

    a. All iron parts of the hydrant, inside and outside, shall be cleaned and all surfaces shall be coated with a two part epoxy. Epoxy shall be Amercoat 370.
    b. The outside of the hydrant above ground level shall be cleaned and thereafter shop painted with two (2) coats of Sherwin Williams Quick Dry Alkyd Enamel, Mueller paint code RP. Color shall be aluminum.

17. Lubrication: All bronze, threaded contact moving parts shall, during shop assembly, be lubricated and protected by a coating of rustproof compound to prevent damage in shipment and storage.

PART 3 EXECUTION

3.01 INSPECTION

A. Prior to installation, inspect all hydrants for direction of opening, nozzle threading, operating nut and cap nut dimensions, tightness of pressure containing bolting, cleanliness of inlet elbow, handling damage and cracks. Defective hydrants shall be corrected or held for inspection by the Engineer.

B. (Not Used)

3.02 HYDRANT INSTALLATION

A. Hydrants shall be placed at the locations indicated on the Drawings. The Contractor shall install proper “bury” hydrants or shall use, at no cost to the City, proper length extensions to ensure that each fire hydrant is installed in accordance with the manufacturer’s recommendation and the requirements of these Specifications.

B. Hydrants shall stand plumb with pumper nozzle facing the roadway.

C. Hydrants shall be set to the finished grade with the centerline of the lowest nozzle 18-inches above finished grade.

D. When placed behind curb, the hydrant barrel shall be set such that the distance from the face of the curb to the edge of the hydrant shall be 21-inches. Where no curb exists, the hydrant shall be set as directed by the Engineer.

3.03 CONNECTION TO WATER MAIN

A. Fire hydrant shall be connected to the water main with a ductile iron branch connection. Gate valves shall be used on fire hydrant branches as shown on the Drawings.

B. The connection of the hydrant to the water main shall be through a ductile iron hydrant tee or a welded outlet for main lines with a diameter of 24-inches or greater. Tapping sleeves shall not be allowed.

C. Hydrants shall be attached to the water main by the following method:

1. For water mains 20 inches and smaller, the isolation valve shall be attached to the water main by connecting the valve to the hydrant tee.

2. For water mains 24 inches and larger, the isolation valve shall be attached to the water main by providing an anchor coupling between the valve and welded outlet or hydrant tee.

3. The isolation valve shall be attached to the hydrant by providing an anchor coupling between the valve and hydrant, if the hydrant and valve are less than two feet apart. Otherwise, provide mechanical joint ductile iron pipe with retainer glands on the hydrant and valve.

D. Pipe connecting the fire hydrant to the water main shall be 6-inch diameter class 350 ductile iron pipe meeting the requirements of Section 02665, Water Mains and Accessories. Anchor coupling shall be as specified in Section 02665.

E. Anchoring and Bracing: The shoe of each fire hydrant and the hydrant tee shall be braced against unexcavated earth at the ends of the trench with poured concrete thrust blocks as shown on the Drawings.

F. Drainage: No. 57 stone shall be placed around the shoe of the fire hydrant for a minimum distance of 18-inches below the drain ports, 6-inches above the drain ports, 15-inches laterally on each side of the shoe and 24-inches from the back of the shoe towards the main.

G. Provide resistance to avoid transmitting shock moment to the lower barrel and inlet connection by pouring a concrete collar 6-inches thick with a diameter of 24 inches at the ground line around the hydrant barrel.

3.04 FIELD PAINTING

A. After hydrant is installed and approved by the Engineer, the Contractor shall touch up all exposed hydrant surfaces as directed by the Engineer. Touch up paint shall be as specified in paragraph. 2.01 C 16 of this Section.

B. The bonnet of each hydrant shall be painted in one of the following colors to indicate the diameter of the water main that the hydrant is connected to:

Water Main Diameter (inches)	Hydrant Bonnet Color
6 - 8	Silver

10 - 12	Yellow
16 and larger	Green

C. Hydrants that are connected to non-potable water mains (i.e. raw water mains) shall be painted violet (light purple).

D. Private hydrants shall be painted red.

3.05 TESTING

A. All fire hydrants shall be tested in strict accordance with the requirements of ANSI/AWWA C502, with no additional cost to the City. A certificate of compliance will be furnished to the Engineer.

B. (Not Used)

3.06 REMOVAL AND SALVAGE OF EXISTING HYDRANTS

A. Remove all existing hydrants shown on the Drawings to be removed. Hydrants shall be removed as follows:

1. Disconnect hydrant from barrel section.

2. Saw cut or remove barrel section to a minimum of 12-inches below finished grade.

3. Remove hydrant valve cover and concrete pad, valve box and extension stem. Insure that valve is closed. Valve shall remain in place.

4. Deliver removed hydrant, valve cover, valve box and extension stem to the City's storage yard as directed by the Engineer.

B. Backfill excavations and compact as specified in Section 02225 and restore area as required and as directed by the Engineer.

+ + + END OF SECTION 02645 + + +

SECTION 02650
TESTING FOR ACCEPTANCE OF SANITARY AND STORM SEWERS

PART 1 GENERAL

1.01 SCOPE

A. This section includes sanitary and storm sewer inspection and testing methods; joint testing procedures; manhole testing methods; allowable testing limits for sanitary sewers; and any other incidental or appurtenant operations which may be necessary to properly complete the Work.

B. The Contractor shall provide all labor, materials, and equipment required for all sanitary and storm sewers testing and related operations necessary or convenient for completing the Work as shown on the Drawings or specified herein.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. (Not Used)

1.03 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified in these Specifications.

1. ASTM C828 – Test Method for Low-pressure Air Test of Vitrified Clay Pipe Lines

2. ASTM C969 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

3. ASTM C1103 - Standard Practice For Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

4. ASTM C1244 – Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

5. ASTM F1417 – Standard Practice for Installation Acceptance of Plastic non-pressure Sewer Lines Using Low Pressure Air

B. (Not Used)

1.04 ACCEPTANCE TESTS

A. Upon completion of all or a part of a sanitary sewer installation, the Contractor shall test and/or inspect the sewer for acceptability. The method(s) of testing and/or inspection shall be as specified in the individual Specifications sections. Testing and inspection shall be performed in accordance with the requirements of this Section.

B. One or more of the following tests and/or inspections may be required:

1. Infiltration of Water
2. Exfiltration of Water
3. Exfiltration of Air under Pressure
4. Smoke Testing
5. Joint Testing
6. Direct Visual Inspection
7. Deflection Testing
8. Dye Testing
9. Closed Circuit Television Inspection (CCTV).

C. The specified testing method shall be completed by the Contractor when directed by the Engineer. The Contractor shall notify the Engineer 48 hours in advance prior to the Contractor performing any testing.

D. Prior to any testing, all lines shall be cleaned of debris and flushed clean. Debris shall be caught and removed from the line and shall not be flushed into existing live sanitary sewers.

1.05 TEST SECTIONS

A. Unless otherwise specified or directed by the Engineer, each section of sanitary sewer between manholes shall be tested by the air testing method.

B. The Contractor may at his option divide the installed sewer into subsections of more convenient length for testing. If the section or subsection tested does not pass the tests, it shall be repaired and the test repeated until a satisfactory test is obtained.

C. The Engineer may allow alternate testing methods at his discretion or require additional testing methods if, in his opinion, they are warranted.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SANITARY AND STORM SEWER INSPECTION AND TESTING METHODS

A. All Testing Methods: All wyes, tees, and stubs shall be plugged with flexible jointed caps, or acceptable alternate, and securely fastened to withstand the internal test pressure. Plugs or caps shall be readily removable.

B. The Contractor shall clean and test lines before requesting final acceptance. Where any obstruction is met, the Contractor shall clean the sewers by means of rods, swabs, or other instruments. When requested by the Engineer, the Contractor shall flush out lines and manholes before final inspection.

C. Pipe lines shall be straight and show a uniform grade between manholes, except for curves specifically shown on the Drawings. The Contractor shall correct any discrepancies discovered during inspection at no cost to the City.

D. Watertightness

1. All sewers constructed shall be tested for watertightness. Infiltration and exfiltration tests shall be performed on all new sewers constructed as specified in this section, except for those new sewers constructed which have active services tied into them as the pipe is being installed. In such cases the watertightness of the sewers less than or equal to thirty-six (36) inches in diameter shall be based on a visual inspection, and for sewers forty-two (42) inches in diameter and larger based on the individual joint test as specified in this section.

2. All visible leaks, regardless of the amount of leakage, shall be repaired at the Contractor’s expense.

E. Infiltration Tests

1. The Contractor shall install weirs in manholes selected by the Engineer to determine the leakage of ground water into the sewer. The Contractor shall install weirs for a minimum of four hours before measuring flow. If leakage in any section of the sewer line exceeds one hundred (100) gallons per inch of diameter per day per mile, the Contractor shall locate and repair leaks. Repair methods shall be approved by the Engineer. After repairs are completed, the Contractor shall re-test for leakage.

2. Infiltration testing shall be performed before sanitary sewer lateral connections or reconnections are made.

3. The Contractor shall furnish, install and remove the weirs, plugs, and bulkheads required to perform the leakage tests.

4. Weirs shall be V-notch type equal to Pollard.

F. Exfiltration Tests

1. Low-Pressure Air Test:

a. Prior to air testing, the section of sewer between manholes shall be thoroughly cleaned and wetted. Immediately after cleaning or while the pipe is water soaked, the sewer shall be tested with low-pressure air. At the Contractor's option, sewers may be tested in lengths between manholes or in short sections using inflatable balls pulled through the line from manhole to manhole.

b. Air shall be slowly supplied to the plugged sewer section until the internal air pressure reaches approximately four (4) psi. After this pressure is reached and allowed to stabilize (approximately two (2) to five (5) minutes), the pressure shall be reduced to three and one-half (3.5) psi before starting the test.

c. Record the drop in pressure for the test period. If the pressure drop is equal to or less than one (1) psi during the test time, then the line will pass the test. If the pressure drops more than one (1) psi during the test time, the line will fail the test and the Contractor shall locate the failure, make necessary repairs, and retest the line.

d. The minimum test time for various pipe sizes and types is as follows:

Nominal Pipe Size(Inches)	Time (Min/100 feet)	
	VCP, RCP	DIP, PVC
6	0.7	5.7
8	1.2	7.6
10	1.5	9.4
12	1.8	11.3
15	2.1	14.2
18	2.4	17
21	3	19.8
24	3.6	22.8
30	4.8	35.4

36	6	51.2
42	7.3	69.5

e. Required test equipment, including inflatable balls, braces, air hose, air source, time meter, rotameter as applicable, cut-off valves, pressure reducing valve, 0-15 psi pressure gauge, 0-5 psi pressure gauge with gradations in 0.1 psi and accuracy of ± two (2) percent shall be provided by the Contractor. Testing equipment shall be equal to Cherne Air-Loc Testing Systems.

f. The Contractor shall keep records of all tests made. Copies of records shall be given to the Engineer. Records shall show date, line number and stations, operator, and such other pertinent information as required by the Engineer.

g. The Contractor shall take safety precautions in the performance of the air testing. Plugs shall be properly secured and care be exercised in their removal. Every precaution shall be taken to avoid the possibility of over-pressurizing the sewer line.

2. Individual Joint Test: Pipe joints for sewers thirty (30) inches in diameter and larger shall be air tested individually. The joint tester assembly shall be placed over the joint and the joint area pressurized to four (4) psi. The pressure shall not drop more than two (2) psi in ten (10) seconds. The joint tester assembly shall be equal to Cherne Industries, Inc.

G. Smoke Testing

1. Smoke testing may be used only to locate leaks and in no case shall be considered conclusive or a substitute for air tests, infiltration tests, or exfiltration tests. In all cases a smoke test shall be accompanied by an air test, infiltration test or exfiltration test. The Engineer may order a smoke test if another leakage test fails and the source of the leak cannot be determined by other means. Smoke testing shall only be performed where ground water is low. Smoke shall be blown into a sealed section of sewer under pressure and the Contractor and Engineer shall observe for any smoke appearing on top of the ground indicating the presence of leaks.

2. The Engineer may require that the Contractor excavate the sewer to determine the source of any smoke appearing during the smoke test. All leaks or breaks discovered by the smoke tests shall be repaired and/or corrected by the Contractor at his own expense in a manner acceptable to the Engineer. Equipment and supplies required for smoke tests shall be furnished by the Contractor.

3. The Contractor may perform smoke tests at any time during construction at his option; however, any such tests shall not supplant the final test of the completed work.

H. Deflection Test

1. The Contractor shall test all PVC gravity sewers for excessive deflection by passing a mandrel through the pipe. Deflection of the pipe shall not exceed five (5) percent.

2. The mandrel size shall be based upon the maximum possible inside diameter for the type of pipe being tested, taking into account the allowable manufacturing tolerances of the pipe. The mandrel shall be configured as shown on the Drawings and shall have an odd number of legs, or vanes, with a quantity equal to or greater than nine (9). The legs of the mandrel shall be permanently attached to the mandrel. A mandrel with variable sizes shall not be allowed. The mandrel shall be constructed of steel, aluminum, or other material approved by the Engineer, and shall have sufficient rigidity so the legs of the mandrel will not deform when pulled through the pipe. The Contractor shall provide a proving ring for each size mandrel, with a tolerance of no more than 0.02-inch clearance, and the mandrel dimensions shall be checked by the Engineer, using this proving ring, before use by the Contractor.

3. The Contractor shall excavate and properly install any section of pipe not passing this test and re-test until results are satisfactory.

4. This test shall be performed twice:

   a. Once within the first thirty (30) days of installation, and
   b. Once during final inspection, but no sooner than thirty (30) days after pavement backfill is done, at the completion of this Contract.

I. Dye Testing

1. Dye testing shall be used only to confirm service connection or disconnection and in no case shall be considered conclusive or a substitute for air tests, infiltration tests or exfiltration tests. Dye testing shall only be performed where ground water is low. Dye shall be introduced into the service lateral and the Contractor and Engineer shall observe for any dye appearing on sanitary or storm sewers. Equipment and supplies required for dye tests shall be furnished by the Contractor.

2. The Contractor may conduct dye tests at any time during construction at his option; however, any such tests shall not supplant the final test of the completed work.

J. Closed Circuit Television Inspection

1. The Engineer shall require that the interior of all new gravity sewers be subjected to a televised inspection. Such internal inspection shall be conducted and documented in accordance with the requirements of Section 02655, Closed Circuit Television Inspection.

2. Prior to Final Acceptance the City shall be provided with one copy of the TV inspection report and CD-ROMs showing the entire length of the gravity sewer tested. The report shall contain the condition of pipe, type of pipe, depth, location of services, length, type of joints, roundness and distance between manholes. Any pipe found to be cracked, leaking, misaligned, bellied, or otherwise defective shall be removed and replaced by the Contractor.

3.02 JOINT TESTING PROCEDURES

A. Joint Testing Procedures: Each sanitary sewer joint shall be individually air tested using a packer or other approved testing device at a test pressure of four (4) psi plus one-half (1/2) psi per vertical foot of depth up to a maximum of ten (10) psi. The packer or testing device shall be positioned within the sanitary sewer so as to straddle the joint to be tested. The ends of the packer or testing device shall be expanded to isolate the pipe joint from the remainder of the sewer and create a void space between the packer or testing device and the pipe joint. The sealing elements shall be inflated with air in accordance with the test equipment manufacturer's instructions. Air shall then be introduced into the void space until the required test pressure is recorded on the void pressure meter. If the required test pressure cannot be developed, the joint will fail the test. After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the pressure holds or drops less than two (2) psi in fifteen (15) seconds, the joint is acceptable.

1. All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation by the Engineer. The void pressure data shall be transmitted electronically from the void to the monitoring equipment.

2. Prior to starting the sanitary sewer joint testing, a two (2) part control test shall be performed as follows:

    a. A demonstration test shall be performed in a test cylinder constructed in such a manner that a minimum of three (3) known leak sizes (0.062, 0.094, 0.125 inch diameter) can be simulated. During the demonstration test, the Contractor shall use a test cylinder gauge to measure void pressure. The Contractor shall also install the void pressure monitoring equipment in the same manner as will be done to measure the void pressure at a sanitary sewer joint. The Contractor shall then apply pressure to the void space. During the demonstration test, the void pressure reading on the test cylinder gauge shall be the same as that observed on the void pressure monitoring equipment at all times during the test. If the pressure reading on the test cylinder gauge is not the same as the pressure reading observed on the void pressure monitoring equipment at all times, the Contractor shall repair or otherwise modify the packer or testing device and perform the test until the results are satisfactory to the Engineer. The demonstration test may be required, by the Engineer, at any other time during the joint testing work.

b. Upon entering each manhole to manhole section with the test equipment, but prior to the commencement of joint testing, the packer or testing device shall be positioned on a section of sound sanitary sewer between pipe joints. The Contractor shall then perform the test at the required pressure. If the test indicates that the sanitary sewer will not meet the joint test requirements, the Contractor shall inform the Engineer who will have the discretion of modifying the joint test requirements.

3. During the sanitary sewer joint testing work, the Contractor shall keep the following records:

   a. Manhole to manhole section tested.
   b. Test pressure used.
   c. Location (footage) of each joint tested.
   d. Test results for each joint tested.

B. Lamping Procedures: Lamping will be performed on all sewer pipelines by the Engineer.

3.03 MANHOLE TESTING

A. All new manholes, rehabilitated manholes, manhole inserts and replacement manholes shall be tested by the Contractor using the vacuum test method, following the manufacturer's recommendations. Vacuum testing of manholes and structures shall be performed after curing of linings and installation of inserts. Any leakage in the manhole or structure, before, during, or after the test shall be repaired at no cost to the City.

B. Prior to testing manholes for watertightness, all lift holes shall be plugged with a non-shrink grout, all joints between precast sections shall be properly sealed and all pipe openings shall be temporarily plugged and braced.

C. Vacuum Tests:

1. The manhole, after preparation as noted above, shall be vacuum tested. All testing shall be performed in accordance with the requirements of ASTM C1244. A vacuum shall be drawn and the vacuum drop over a specified time period shall be used to determine the acceptability of the manhole.

2. The test head shall be placed at the inside of the top of the manhole in accordance with the manufacturer’s instructions. A vacuum of ten (10) inches of mercury [five (5) psi] shall be drawn on the manhole, the valve on the vacuum line of the test head closed and the vacuum pump shut off. The time shall be measured for the vacuum to drop from ten (10) inches of mercury [five (5) psi] to nine (9) inches of mercury [four and one-half (4.5) psi]. The manhole shall pass the vacuum test if the time for the vacuum reading to drop from 10-inches of mercury to 9-inches of mercury meets or exceeds the values indicated in the table below.

MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS				
	Manhole Diameter (Inches)			
	48	60	66	72
Depth (Feet)	Time (Seconds)			
8	20	28	29	33
10	25	33	36	41
12	30	39	43	49
14	35	48	51	57
16	40	52	58	67
18	45	59	65	73
20	50	65	72	81
22	55	72	79	89
24	59	78	87	97
26	64	85	94	105
28	69	91	101	113
30	74	96	108	121

D. For manholes less than 8-feet in depth, the minimum value listed shall be used.

E. If the manhole fails the initial test, necessary repairs shall be made with non-shrink grout. Retesting shall proceed until a satisfactory test is obtained.

F. Vacuum testing equipment shall be equal to that as manufactured by P.A. Glazier, Inc.

G. The City reserves the right to have third party consultants perform construction materials testing and assessments to any new manhole.

3.04 ALLOWABLE TESTING LIMITS FOR SANITARY SEWERS

A. No infiltration and exfiltration of ground water or other leakage into or out of the sewer shall be allowed during the twenty-four (24) hour test period.

B. Any visible or audible leaks into the sewer shall be repaired or corrected as directed by the Engineer.

+ + + END OF SECTION 02650 + + +

SECTION 02655
PIPING SYSTEM CLEANING AND TELEVISION INSPECTION

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to complete all piping system cleaning and television inspection Work as shown on the Drawings and as specified herein.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. The Contractor shall provide to the Engineer the following information in writing prior to the set deadline, or at the indicated frequency, whichever is applicable.

Type of Submittal	Time/Frequency of Submittal
Experience Record of Contractor/Subcontractor	At Preconstruction Conference
Listing of Safety Precautions and Traffic Control Measures	At Commencement
Listing of CCTV and Sonar Equipment	At Commencement
Manufacturers Details of CCTV and Sonar Equipment	At Commencement
Internal Piping Inspection Project Schedule	At Preconstruction Conference
Listing of Cleaning Equipment & Procedures	At Commencement
Listing of Flow Diversion Procedures	At Commencement
Listing of Preconditioning Procedures	At Commencement
Listing of Backup and Standby Equipment	At Commencement
Location where Debris from Cleaning will be Disposed	At Commencement
Updated Schedule of Planned Inspections/Cleaning of Piping Reaches	Post Commencement and Weekly

Two (2) copies of CCTV and Sonar findings (2 hard copies of fully detailed logs incorporating a summary statistical breakdown of defects and main findings, two (2) electronic discs of fully detailed logs and CD-ROMS of video output)	One (1) week After Completion of Section
Daily Logs and Progress Reports	Daily
Confined Space Entry Logs	Daily

2. Daily reports and weekly reports survey) shall be e-mailed to the Engineer.

3. The Contractor shall complete a daily written record (diary) detailing the work carried out and any small items of Work which were incidental to the Work. The Contractor shall include in his daily record and reference to the following:

   a. Delays: Dense traffic, lack of information, sickness, labor, or equipment shortage, etc.
   b. Weather: Conditions, e.g. rain, sunny, windy, etc.
   c. Equipment: On site, e.g. specialty cleaning, by-pass equipment, etc.
   d. Submittals: To the Engineer.
   e. Personnel: On site by name, e.g., all labor, specialty services, etc.
   f. Accident: Report, e.g. all injuries, vehicles, etc.
   g. Incident: Report, e.g. damage to property, property owner complaint, etc.
   h. Major defects encountered, including collapsed pipe, if any: Cave-ins, sink holes, etc.

4. The Engineer shall certify receipt of the daily record noting any items and adding any observations with reference to claims for payment to the Contractor. The Engineer may at his discretion, for which the Contractor must receive direction in writing, provide for an exception to this requirement for weekly submission of progress rather than for daily submission.

1.03 GENERAL

A. Internal piping condition assessment shall be used to determine the structural and service condition of piping prior to abandonment, preconditioning or rehabilitation. Assessment shall be performed using pan and tilt color camera CCTV. In those circumstances where depth of flow is too great for CCTV, Sonar or a combination of Sonar and CCTV shall be used.

B. Internal piping condition assessment shall also be used to inspect newly constructed piping and to survey individual lines that have been preconditioned to further assess condition and record findings.

C. It is the responsibility of the Contractor to comply with OSHA regulations, the City of Atlanta's Safety Guidelines, and the City of Atlanta's Confined Space entry Guidelines as applicable. The Contractor shall provide written documentation that all workers have received the training required under these regulations and guidelines.

D. Two forms of internal condition assessment are required as part of this Contract as follows:

1. Piping Survey: Detailed viewing of the piping ("survey") either manually or with the aid of CCTV and/or Sonar equipment, to assess internal structural condition, service condition, and identify and locate miscellaneous construction features as well as assess the structural and service condition of laterals. Data logging shall be required.

2. Piping Inspection: Viewing the piping ("pull-through") pursuant to investigative work possibly incorporating a radio-sonde transmitter for locating purposes and/or following other operational activity including:

   a. Locating manhole(s) and/or lateral(s) with or without radio-sonde.
   b. Piping preconditioning and cleaning activities.
   c. Piping rehabilitation including point repairs.
   d. Such other similar purposes as may be required by the Engineer.

E. Piping inspection shall be carried out manually or with the aid of CCTV and/or Sonar equipment, to assess overall condition. Data logging shall not be required.

1.04 REQUIREMENTS AND EXTENT OF SURVEY/INSPECTION

A. The Contractor shall survey and/or inspect pipelines with color pan and tilt CCTV imagery and sonar and or combined color pan and tilt CCTV/Sonar (TISCIT) as specified so as to record all relevant features and to confirm their structural and service condition. Surveys/inspections of pipelines shall be carried out in accordance with the reporting format determined by the Engineer. A sample report sheet is attached to this section (Attachment A) and includes the recording of both target total length of piping surveyed/inspected between manholes as well as actual length surveyed/inspected.

B. All CCTV/Sonar operator(s) responsible for direct reporting of piping condition shall have a minimum of three (3) years previous experience in surveying, processing, and interpretation of data associated with CCTV and Sonar surveys/inspections. The Contractor shall provide the Engineer with written documentation that all CCTV and Sonar survey operators meet these experience requirements. Documentation shall include a list of projects undertaken as well as client name and telephone number for reference.

C. The Contractor shall provide certification indicating that all personnel have undergone training prior to undertaking internal condition assessment work. Defect Coding, as well as Material, Shape, and Lining Coding used throughout this Project shall conform to the attached listing (Attachment B). General inspection logging requirements are also

included with this section (Attachment C). Training will be carried out at the Contractor's expense.

D. The Contractor shall complete a daily written record detailing the Work carried out as described in this section.

1.05 FIELD SUPERVISION BY CONTRACTOR

A. The Contractor shall maintain on the site of the Work at all times a competent field supervisor in charge of the Survey/Inspection. The field supervisor shall be approved in writing by the Engineer prior to commencement of the Work. Any change of supervisor must be approved in writing by the Engineer prior to the change. The field supervisor shall be responsible for the safety of all workers and site conditions as well as ensuring that all work is conducted in conformance with the requirements of these specifications and to the level of quality specified.

1.06 APPLICATION OF INSPECTION TYPE

A. The following guidelines concerning the use of CCTV and Sonar shall be followed, subject to the review and approval of the Engineer.

1. CCTV alone shall be used for internal condition assessment where the depth of flow of wastewater is less than twenty-five (25) percent of overall piping diameter at the start of the survey. The Contractor shall make an informed decision to continue should the depth of flow increase beyond the twenty-five (25) percent level but no greater than forty (40) percent of pipe diameter at any time throughout the length.

2. CCTV combined with Sonar shall be used for internal condition assessment where depth of flow of wastewater varies from twenty-five (25) percent to seventy-five (75) percent of overall piping diameter for piping greater than twenty-four (24) inches in diameter. Where the piping is less than twenty-four (24) inches in diameter and depth of flow of wastewater exceeds twenty-five (25) percent but is less than seventy-five (75) percent of pipe diameter the Engineer shall instruct the Contractor to either: (a) continue using CCTV (where depth of flow is only marginally greater than twenty-five (25) percent of pipe diameter) or (b) use Sonar (by damming or plugging the piping so that the depth of flow exceeds seventy-five (75) percent of pipe diameter).

3. Sonar alone shall be used where depth of flow in the piping exceeds seventy-five (75) percent of pipe diameter and the level of the flow will be artificially increased, without the risk of flooding, to ensure that the pipe is completely surcharged.

1.07 RESPONSIBILITY FOR OVERFLOWS OR SPILLS

A. It shall be the responsibility of the Contractor to schedule and perform the Work in a manner that does not cause or contribute to incidence of overflows or spills of wastewater from the piping system.

B. In the event that the Contractor's activities contribute to overflows or spills, the Contractor shall immediately take appropriate action to contain and stop the overflow, clean up the spillage, disinfect the area affected by the spill, and notify the Engineer in a timely manner.

C. The Contractor shall indemnify and hold harmless the City for any fines or third-party claims for personal or property damage arising out of a spill or overflow that is fully or partially the responsibility of the Contractor, including the legal, engineering, and administrative expenses of the City in defending such fines and claims.

PART 2 PRODUCTS

2.01 SURVEY/INSPECTION UNITS

A. The Contractor shall provide sufficient survey/inspection units and all relevant ancillary equipment, including standby units in the event of breakdown, in order to complete all piping and manhole surveys/inspections as specified in this section.

2.02 SURVEY/INSPECTION VEHICLE

A. The survey/inspection vehicle shall comprise two totally separate areas.

B. One area shall be designated as the viewing area and shall be insulated against noise and extremes in temperature, shall be air conditioned and shall be provided with means of controlling external and internal sources of light in a manner capable of ensuring that the monitor screen display is in accordance with the requirements of this section. Seating accommodation shall be provided to allow two (2) people, in addition to the operator, to view clearly the on-site monitor, which shall display the survey/inspection as it proceeds.

C. The second area shall be a working area and shall be reserved for equipment, both operational and stored. No equipment utilized within the piping shall be allowed to be stored in the viewing area.

2.03 CCTV SURVEY/INSPECTION AND OPERATIONAL EQUIPMENT REQUIREMENTS

A. The surveying/inspecting equipment shall be capable of surveying/inspecting a length of piping up to at least one-thousand five-hundred (1500) feet when entry onto the piping may be obtained at each end and up to one-hundred (100) feet by rodding or up to seven-hundred and fifty (750) feet where a self propelled unit is used, where entry is possible at one (1) end only. The Contractor shall maintain this equipment in full working order and shall satisfy the Engineer at the commencement of each working shift that all items of equipment have been provided and are in full working order.

B. Each survey/inspection unit shall contain a means of transporting the CCTV camera and/or Sonar equipment in a stable condition through the piping under survey and/or inspection. Such equipment shall ensure the maintained location of the CCTV camera or

Sonar equipment when used independently on or near to the central axis of a circular shaped piping when required in the prime position.

C. Where the CCTV camera and/or Sonar head are towed by winch and bond through the piping, all winches shall be stable with either lockable or ratcheted drums. All bonds shall be steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera and/or Sonar equipment. All winches shall be inherently stable under loaded conditions.

D. Each unit shall carry sufficient numbers of guides and rollers such that, when surveying or inspecting, all bonds are supported away from pipe and manhole structures and all CCTV/Sonar cables and/or lines used to measure the CCTV camera's/Sonar head location within the piping are maintained in a taut manner and set at right angles where possible, to run through or over the measuring equipment.

E. Each unit shall carry a range of flow control plugs or diaphragms for use in controlling the flow during the survey/inspection. A minimum of one (1) item of each size of plug or diaphragm ranging from six (6) inches to two (2) feet diameter inclusive shall be carried.

F. Each survey/inspection unit shall have on call equipment available to carry out the flushing, rodding, and jetting of piping when such procedures are deemed to be necessary.

PART 3 EXECUTION

3.01 CLEANING PRIOR TO INTERNAL CONDITION INSPECTION

A. Where required by the Engineer and only when instructed in writing, the Contractor shall clean the piping prior to internal condition inspection.

3.02 PIPING CLEANING UNITS AND EQUIPMENT

A. The Contractor shall provide sufficient piping cleaning units and equipment, including standby units in the event of breakdown, in order to complete cleaning operations as specified.

3.03 CLEANING OF PIPING

A. Cleaning means the removal and extraction of silt, debris, and obstructions from the piping which actually prevent entry and use of CCTV equipment, or the completion of the piping run and/or manned-entry inspection of piping, or which is specifically requested by the Engineer. In general cleaning shall not be required as part of the internal condition inspection service unless specifically instructed by the Engineer.

B. No cleaning shall be required prior to:

1. Sonar surveys or Sonar combined with CCTV surveys, or Sonar inspections or Sonar combined with CCTV inspections unless specifically instructed.

2. Internal inspection completed following construction and testing of new piping.

3.05 EXTENT OF CLEANING

A. Cleaning is not required as part of the internal condition inspection service unless specifically instructed by the Engineer or designated in the Bid Schedule.

B. In the event that cleaning is required and an instruction has been specifically given by the Engineer, the Contractor shall:

1. Provide and/or manage the equipment necessary for proper jetting, rodding, bucketing, brushing, root cutting, flushing, and vacuum uplift or any other approved removal and extraction system necessary to remove and extract silt, debris, and obstructions from the piping which would otherwise preclude use of CCTV equipment and/or manned-entry inspection of the piping.

2. Demonstrate the performance capabilities of the cleaning equipment and method for use when requested by the Engineer. If results obtained by the demonstration are not satisfactory, the Contractor shall select other methods or equipment that will clean the piping line and repeat the demonstration.

3. Install a gauge to monitor working pressure on the discharge of high-pressure pumps for jetting equipment.

4. Provide more than one (1) type of equipment or attachments on a single reach or at a single location as required.

C. The Contractor shall exert all reasonable care to avoid damage to the piping or manhole during the cleaning operation. Mechanical equipment used for cleaning shall be equipped with an overload clutch to limit the risk of damage to the pipe.

3.06 REMOVAL OF DEBRIS WITH CLEANING

A. The Contractor shall provide all equipment and personnel necessary to safely remove and extract silt and debris from the piping through existing manhole access, load it onto trucks for disposal, and dispose of the silt and debris at approved sites.

3.07 CCTV/SONAR - GENERAL

A. CCTV Camera/Sonar Head Prime Position: The CCTV camera/sonar head shall be positioned to reduce the risk of picture distortion. In circular piping the CCTV camera lens and/or Sonar head shall be positioned centrally (i.e. in prime position) within the piping. In non-circular piping, picture orientation shall be taken at mid-height, unless

otherwise agreed, and centered horizontally. In all instances the camera lens/sonar head shall be positioned looking along the axis of the piping when in prime position. A positioning tolerance of ± 10% of the vertical piping dimension shall be allowed when the camera is in prime position.

B. CCTV Camera/Sonar Head Speed: The speed of the CCTV camera in the piping shall be limited to eight (8) inches per second for surveys to enable all details to be extracted from the ultimate CD-ROM recording. Similar or slightly higher speed as agreed by the Engineer shall be provided for inspections. The speed of scanning Sonar shall be limited to four (4) inches per second.

C. CCTV Color Camera: The Contractor shall provide a color pan and tilt camera(s) to facilitate the survey and inspection of all laterals, including defects such as hydrogen sulfide corrosion in the soffit of piping and benching or walls of manholes over and above the standard defects that require reporting, where required by the Engineer. These will be carried out as part of the normal CCTV assessment as the survey or inspection proceeds when instructed by the Engineer. A three-hundred sixty (360) degrees rotational scan indicating general condition must be implemented at every fifty (50) feet interval (min.) along piping, and at manholes and any salient, specified, defect features. The tilt arc must not be less than two-hundred twenty-five (225) degrees.

D. Linear Measurement:

1. The CCTV/Sonar monitor display shall incorporate an automatically updated record in feet and tenths of a foot of the footage of the camera or center point of the transducer, whichever unit is being metered, from the cable calibration point. The relative positions of the two (2) center points shall also be noted.

2. The Contractor shall use a suitable metering device, which enables the cable length to be accurately measured; this shall be accurate to ± 1% or three (3) inches whichever is the greater.

3. The Contractor shall demonstrate compliance with the tolerances in this section, using one or both of the following methods in conjunction with a linear measurement audit form which shall be completed each day during the survey:

    a. Using of a cable calibration device.
    b. Tape measurement of the surface between manholes.
    c. A quality control form will be completed and submitted by the Contractor depicting the level of accuracy achieved.

4. If the Contractor fails to meet the required standard of accuracy, the Engineer shall instruct the Contractor to provide a new device to measure the footage. The Engineer retains the right to instruct the Contractor in writing, to re-survey those lengths of the piping first inspected with the original measuring device using the new measuring device.

E. Data Display, Recording, and Start of Survey/Inspection:

1. At the start of each piping length being surveyed or inspected and each reverse set-up, the length of pipeline from zero (0) footage, the entrance to the pipe, up to the cable calibration point shall be recorded and reported in order to obtain a full record of the piping length. Only one (1) survey shall be indicated in the final report. All reverse set-ups, blind manholes, and buried manholes shall be logged on a separate log. Video digits shall be recorded so that every recorded feature has a correct tape elapsed time stamp. Each log shall make reference to a start (ST) and finish (FH) manhole unless abandonment took place because of blockage. Manhole number shall be indicated in the remark's column of the detail report. Surveys must not extend over two (2) tapes.

2. The footage reading entered on to the data display at the cable calibration point must allow for the distance from the start of the survey/inspection to the cable calibration point such that the footage at the start of the survey is zero (0).

3. In the case of surveying through a manhole where a new header sheet must be completed, the footage shall be set at zero (0) with the camera focused on the outgoing pipe entrance.

4. At the start of each manhole length a data generator shall electronically generate and clearly display on the viewing monitor and subsequently on the CD-ROM recording a record of data in alpha-numeric form containing the following minimum information:

    a. Automatic update of the camera's footage position in the piping line from adjusted zero (0).
    b. Piping dimensions.
    c. Manhole/pipe length reference numbers.
    d. Date of survey.
    e. Road name/location.
    f. Direction of survey.
    g. Time of start of survey.
    h. Piping use.
    i. Material of construction of the pipe.

5. The size and position of the data display shall be such as not to interfere with the main subject of the picture.

6. Once the survey of the pipeline is under way, the following minimum information shall be continually displayed:

    a. Automatic update of the camera's footage position in the piping line from adjusted zero (0).
    b. Piping dimensions in inches.

c. Manhole or pipe length reference number (PLR). General convention allows upstream manhole number to be designated PLR.
d. Direction of survey, i.e., downstream or upstream.

7. Correct adjustment of the recording apparatus and monitor shall be demonstrated by use of the test tape or other device approved by the Engineer. Satisfactory performance of the camera shall be demonstrated by the recording of the appropriate test device at the commencement of each day for a minimum period of thirty (30) seconds.

8. Footage and corresponding time elapsed video digit shall be given throughout survey/inspection for all relevant defects and construction features encountered unless otherwise agreed.

9. Where silt encountered is greater than ten (10) percent of the diameter of the pipe, the depth of silt shall be measured and recorded at approximately fifty (50) foot intervals.

10. CD-ROM capacity shall be adequate to record two (2) hours of video inspection. Recording of a single segment shall not extend over more than one (1) video tape. No unrecorded gaps shall be left in the recording of a segment between surveys/inspections as the original video tape.

11. Only segments between manholes on the same piping reach or basin shall be included on one (1) CD-ROM. There shall be no “split surveys” or “split-basins” between CD-ROMs.

12. All continuous defects shall incorporate a start and finish abbreviation in the log report.

F. Coding: Defect Coding, as well as material, shape, and lining coding, and conventions used will be provided by the Engineer. The Contractor shall ensure that all surveyors conform to the detailed requirements of the reporting procedure concerning feature description and feature definition as well as the Piping.Dat computer file format attached. An example Piping.Dat Data File is presented in Attachment D.

3. 08 MAN ENTRY SURVEY - GENERAL

A. Photographic Camera Position - General Illustration of Piping Interior:

1. The hand-held photographic camera or CCTV camera shall be positioned to reduce the risk of picture distortion. In circular piping the camera lens shall be positioned centrally looking along the axis of the piping. In non-circular piping picture orientation shall be taken at mid-height, unless otherwise agreed, and centered horizontally.

2. The hand held photographic camera or CCTV camera shall be positioned so that the long side of the photograph or CD-ROM frame is horizontal.

B. Photographic Camera Position - Laterals/Specific Defect:

1. A means of accurately locating the photographic or camera's footage and any recorded lateral or defect, along the piping shall be provided, to an accuracy of ± 1% or six (6) inches whichever is greater. When requested by the Engineer in writing at any time during a survey or inspection, the Contractor shall demonstrate compliance with this tolerance.

2. The device used by the Contractor to measure the footage along the piping will be compared with a standard tape measure. The results will be noted. If the Contractor fails to meet the required standard of accuracy, the Engineer shall instruct the Contractor to provide a new device to measure the footage. The Engineer retains the right to instruct the Contractor in writing to re-survey those lengths of piping inspected with the original measuring device at no extra cost.

C. Photographic Quality: The in-piping photographic camera or hand held CCTV system and suitable illumination shall be capable of providing an accurate, uniform and clear record of the piping's internal condition. In-piping lighting standards shall meet the requirements of the Engineer and applicable codes regarding safety and power.

3.09 CCTV, MAN ENTRY AND SONAR SURVEY DATA SPECIFICATION

A. Survey Reporting:

1. No later than fourteen (14) days following the completion of a pipeline survey/inspection, the Contractor shall submit to the Engineer two (2) hard copies of all details, i.e. typed reports including summary statistical breakdown of all defects encountered, two CDE-ROMs containing the data transfer file and two CD-ROMs shall be submitted to the Engineer. The supplied data and information shall remain the property of the City.

2 The report shall be computer validated using AMPS/EXAMINER software, or equivalent approved by the Engineer, and presented on two (2) floppy diskettes to provide a summary listing of the number and type of features including defects found for each section of pipeline. The report format is shown in the attached specimen report. This specimen report sheet shall be accurately and fully adopted in style, format, and detail.

3. When requested by the Engineer, the Contractor shall provide hard copy output or manually completed coding sheets at the time of the survey and shall forward copies of these sheets to the Engineer, preferably each day, but at least every other day, together with a daily report on progress.

B. Site Coding Sheets: Each piping length, i.e. the length of piping between two (2) consecutive manholes, shall be entered on a separate coding sheet or entered separately electronically. Thus where the Contractor elects to "pull through" a manhole during a CCTV and/or Sonar Survey or "walk through" during a “Man Entry” survey, a new coding sheet shall be started at the manhole "pulled or walked through" and the footage re-set to zero (0) on the coding sheet. Where a length of piping between consecutive manholes is surveyed from each end (due to an obstruction) two (2) coding sheets shall be used. Where a length of piping between two (2) consecutive manholes cannot be surveyed or attempted for practical reasons a (complete header) coded sheet shall be made out defining the reason for abandonment. At uncharted manholes a new coding sheet shall be started and the footage re-set to zero (0).

C. Measurement Units: All dimensions shall be in feet and inches. Measurement of piping shall be to the nearest inch.

D. CCTV and Man-Entry Photographs:

1. Photographs shall be taken of all defective laterals and pipeline defects where requested in writing. Where a defect is continuous or repeated the photographs shall be taken at the beginning of the defect and at not less than ten (10) foot intervals thereafter. Where photographs are not otherwise required a general condition photograph shall be taken not more than fifty (50) feet after the previous photograph.

2. CCTV photographs must clearly and accurately show what is displayed on the monitor, which shall be in proper adjustment.

3. Photographs must be durable and 3-inch x 5-inch size and shall be supplied in a suitable album or storage drawer the standard of which shall be to the satisfaction of the Engineer.

4. Still photographs shall be durable and clearly identified in relation to the photograph number (cross referenced to the site survey sheet) street location, piping dimensions, manhole start and finish numbers, survey direction, footage and date when the photograph was taken.

5. The annotation shall be clearly visible and in contrast to its background, shall have a figure size no greater than fourteen (14) point, and be type printed in upper case.

6. The annotation shall be positioned so as not to interfere with the subject of the photograph.

7. The Contractor shall provide color photographs using digital camera or such other mutually agreed upon hard copy color image together with electronic copy.

E. Control Sample Photographs and/or CD-ROMs: The Engineer may issue a written instruction to the Contractor to provide a sample of the photographs and/or CCTV/Sonar

tapes taken during the contract period which the Contractor shall provide within five (5) working days of receiving the written instruction.

3.10 CCTV/SONAR PERFORMANCE

A. Color CCTV/Sonar: All CCTV and/or Sonar work shall use color CCTV/Sonar reproduction.

B. CCTV Picture Quality:

1. An approved test device shall be provided and be available on the site of the Work throughout the Contract, enabling the tests specified in this clause to be checked.

2. The test card shall be Marconi Regulation Chart No. 1 or its approved derivatives with a color bar, clearly differentiating between colors, with no tinting, to show the following: White, Yellow, Cyan, Green, Magenta, Red, Blue, and Black.

3. At the start of each and every working shift, the camera shall be positioned centrally and at right angles to the test card at a distance where the full test card just fills the monitor screen. The Contractor shall ensure that the edges of the test card castellations coincide with the edges of the horizontal and vertical scan (raster). The card shall be illuminated evenly and uniformly without any reflection. The illumination shall be to the same color temperature as the color temperature of the lighting that recorded for subsequent use by the Engineer, the recording time shall be at least thirty (30) seconds. The type of camera used shall be identified on the test recording. The recording must show the camera being introduced into the test device and reaching its stop position. Other test devices may be used subject to approval by the Engineer.

C. Shades of Gray: The gray scale shall show equal changes in brightness ranging from black to white with a minimum of five (5) clearly recognizable stages.

D. Color: With the monitor adjusted for correct saturation, the six (6) colors plus black and white shall be clearly resolved with the primary and complementary colors in order of decreasing luminance.The gray scale shall appear in contrasting shades of gray with no tint.

E. Linearity: The background grid shall show squares of equal size, without convergence/divergence over the whole picture. The center circle shall appear round and have the correct height/width relationship (± 5%).

F. Resolution: The live picture shall be clearly visible with no interference and capable of registering a minimum number of TV lines/pictures height lines. The resolution shall be checked with the monitor color turned down. In the case of tube cameras this shall be six-hundred (600) lines.

G. Color Constancy:

1. To ensure the camera shall provide similar results when used with its own illumination source, the lighting shall be fixed in intensity prior to commencing the survey. In order to ensure color constancy, generally no variation in illumination shall take place during the survey.

2. The Contractor shall note that the Engineer may periodically check both the live and picture color consistency against the color bar. Any differences will require re-survey of the new length or lengths affected, at the Contractor's expense.

H. Playback and CD-ROM Labeling:

1. CD-ROM playback imaging shall be linked to electronic out put of alpha-numeric data so that if necessary direct interrogation of database can take place with simultaneous viewing of CCTV/Sonar images.

2. Each CD-ROM disc shall be labeled by reference to the header record for the survey section completed together with the following information:

a. Sequential (unique) CD-ROM number.
b. Basin/catchment worked in.
c. Survey company name and logo.
d. Survey date.

I. CCTV Focus/Iris/Illumination: The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The adjustment of focus and iris shall provide a minimum focal range from six (6) inches in front of the camera's lens to infinity. The distance along the piping in focus from the initial point of observation shall be a minimum of twice the vertical height of the piping. The illumination must allow an even distribution of the light around the piping perimeter without the loss of contrast picture, flare out, or shadowing.

J. Sonar Survey Requirements:

1. Unit rates shall allow for:

a. Complete structural and service assessment to the equivalent standard as that obtained through conventional CCTV imagery.
b. The means of attenuating flow, where necessary, to facilitate appraisal of the full piping cross section.
c. Measurement of flow depth and silt depth.

2. Rates shall allow for continuous output on conventional annotated CD-ROM format of all piping surveyed, supported by complete defect code sheets. Additionally, silt levels shall be assessed as a percentage depth of piping at twenty-five (25) foot

intervals for each pipeline surveyed. To facilitate this requirement, and in addition, to assist in diametrical measurement particularly where a piping is deformed and/or where a piping has suffered hydrogen sulfide corrosion; screen graphic facilities shall be made available to enable measurements to be taken in any position across the diametrical profile of the piping as the Sonar survey proceeds and where specifically directed by the Engineer.

3. Where combined CCTV and Sonar imagery is required the output shall display combined CCTV and Sonar images of the piping being surveyed. The Sonar image shall be superimposed on the real CCTV image as a combined operation.

4. Unit rates shall allow for a comprehensive final report on the findings concerning major defects, including fractures, displaced joints, deformation, corrosion, and lateral intrusions, as well as dominant surface features, including encrustation and silt depths.

5. The monitor display resolution shall be a minimum of 512 x 512 pixels. The color palette shall have a minimum of sixteen (16) colors with text.

6. The picture update speed shall not compromise compliance with Sub-clause A (1) or result in unsatisfactory picture resolution.

7. The range of resolution shall be $\pm\ ^{1}/_{10}$ inch.

8. The maximum beam width of Sonar energy pulse shall be no greater than two (2) degrees from the center of the transducer.

9. The transducer shall be of the continuous scanning type.

K. Contractor's Data Quality Control Procedure:

1. The Contractor shall operate a quality control system, to be approved by the Engineer, which will effectively gauge the accuracy of all survey reports produced by the operator.

2. The system shall be such that the accuracy of reporting is a function particularly of:

   a. The number of faults not recorded (omissions).
   b. The correctness of the coding and classification of each fault recorded.

3. The minimum levels of accuracy to be attained under the various survey headings are as follows:

   a. Header Accuracy: ninety-five (95) percent.
   b. Detail Accuracy: eighty-five (85) percent.

L. The Contractor's data quality control program shall include routine outside auditing of the work completed by a qualified subcontractor. The qualified subcontractor shall meet the minimum specified Contract requirements for the performance of the Work and shall be approved in writing by the Engineer. The accuracy of the Contractor's data shall be based on the percentage of the data confirmed correct by the subcontractor. The minimum acceptable accuracy of the data shall be eighty-five (85) percent. The general sequence of the auditing shall be as follows:

1. The Engineer shall randomly select one (1) day per month, typically in the first week of the month, and the work performed during this day shall be reviewed and/or repeated by the qualified subcontractor.

2. If the work is greater than or equal to eighty-five (85) percent accurate, no further outside auditing will be required for the month unless requested by the Engineer at his sole discretion. The cost for this audit is included in the allowances specified in the Bid Form.

3. If the work is less than eighty-five (85) percent accurate, the Contractor shall at its own expense repeat and/or correct the work and have the work re-audited by the qualified subcontractor.

4. If the work is still less than eighty-five (85) percent accurate, the Contractor shall repeat and/or correct and have the work re-audited, at its own expense, until the work is greater than or equal to eighty-five (85) percent accurate.

5. When this re-audited work is found to be greater than or equal to eighty-five (85) percent accurate, the Contractor shall have the work of another randomly selected day in the same month reviewed and/or repeated by the qualified subcontractor at the Contractor's own expense.

6. Steps 2 through 5 shall be repeated at the Contractor's own expense until the selected day is eighty-five (85) percent accurate on the initial audit.

7. The occurrence of five (5) randomly selected days not achieving eighty-five (85) percent accuracy on initial subcontractor review will constitute cause for dismissal.

8. If the Contractor successfully meets the eighty-five (85) percent accuracy requirement for the initial randomly selected day for two (2) consecutive months, the Contractor may subsequently audit one (1) day every other month. The Contractor may continue auditing one (1) day every other month until the initial randomly selected day does not meet eighty-five (85) percent accuracy, at which time it must resume auditing one (1) day every month.

3.11 COLLAPSED PIPING/DEFECTIVE MANHOLES

A. Any piping found with greater than ten (10) percent deformation (i.e. collapsed or near to collapse) shall be reported to the Engineer immediately for remedial action. In the event of emergency the Contractor shall call (404)-65-WORKS.

B. Any manhole found broken, cracked, with missing covers or surcharged, shall be reported to the Engineer immediately for remedial action. In the event of emergency the Contractor shall call (404)-65-WORKS.

C. Any piping found where the existing conditions pose a threat of personal injury to the public, such as a collapsed piping with attendant depression to roadway, shall be protected by the Contractor until the Engineer arrives at the site of the Work. In the event of emergency the Contractor shall call (404)-65-WORKS.

D. Any manhole found where the existing conditions pose a threat of personal injury to the public, such as broken, cracked, or missing covers or covers found in traveled portions of any sidewalk or roadway shall be protected by the Contractor until the Engineer arrives at the site of the Work. In the event of emergency the Contractor shall call (404)-65-WORKS.

3.12 TRAFFIC CONTROL

A. The Contractor shall control traffic in accordance with the requirements of Section 01550, Traffic Regulation.

ATTACHMENT A

INTERNAL PIPING CONDITION ASSESSMENT SAMPLE REPORTS

(For use with City of Atlanta Database)

SURVEY REPORT — Page Number : 167

Date : 02 05 2000 Time : 10:28

Contractor	Contract No	Job No	Drainage Area	Div	Dist	Pipe L. Ref
ASI/DG	ASG/0001	0	0	0	000	23250201501X

Location	Place Name
BERKELE STREET	MCDANIEL BASIN

Start Manhole No. : 23250201001 Depth : 08.0 Total Length : 365.0
Finish Manhole No. : 23250201501 Depth : 09.0 Suyed Length : 280.7

Use	Direction	Size	Shape	Material	Lining Yr Laid	Pipe L
COMBINED	UPSTREAM	8in	CIRC.	V. CLAY	Z	3.00

CD-ROM No	V. Model	Comments
00016		-

Purpose	Weather	Location	Further Information
	DRY		-

DETAIL — Page Number : 167

Digit Ph.	Dist	CD	Code	Other Details
0136	0.0		ST	Start of Survey [0065]
0280	0.0		MH	Manhole 23250201001
0560	0.0		WL	Water Level is now 05%
0163	30.2		JN	Junction. 6in at 03o/c FW
0180	41.6		JDM	Joint Displaced Medium
0186	43.3		JN	Junction. 6in at 09o/c SW
0200	54.6		OJM	Open Joint Medium
0203	56.3		JN	Junction. 6in at 09o/c SW
0226	79.0		JN	Junction. 6in at 03o/c FW?
0236	83.2		JN	Junction. 6in at 09o/c FW
0260	106.5		JN	Junction. 6in at 02o/c FW?
0270	108.5		JN	Junction. 6in at 09o/c FW
0286	120.9		CNI	Conn. Intruding by 1in. 6in Dia at 12o/c FW
0303	135.4		CL	Longitudinal Crack at 12o/c
0310	136.0		CNI	Conn. Intruding by 1in. 6in Dia at 12o/c FW?
0326	147.2		JN	Junction. 6in at 03o/c FW
0333	149.8		JN	Junction. 6in at 09o/c SW
0346	157.5		JN	Junction. 6in at 03o/c SW
0366	175.9		JN	Junction. 6in at 10o/c SW
0376	181.0		JN	Junction. 6in at 02o/c FW?
0386	184.9		JN	Junction. 6in at 10o/c SW
0780	184.9	S1	DES	Debris Silt. 05% loss
0416	209.3		JN	Junction. 6in at 10o/c FW?
0840	209.3	F1	DES	Debris Silt. 05% loss
0433	218.9		JN	Junction. 6in at 02o/c SW
0453	234.2		JN	Junction. 6in at 10o/c SW
0470	244.8		FCJ	Circumferential Fracture at Joint at 03 to 05o/c
0483	254.7		JN	Junction. 6in at 02o/c FW?
0970	254.7	S2	DES	Debris Silt. 05% loss
1940	254.7	S3	RF	Fine Roots
0490	257.5		JN	Junction. 6in at 09o/c SW
0513	279.5	C2	DES	Debris Silt. 50% loss
0520	280.6		JN	Junction. 6in at 02o/c SW

DETAIL CONTINUED ON NEXT PAGE For Page Number : 167

< CONTINUATION PAGE > < Page Number : 167 >

Location	Place Name
BERKELE STREET	MCDANIEL BASIN

Start Manhole No. : 23250201001 Depth : 08.0 Total Length : 365.0
Finish Manhole No. : 23250201501 Depth : 09.0 Suyed Length : 280.7

< DETAIL CONTINUED > < Page Number : 167 >

Digit Ph.	Dist	CD	Code	Other Details
0523	280.7	F2	DES	Debris Silt. 50% loss
1050	280.7	F3	RF	Fine Roots
0523	280.7		SA	Survey Abandoned DUE TO SURVEY OVERLAP

< SUMMARY > < Page Number : 167 >

St Mh No. : 23250201001 Fh Mh No. : 23250201501 Suyed Length : 280.7

SOME MAJOR defects in this length : Deformations : NO

Breaks/Holes	Mult/Long/Circ Fractures	Heavy/Medium Encrustation	Gusher/Runner Infiltration	Mass Roots	Obstructions
NO	CIRC	NO	NO	NO	NO

Faulty Junctions/Connections : YES

< END OF SUMMARY >

SURVEY REPORT — Page Number : 170

Date : 02 05 2000 Time : 17:20

Contractor	Contract No	Job No	Drainage Area	Div Dist	Pipe L. Ref
ASI/DG	ASG/0001	0	0	0 000	23250200401X

Location	Place Name
MCDANIEL STREET	MCDANIEL BASIN

Start Manhole No. : 23250201901 Depth : 09.6 Total Length : 085.8
Finish Manhole No. : 23250200401 Depth : 08.0 Suyed Length : 085.8

Use	Direction	Size	Shape	Material	Lining	Yr Laid	Pipe L
COMBINED	UPSTREAM	12in	CIRC.	V. CLAY		2	3.00

CD-ROM No	V. Model	Comments
00016		-

Purpose	Weather	Location	Further Information
	.DRY		-

DETAIL — Page Number : 170

Digit Ph.	Dist	CD	Code	Other Details
0683	0.0		ST	Start of Survey [0341]
1370	0.0		MH	Manhole 23250201901
1940	0.0		WL	Water Level is now 05%
0683	0.0	S1	DEG	Debris Grease at 07o/c to 05o/c. 05% loss
0693	13.9		JDM	Joint Displaced Medium
0700	18.3		OB	Obstruction. 05% loss STONE
0710	26.3	S2	DES	Debris Silt. 05% loss
0720	35.4		CXI	Conn Defect/Intr. by 3in. 6in Dia. At 10o/c SW
1440	35.4		JN	Junction. 6in at 02o/c CAPPED OFF
0736	40.5		JN	Junction. 6in at 02o/c CAPPED OFF
0750	46.6	C2	DES	Debris Silt. 15% loss
0766	60.9		JN	Junction. 6in at 10o/c CAPPED OFF
0783	73.7		JX	Junction. Defective. 6in Dia at 02o/c SW
1570	73.7		B	Break. From 11o/c to 01o/c
0796	81.1		JN	Junction. 6in at 10o/c
0800	85.8	F1	DEG	Debris Grease at 07o/c to 05o/c. 05% loss
1600	85.8	F2	DES	Debris Silt. 15% loss
2400	85.8		MH	Manhole 23250200401
0800	85.8		FH	Finish of Survey.

SUMMARY — Page Number : 170

St Mh No. : 23250201901 Fh Mh No. : 23250200401 Suyed Length : 085.8

SOME MAJOR defects in this length : Deformations : NO

Breaks/Holes	Mult/Long/Circ Fractures	Heavy/Medium Encrustation	Gusher/Runner Infiltration	Mass Roots	Obstructions
YES	NO	NO	NO	NO	YES

Faulty Junctions/Connections : YES

END OF SUMMARY

SURVEY REPORT — Page Number : 184

Date : 02 07 2000 Time : 14:52

Contractor	Contract No	Job No	Drainage Area	Div	Dist	Pipe L. Ref
ASI/DG	ASG/0001	0	0	0	000	23350305601X

Location	Place Name
GAULT STREET	BOULEVARD BASIN

Start Manhole No. : 23350305601 Depth : 22.0 Total Length : 501.2
Finish Manhole No. : 23350315501 Depth : 00.0 Suyed Length : 501.2

Use	Direction	Size	Shape	Material	Lining	Yr Laid	Pipe L
COMBINED	D/STREAM	12in	CIRC.	V. CLAY		2	3.00

CD-ROM No	V. Model	Comments
00017		-

Purpose	Weather	Location	Further Information
	DRY		-

DETAIL — Page Number : 184

Digit Ph.	Dist	CD	Code	Other Details
0786	0.0		ST	Start of Survey [0392]
1580	0.0		MH	Manhole 23350305601
2360	0.0		WL	Water Level is now 05%
0790	6.0	S1	EMJ	Encrust Med at Jnt. 15% loss at 07o/c to 05o/c CLOCKS VARY
0800	12.9		EHJ	Encrust Heavy at Jnt. 25% loss at 12o/c to 05o/c
0810	15.3		IDJ	Infiltration Dripping at Joint at 11o/c to 12o/c
0816	18.6		EHJ	Encrust Heavy at Jnt. 25% loss at 01o/c to 05o/c
0823	24.7		CL	Longitudinal Crack at 12o/c
0830	31.5		FL	Longitudinal Fracture at 12o/c
0840	43.2		EHJ	Encrust Heavy at Jnt. 30% loss at 07o/c to 05o/c
0846	46.3		EHJ	Encrust Heavy at Jnt. 25% loss at 07o/c to 05o/c
1700	46.3	S2	IDJ	Infiltration Dripping at Joint at 12o/c
2600	46.3		RFJ	Fine Roots at Joint
0856	50.9		EHJ	Encrust Heavy at Jnt. 50% loss at 09o/c to 03o/c OBSCURING VISION
0920	87.5	F2	IDJ	Infiltration Dripping at Joint at 12o/c
0956	147.1		IDJ	Infiltration Dripping at Joint at 12o/c
0966	161.0		EHJ	Encrust Heavy at Jnt. 25% loss at 09o/c to 03o/c
1940	161.0		IDJ	Infiltration Dripping at Joint at 11o/c
3080	161.0		RFJ	Fine Roots at Joint
0973	166.5		EHJ	Encrust Heavy at Jnt. 25% loss at 08o/c to 12o/c
0983	171.1		IDJ	Infiltration Dripping at Joint at 11o/c
0996	194.7		IDJ	Infiltration Dripping at Joint at 11o/c
1003	202.4		IDJ	Infiltration Dripping at Joint at 01o/c
1016	213.7		BJ	Break at Joint. From 06o/c to 08o/c
1026	217.6		IDJ	Infiltration Dripping at Joint at 11o/c to 12o/c
1033	225.2		IDJ	Infiltration Dripping at Joint at 01o/c
1050	252.9	F1	EMJ	Encrust Med at Jnt. 15% loss at 07o/c to 05o/c CLOCKS VARY
1300	252.9	S3	ELJ	Encrust Light at Joint at 07o/c to 05o/c CLOCKS VARY
1066	286.4		IDJ	Infiltration Dripping at Joint at 12o/c
1073	296.2		RMJ	Mass Roots at Joint. 30% loss
1350	296.2		IDJ	Infiltration Dripping at Joint at 02o/c

DETAIL CONTINUED ON NEXT PAGE For Page Number : 184

< CONTINUATION PAGE > < Page Number : 184 >

Location	Place Name
GAULT STREET	BOULEVARD BASIN

Start Manhole No. : 23350305601 Depth : 22.0 Total Length : 501.2
Finish Manhole No. : 23350315501 Depth : 00.0 Suyed Length : 501.2

< DETAIL CONTINUED > < Page Number : 184 >

Digit Ph.	Dist	CD	Code	Other Details
1086	304.2		RMJ	Mass Roots at Joint. 10% loss
1113	349.6		RMJ	Mass Roots at Joint. 65% loss
1130	367.7		RMJ	Mass Roots at Joint. 05% loss
1133	370.7		RMJ	Mass Roots at Joint. 60% loss
1146	375.8		RMJ	Mass Roots at Joint. 05% loss
1150	377.8	S4	RFJ	Fine Roots at Joint
1186	441.6		BJ	Break at Joint. From 09o/c to 12o/c
1193	442.7		B	Break. From 11o/c to 01o/c
1200	444.8		B	Break. From 11o/c to 01o/c
				REPAIRED
1206	446.3		CCJ	Circumferential Crack at Joint at 07o/c to 09o/c
1213	448.5		B	Break. From 10o/c to 01o/c
				REPAIRED
1220	451.8		B	Break. From 11o/c to 01o/c
				REPAIRED
1230	454.7		B	Break. From 10o/c to 12o/c
				REPAIRED
1240	457.2		B	Break. From 10o/c to 12o/c
				REPAIRED
1250	460.3		B	Break. From 09o/c to 01o/c
				REPAIRED
1256	462.1		B	Break. From 10o/c to 01o/c
				REPAIRED
1266	471.9		B	Break. From 11o/c to 02o/c
				REPAIRED
1273	478.5		RMJ	Mass Roots at Joint. 25% loss
1750	478.5		RTJ	Tap Roots at Joint
1346	485.1		RMJ	Mass Roots at Joint. 25% loss
1360	492.7	S5	DES	Debris Silt. 10% loss
1370	501.2	F3	ELJ	Encrust Light at Joint at 07o/c to 05o/c
				CLOCKS VARY
1940	501.2	F4	RFJ	Fine Roots at Joint
3080	501.2	F5	DES	Debris Silt. 10% loss
3760	501.2		MH	Manhole 23350315501
1370	501.2		FH	Finish of Survey.

< SUMMARY > < Page Number : 184 >

St Mh No. : 23350305601 Fh Mh No. : 23350315501 Suyed Length : 501.2

SOME MAJOR defects in this length : Deformations : NO

Breaks/Holes	Mult/Long/Circ Fractures	Heavy/Medium Encrustation	Gusher/Runner Infiltration	Mass Roots	Obstructions
YES	LONG	HEAVY	NO	MASS	NO
		MEDIUM			

Faulty Junctions/Connections : NO

< END OF SUMMARY >

ATTACHMENT B

DEFECT, MATERIAL, SHAPE, AND LINING CODES

DEFECT CODES SORTED ALPHABETICALLY BY CODE		
Code	**Type**	**Definition**
B	Structural	Conduit broken at..(OR from …to…) o'clock
BSV	Structural	Conduit broken with soil visible at .. (OR from …to…) o'clock
BVV	Structural	Conduit broken with void visible at .. (OR from …to…) o'clock
CC	Structural	Circumferential crack from …to… o'clock
CI	Miscellaneous	Cameral inverted, top of center line at …o'clock
CL	Structural	Longitudinal crack at …o'clock
CM	Structural	Multiple cracks from …to …o'clock
CS	Structural	Spiral crack from …to…o'clock
CU	Miscellaneous	Camera submerged
DAE	Service	Encrustation, …%cross-sectional area loss from …to…o'clock
DAES	Service	Light Encrustation, …%cross-sectional area loss from …to…o'clock
DAEM	Service	Medium Encrustation, …%cross-sectional area loss from …to…o'clock
DAEL	Service	Heavy Encrustation, …%cross-sectional area loss from …to…o'clock
DAGS	Service	Debris (grease) …% cross-sectional loss from … to … o'clock
DAR	Service	Debris (ragging) …% cross-sectional loss from … to … o'clock
DAZ	Service	Debris (not silt/grease/ragging) ….%cross-sectional loss from… to … o'clock
DB	Structural	Brick displaced at ….to….o'clock
DC	Service	Deposits, hard/compacted ….% cross-sectional loss from … to … o'clock
DF	Service	Deposits, fine ….% cross-sectional loss from … to … o'clock
DGV	Service	Deposits, gravel ….% cross-sectional loss from … to … o'clock
DH	Structural	Conduit deformed. … % change of horizontal dimension
DI	Structural	Dropped brick invert, gap … mm
DIF	Service	Ingressed deposit, (fine) …%cross-sectional loss from … to ….o'clock
DIGV	Service	Ingressed deposit, (gravel) …%cross-sectional loss from … to ….o'clock
DIP	Service	Ingressed deposit, (peat) …%cross-sectional loss from … to ….o'clock
DIS	Service	Ingressed deposit, (sand) …%cross-sectional loss from … to ….o'clock
DIZ	Service	Ingressed deposit, (other) …%cross-sectional loss from … to ….o'clock
DS	Service	Deposits settled, …% cross-sectional loss from … to … o'clock
DV	Structural	Conduit deformed, … % change of vertical dimension
DZ	Service	Deposits settled (other), … % cross-sectional loss from … to … o'clock
FC	Structural	Circumferential fracture from … to … o'clock
FH	Miscellaneous	Finish on conduit survey length
FL	Structural	Longitudinal fracture at … o'clock
FM	Structural	Multiple fractures from … to … o'clock
FS	Structural	Spiral fracture from … to … o'clock
GO	Miscellaneous	General observation
GP	Miscellaneous	General photograph
H	Structural	Hole in piping at … (OR from … to …) o'clock
HSV	Structural	Hole in piping w/soil visible at … (OR from … to …) o'clock
HVV	Structural	Hole in piping w/void visible at … (OR from … to …) o'clock
ID	Service	Infiltration dripper at … (OR from … to …) o'clock
IG	Service	Infiltration gusher at … (OR from … to …) o'clock
IR	Service	Infiltration runner at … (OR from … to …) o'clock
ISGT	Construction	Intruding grout material at … (OR from … to …) o'clock
ISSR	Construction	Intruding sealing material at … (OR from … to …) o'clock
ISZ	Construction	Intruding sealing material (other) at … (OR from … to…)

IW	Service	Infiltration weeper at … (OR from … to …) o'clock
JA	Structural	Joint Angular
JAM	Structural	Joint Angular, medium
JAL	Structural	Joint Angular, large
JL	Miscellaneous	Joint length changes at … (OR from … to…) o'clock
JO	Structural	Joint offset (displaced)
JOS	Structural	Joint offset (displaced), small/slight(< "t")
JOM	Structural	Joint offset (displaced), medium ("t" to 1.5 "t")
JOL	Structural	Joint offset (displaced), large (>1.5 "t")
JS	Structural	Joint separated (open)
JSS	Structural	Joint separated (open), small (< "t")
JSM	Structural	Joint separated (open), medium ("t" to 1.5 "t")
JSL	Structural	Joint separated (open), large (> 1.5 "t")
LC	Miscellaneous	Conduit lining changes (starts) at this point
LD	Construction	Line of conduit deviates down
LFAC	Structural	Lining, abandoned connection at … to … o'clock
LFB	Structural	Lining/coating blistered at … (OR from… to…) o'clock
LFBK	Structural	Lining/coating buckled at … (OR from… to…) o'clock)
LFCS	Structural	Lining, service cut shifted at … o'clock
LFD	Structural	Lining/coating detached at … (OR from … to ….) o'clock
LFE	Structural	Lining, defective end at …. (OR from … to …) o'clock
LFOC	Structural	Lining, overcut service at … (OR from … to …) o'clock
LFR	Structural	Lining/coating wrinkled at … (OR from … to …) o'clock
LFUC	Structural	Lining, undercut service at … (OR from … to …) o'clock
LFZ	Structural	Lining/Coating failure, other at … (OR from … to …) o'clock
LL	Construction	Line of conduit deviates left
LLD	Construction	Line of conduit deviates left then down
LLU	Construction	Line of conduit deviates left then up
LR	Construction	Line of conduit deviates right
LRD	Construction	Line of conduit deviates right then down
LRU	Construction	Line of conduit deviates right then up
LU	Construction	Line of conduit deviates up
MB	Structural	Missing bricks at … (OR from … to …) o'clock
MC	Miscellaneous	Conduit material changes at this point
MM	Structural	Mortar missing at … (OR from … to …) o'clock, may include Slight (S), Medium (M), or Large (L)
NBR	Construction	Node, branch at … o'clock
NCOM	Construction	Node, mainline clean out, at … o'clock
NCOP	Construction	Node, property clean out, at … o'clock
NDP	Construction	Node, discharge point, at … o'clock
NJB	Construction	Node, junction box
NM	Construction	Node, meter
NMH	Construction	Node, manhole
NOC	Construction	Node, other special chamber
NWA	Construction	Node, wastewater access
NWW	Construction	Node, wet well
OBB	Service	Obstruction, brick/masonry at … o'clock and/or % cross-sectional loss
OBC	Service	Obstruction, through connection, at … o'clock and/or % cross-sectional loss
OBI	Service	Obstruction, protruding through wall, at … o'clock and/or % cross-sectional loss

OBJ	Service	Obstruction, wedged in joint, at … o'clock and or % cross-sectional loss
OBM	Service	Obstruction, pipe material in invert, % cross-sectional loss
OBN	Service	Obstruction, construction debris, % cross-sectional loss
OBP	Service	Obstruction, external pipe/cable through piping, % cross-sectional loss
OBR	Service	Obstruction, rocks, % cross-sectional loss
OBS	Service	Obstruction, built into structure, % cross-sectional loss
OBZ	Service	Obstruction, other, % cross-sectional loss
RB	Service	Ball of roots, … % cross-sectional area loss from … to … o'clock
RBB	Service	Ball of roots, barrel, … % cross-sectional area loss from … to … o'clock
RBL	Service	Ball of roots, lateral - inside service, … % cross-sectional area loss
RBC	Service	Ball of roots, Connection - outside service, … % cross-sectional area loss
RF	Service	Fine roots
RFB	Service	Fine roots, barrel
RFL	Service	Fine roots, lateral - inside service
RFC	Service	Fine roots, connection - outside service
RM	Service	Medium roots, … %cross-sectional area loss from … to … o'clock
RMB	Service	Medium roots, barrel, … %cross-sectional area loss from … to … o'clock
RML	Service	Medium roots, lateral - inside service, … %cross-sectional area loss from … to … o'clock
RMC	Service	Medium roots, connection - outside service, … %cross-sectional area loss from … to … o'clock
RPL	Structural	Point repair, localized liner, at … (OR from … ft to … ft)
RPP	Structural	Point repair, patch repair, at … (OR from… to…) o'clock
RPR	Structural	Point repair, pipe replaced, at … (OR from … to …) ft
RPZ	Structural	Point repair, other (including joint seal), at … (OR from… to…) ft or o'clock
RT	Service	Tap roots, … % cross-sectional area loss from … to … o'clock
RTB	Service	Tap roots, barrel, … % cross-sectional area loss from … to … o'clock
RTL	Service	Tap roots, lateral - inside service, … % cross-sectional area loss from … to … o'clock
RTC	Service	Tap roots, connection - outside service, … % cross-sectional area loss from … to … o'clock
SA	Miscellaneous	Survey abandoned
SAP	Structural	Surface damage, aggregate projecting at … (OR from … to …) o'clock
SAV	Structural	Surface damage, aggregate visible at … (OR from … to …) o'clock
SC	Miscellaneous	Conduit shape changes at this point
SCP	Structural	Surface corrosion, metal pipe, at … (OR from … to …) o'clock
SMW	Structural	Missing Wall at … (OR from … to …) o'clock
SRC	Structural	Surface damage, Reinforcement corroded at … (OR from … to …) o'clock
SRI	Structural	Surface damage, Roughness increased at … (OR from … to …) o'clock
SRP	Structural	Surface damage, Reinforcement projecting at … (OR from … to …) o'clock
SRV	Structural	Surface damage, Reinforcement visible at … (OR from … to …) o'clock
SSS	Structural	Surface damage, Surface spalling at … (OR from … to …) o'clock
ST	Miscellaneous	Start of conduit survey length
SZC	Structural	Surface damage, chemical at … (OR from … to …) o'clock
SZM	Structural	Surface damage, mechanical at … (OR from … to …) o'clock
SZZ	Structural	Surface damage, not evident at … (OR from … to …) o'clock
TB	Construction	Tap, Break-In/Hammer at … o'clock
TBC	Construction	Tap, Break-In/Hammer, capped at … o'clock
TBI	Construction	Tap, Break-In/Hammer, Intruding at … o'clock, … % cross-sectional area loss
TF	Construction	Tap, factory made junction at … o'clock
TFC	Construction	Tap, factory made junction, capped at … o'clock
TS	Construction	Tap, saddle at … o'clock

TSC	Construction	Tap, saddle, capped at … o'clock
VC	Service	Vermin, cockroach
VR	Service	Vermin, rat
VZ	Service	Vermin, other
WFC	Structural	Circumferential weld failure (at joint) from … o'clock to … o'clock
WFL	Structural	Longitudinal weld failure (at joint) at … o'clock
WFS	Structural	Spiral weld failure (at joint) from … to … o'clock
WL	Miscellaneous	Water level, … % height/diameter
WM	Miscellaneous	Water mark, … % height/diameter
XB	Structural	Brick pipe collapsed, …% of cross-sectional area loss
XM	Structural	Manhole collapsed, … % of cross-sectional area loss
XP	Structural	Pipe collapsed, … % of cross-sectional area loss
YN	Miscellaneous	Dye test not visible, … color
YV	Miscellaneous	Dye test visible, … color

For the last five years the City of Atlanta has used WRc codes for describing defects. NASSCO (National Association of Sanitary Piping Contractors) has modified WRc codes, in conjunction with WRc, to reflect piping inspection nomenclature currently used throughout North America.

DEFECT CODES SORTED ALPHABETICALLY BY TYPE

Code	Type	Definition
ISGT	Construction	Intruding grout material at … (OR from … to …) o'clock
ISSR	Construction	Intruding sealing material at … (OR from … to …) o'clock
ISZ	Construction	Intruding sealing material (other) at … (OR from … to…)
LD	Construction	Line of conduit deviates down
LL	Construction	Line of conduit deviates left
LLD	Construction	Line of conduit deviates left then down
LLU	Construction	Line of conduit deviates left then up
LR	Construction	Line of conduit deviates right
LRD	Construction	Line of conduit deviates right then down
LRU	Construction	Line of conduit deviates right then up
LU	Construction	Line of conduit deviates up
NBR	Construction	Node, branch at … o'clock
NCOM	Construction	Node, mainline clean out, at … o'clock
NCOP	Construction	Node, property clean out, at … o'clock
NDP	Construction	Node, discharge point, at … o'clock
NJB	Construction	Node, junction box
NM	Construction	Node, meter
NMH	Construction	Node, manhole
NOC	Construction	Node, other special chamber
NWA	Construction	Node, wastewater access
NWW	Construction	Node, wet well
TB	Construction	Tap, Break-In/Hammer at … o'clock
TBC	Construction	Tap, Break-In/Hammer, capped at … o'clock
TBI	Construction	Tap, Break-In/Hammer, Intruding at … o'clock, … % cross-sectional area loss
TF	Construction	Tap, factory made junction at … o'clock
TFC	Construction	Tap, factory made junction, capped at … o'clock
TS	Construction	Tap, saddle at … o'clock
TSC	Construction	Tap, saddle, capped at … o'clock
CI	Miscellaneous	Cameral inverted, top of center line at …o'clock
CU	Miscellaneous	Camera submerged
FH	Miscellaneous	Finish on conduit survey length
GO	Miscellaneous	General observation
GP	Miscellaneous	General photograph
JL	Miscellaneous	Joint length changes at … (OR from … to…) o'clock
LC	Miscellaneous	Conduit lining changes (starts) at this point
MC	Miscellaneous	Conduit material changes at this point
SA	Miscellaneous	Survey abandoned
SC	Miscellaneous	Conduit shape changes at this point
ST	Miscellaneous	Start of conduit survey length
WL	Miscellaneous	Water level, … % height/diameter
WM	Miscellaneous	Water mark, … % height/diameter
YN	Miscellaneous	Dye test not visible, … color
YV	Miscellaneous	Dye test visible, … color
DAE	Service	Encrustation, …%cross-sectional area loss from …to…o'clock
DAES	Service	Light Encrustation, …%cross-sectional area loss from …to…o'clock
DAEM	Service	Medium Encrustation, …%cross-sectional area loss from …to…o'clock

DAEL	Service	Heavy Encrustation, …%cross-sectional area loss from …to…o'clock
DAGS	Service	Debris (grease) …% cross-sectional loss from … to … o'clock
DAR	Service	Debris (ragging) …% cross-sectional loss from … to … o'clock
DAZ	Service	Debris (not silt/grease/ragging) ….%cross-sectional loss from… to … o'clock
DC	Service	Deposits, hard/compacted ….% cross-sectional loss from … to … o'clock
DF	Service	Deposits, fine ….% cross-sectional loss from … to … o'clock
DGV	Service	Deposits, gravel ….% cross-sectional loss from … to … o'clock
DIF	Service	Ingressed deposit, (fine) …%cross-sectional loss from … to ….o'clock
DIGV	Service	Ingressed deposit, (gravel) …%cross-sectional loss from … to ….o'clock
DIP	Service	Ingressed deposit, (peat) …%cross-sectional loss from … to ….o'clock
DIS	Service	Ingressed deposit, (sand) …%cross-sectional loss from … to ….o'clock
DIZ	Service	Ingressed deposit, (other) …%cross-sectional loss from … to ….o'clock
DS	Service	Deposits settled, …% cross-sectional loss from … to … o'clock
DZ	Service	Deposits settled (other), … % cross-sectional loss from … to … o'clock
ID	Service	Infiltration dripper at … (OR from … to …) o'clock
IG	Service	Infiltration gusher at … (OR from … to …) o'clock
IR	Service	Infiltration runner at … (OR from … to …) o'clock
IW	Service	Infiltration weeper at … (OR from … to …) o'clock
OBB	Service	Obstruction, brick/masonry at … o'clock and/or % cross-sectional loss
OBC	Service	Obstruction, through connection, at … o'clock and/or % cross-sectional loss
OBI	Service	Obstruction, protruding through wall, at … o'clock and/or % cross-sectional loss
OBJ	Service	Obstruction, wedged in joint, at … o'clock and or % cross-sectional loss
OBM	Service	Obstruction, pipe material in invert, % cross-sectional loss
OBN	Service	Obstruction, construction debris, % cross-sectional loss
OBP	Service	Obstruction, external pipe/cable through piping, % cross-sectional loss
OBR	Service	Obstruction, rocks, % cross-sectional loss
OBS	Service	Obstruction, built into structure, % cross-sectional loss
OBZ	Service	Obstruction, other, % cross-sectional loss
RB	Service	Ball of roots, … % cross-sectional area loss from … to … o'clock
RBB	Service	Ball of roots, barrel, … % cross-sectional area loss from … to … o'clock
RBL	Service	Ball of roots, lateral - inside service, … % cross-sectional area loss
RBC	Service	Ball of roots, Connection - outside service, … % cross-sectional area loss
RF	Service	Fine roots
RFB	Service	Fine roots, barrel
RFL	Service	Fine roots, lateral - inside service
RFC	Service	Fine roots, connection - outside service
RM	Service	Medium roots, … %cross-sectional area loss from … to … o'clock
RMB	Service	Medium roots, barrel, … %cross-sectional area loss from … to … o'clock
RML	Service	Medium roots, lateral - inside service, … %cross-sectional area loss from … to … o'clock
RMC	Service	Medium roots, connection - outside service, … %cross-sectional area loss from … to … o'clock
RT	Service	Tap roots, … % cross-sectional area loss from … to … o'clock
RTB	Service	Tap roots, barrel, … % cross-sectional area loss from … to … o'clock
RTL	Service	Tap roots, lateral - inside service, … % cross-sectional area loss from … to … o'clock
RTC	Service	Tap roots, connection - outside service, … % cross-sectional area loss from … to … o'clock
VC	Service	Vermin, cockroach
VR	Service	Vermin, rat
VZ	Service	Vermin, other
B	Structural	Conduit broken at..(OR from …to…) o'clock

BSV	Structural	Conduit broken with soil visible at .. (OR from …to…) o'clock
BVV	Structural	Conduit broken with void visible at .. (OR from …to…) o'clock
CC	Structural	Circumferential crack from …to… o'clock
CL	Structural	Longitudinal crack at …o'clock
CM	Structural	Multiple cracks from …to …o'clock
CS	Structural	Spiral crack from …to…o'clock
DB	Structural	Brick displaced at ….to….o'clock
DH	Structural	Conduit deformed. … % change of horizontal dimension
DI	Structural	Dropped brick invert, gap … mm
DV	Structural	Conduit deformed, … % change of vertical dimension
FC	Structural	Circumferential fracture from … to … o'clock
FL	Structural	Longitudinal fracture at … o'clock
FM	Structural	Multiple fractures from … to … o'clock
FS	Structural	Spiral fracture from … to … o'clock
H	Structural	Hole in piping at … (OR from … to …) o'clock
HSV	Structural	Hole in piping w/soil visible at … (OR from … to …) o'clock
HVV	Structural	Hole in piping w/void visible at … (OR from … to …) o'clock
JA	Structural	Joint Angular
JAM	Structural	Joint Angular, medium
JAL	Structural	Joint Angular, large
JO	Structural	Joint offset (displaced)
JOS	Structural	Joint offset (displaced), small/slight(< "t")
JOM	Structural	Joint offset (displaced), medium ("t" to 1.5 "t")
JOL	Structural	Joint offset (displaced), large (>1.5 "t")
JS	Structural	Joint separated (open)
JSS	Structural	Joint separated (open), small (< "t")
JSM	Structural	Joint separated (open), medium ("t" to 1.5 "t")
JSL	Structural	Joint separated (open), large (> 1.5 "t")
LFAC	Structural	Lining, abandoned connection at … to … o'clock
LFB	Structural	Lining/coating blistered at … (OR from… to…) o'clock
LFBK	Structural	Lining/coating buckled at … (OR from… to…) o'clock
LFCS	Structural	Lining, service cut shifted at … o'clock
LFD	Structural	Lining/coating detached at … (OR from … to ….) o'clock
LFE	Structural	Lining, defective end at …. (OR from … to …) o'clock
LFOC	Structural	Lining, overcut service at … (OR from … to …) o'clock
LFR	Structural	Lining/coating wrinkled at … (OR from … to …) o'clock
LFUC	Structural	Lining, undercut service at … (OR from … to …) o'clock
LFZ	Structural	Lining/Coating failure, other at … (OR from … to …) o'clock
MB	Structural	Missing bricks at … (OR from … to …) o'clock
MM	Structural	Mortar missing at … (OR from … to …) o'clock, may include Slight (S), Medium (M), or Large (L)
RPL	Structural	Point repair, localized liner, at … (OR from … ft to … ft)
RPP	Structural	Point repair, patch repair, at … (OR from… to…) o'clock
RPR	Structural	Point repair, pipe replaced, at … (OR from … to …) ft
RPZ	Structural	Point repair, other (including joint seal), at … (OR from… to…) ft or o'clock
SAP	Structural	Surface damage, aggregate projecting at … (OR from … to …) o'clock
SAV	Structural	Surface damage, aggregate visible at … (OR from … to …) o'clock
SCP	Structural	Surface corrosion, metal pipe, at … (OR from … to …) o'clock
SMW	Structural	Missing Wall at … (OR from … to …) o'clock

SRC	Structural	Surface damage, Reinforcement corroded at … (OR from … to …) o'clock
SRI	Structural	Surface damage, Roughness increased at … (OR from … to …) o'clock
SRP	Structural	Surface damage, Reinforcement projecting at … (OR from … to …) o'clock
SRV	Structural	Surface damage, Reinforcement visible at … (OR from … to …) o'clock
SSS	Structural	Surface damage, Surface spalling at … (OR from … to …) o'clock
SZC	Structural	Surface damage, chemical at … (OR from … to …) o'clock
SZM	Structural	Surface damage, mechanical at … (OR from … to …) o'clock
SZZ	Structural	Surface damage, not evident at … (OR from … to …) o'clock
WFC	Structural	Circumferential weld failure (at joint) from … o'clock to … o'clock
WFL	Structural	Longitudinal weld failure (at joint) at … o'clock
WFS	Structural	Spiral weld failure (at joint) from … to … o'clock
XB	Structural	Brick pipe collapsed, …% of cross-sectional area loss
XM	Structural	Manhole collapsed, … % of cross-sectional area loss
XP	Structural	Pipe collapsed, … % of cross-sectional area loss

For the last five years the City of Atlanta has used WRc codes for describing defects. NASSCO (National Association of Sanitary Piping Contractors) has modified WRc codes, in conjunction with WRc, to reflect piping inspection nomenclature currently used throughout North America.

Material Coding

CODE	DEFINITION
ABS	Acrylonitrile Butatiene Styrene
BR	Brick
CI	Cast Iron Pipe
CMP	Corrugated Metal Pipe
CO	Cast-In-Place Concrete Pipe
CPP	Cured-In-Place Liner
DI	Ductile Iron Pipe
FRP	Fiberglass Reinforced Pipe
NCP	Non-Reinforced Concrete Pipe
ORG	Orangeburg Pipe
PE	Polyethylene Pipe
PLP	PVC Lined Pipe (Fold/Reform)
PVC	PolyvinylChloride Pipe
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
ST	Steel
VC	Vitrified Clay Pipe
WOD	Wood
XXX	Other (state in Comments
ZZZ	Not Known

Shape Coding

CODE	DEFINITION
A	Arched (with flat bottom)
B	Barrel (e.g. beer barrel shape)
C	Circular
E	Egg shaped
H	Horseshoe (i.e., inverted U)
O	Oval
R	Rectangular
S	Square
T	Trapezoidal
U	U-Shaped with flat top
X	Other (state in Comments)

Existing Lining Coding

CODE	DEFINITION
BL	Bitumen
CL	Cement
IS	Soft inversion type liner
PL	Plastic
RL	Resin
XXX	Other (state in Comments)
ZZZ	Not Known

ATTACHMENT C

GENERAL INSPECTION LOGGING REQUIREMENTS

General Inspection Logging Requirements

(To be read in conjunction with other related documentation, i.e. Manual of Piping Condition Classification):

The first three lines of each set of survey details **must** have the codes ST, MH, and WL (WL is optional but is important to the City of Atlanta as it directly relates to the piping flow level at a certain time of day).

The Manhole Number must be entered in the Remarks column against the MH code (this is essential as a number of Data Interrogation packages stores the Header and Detail records separately which are "connected" by an Index. To ensure data integrity, a QC check can be run against the Detail information to confirm that the correct Details are against the relevant Header).
i.e.:

0D10230 0.0 ST
0D1 0.0 MH SJ34255521
0D1 0.0 WL 10

Each line of Detail (or as a minimum the first and last Detail lines) must have the video digit entered against each code, presented in the following way:
– The video digits must conform to the National elapsed time based standards (time into the tape) for Video Tape recorders:

- Always four digits (hmms, where s = units of 10 seconds).
- Always right justified and zero filled.
- The following elapsed time format MUST be adhered to, i.e.:

0230
0 = Number of hours (Zero hours).
23 = Number of minutes (23 minutes).
0 = Units of 10 seconds each (0 seconds).

Other examples:

0032 = 3 minutes and 20 seconds into the tape.
0244 = 24 minutes and 40 seconds into the tape.
1503 = 1 hour, 50 minutes and 30 seconds into the tape.
2451 = 2 hours, 45minutes and 10 seconds into the tape.

The final detail line for each survey must end with a Termination code, either SA or FH.

i.e.
0D1 89.0 RMJ 30
0D1 89.0F1JDS
0D10410 89.0 SA DUE TO ROOTS MASS

---------- or ----------
0D1 33.0 D 10
0D1 34.9 MH SJ35513464
0D10670 34.9 FH

Each Survey Report MUST only contain one survey hence, in the case of Survey Abandonment or a buried or uncharted manhole being encountered, a new Header and Detail must be completed.

The above are essential for the Validation of the data to take place

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CITY OF ATLANTA – INTERNAL CONDITION ASSESSMENT LOG

Surveyors name (1) and Certificate number (1a) System Owner (2) Survey Customer (3) Drainage Area (4) P/O No. (5)

Pipeline Segment Reference (6) Date (7) Time (8) Location (Street Name) Locality

Further Location details (10) Upstream Manhole Number (11) Rim to Invert (12) Grade to Invert (13) Rim to Grade (14)

Downstream Manhole Number (15) Rim to Invert (16) Grade to Invert (17) Rim to Grade (18) Use of Piping (19) Direction (20) Flow Control (21) Height (22)

Width (23) Shape (24) Material (25) Lining (26) Method (27) Pipe Joint Length (28) Total Length (29) Year Laid (30) Year Rehabilitated (31) Tape / Media Number (32) Purpose (33)

Piping Category (34) Pre-Cleaning (35) Cleaned 35a) Weather (36) Location Code (37) Traffic Control 37a) Additional Information (38)

Distance (Feet)	Continuous Defect Code	CODE		Dimension 1	Dimension 2	Circumferential Location		Joint	Image Ref.	Video Ref.	Remarks
		• Group / Descriptor	Modifier/ severity			At/ From	To				

Distance (Feet)	Continuous Defect Code	CODE		Dimension 1	Dimension 2	Circumferential Location		Joint	Image Ref.	Video Ref.	Remarks
		• Group / Descriptor	Modifier/ severity			At/ From	To				

ATTACHMENT D

PIPING.DAT DATA SPECIFICATION
AND
EXAMPLE OF PIPING.DAT DATA FILE

Piping.Dat Data Specification

To ensure that the data transfer file format is correct the following points are to be adhered to :

- The file is to be in a standard ASCII text format (i.e. no control characters) therefore each line in the file should be terminated by an ASCII carriage return/linefeed combination e.g. ASCII code 13 followed by ASCII code 10 (the default termination on most text generating programs).
- The maximum line length must not exceed 81 characters including the ASCII termination code, except for Line 1 where the Contractor can have their own reference after the 80th character.
- Decimal points must not be in any header field.
- Each Header line must start with a three character identifier "0H*n*", *n* being between 1 and 6.
- Each Detail line must start with a three character identifier "0D1".
- Decimal points must be in Detail footage.
- N = Numeric

DATA TRANSFER SPECIFICATION

Line 1	"0H1	1	3	
	Inspected By	4	12	
	Contract No	16	8	
	Job Number	24	10	
	Catchment	34	10	
	Division	44	1	
	District	45	3	
	PLR	48	11	
Line 2	"0H2"	1	3	
	Date	4	6	
	Time	10	4	
	Road Name	14	30	
	Place Name	44	20	
Line 3	"0H3"	1	3	
	Start Manhole	4	10	
	Start Depth	14	4	(NNNN)
	Start Cover	18	5	(NNNNN)
	Start Invert	23	5	(NNNNN)
	Finish Manhole	28	10	

	Finish Depth	38	4	(NNNN)
	Finish Cover	42	5	(NNNNN)
	Finish Invert	47	5	(NNNNN)
Line 4	"0H4"	1	3	
	Use	4	1	
	Direction	5	1	
	Size 1	6	4	(NNNN)
	Size 2	10	4	(NNNN)
	Shape	14	1	
	Material	15	3	
	Lining	18	3	
	Pipe Length	21	3	
	Total Length	24	4	(NNNN)
	Year Laid	28	4	
Line 5	"0H5"	1	3	
	VT No.	4	5	
	Video Recorder	9	10	
	Comments	19	40	
Line 6	"0H6"	1	3	
	Purpose	4	1	
	Weather	5	1	
	Location	6	1	
	Location Details	7	50	
	Category Code	57	1	
	Pre-Cleanse	58	1	
Details	"0D1"	1	3	
	Video No.	4	4	(NNNN)
	Photo No.	8	3	(NNN)
	Distance	11	5	(NNN.N)
	CD	16	2	
	Code	18	4	
	Diameter	22	3	(NNN)
	Clock At	25	2	(NN)
	Clock To	27	2	(NN)
	*Percentage %	29	2	(NN)
	*Intrusion	29	4	(NNNN)
	Remarks	33	30	

***Note**: The position from character 29 to 32 is a shared field in that there is no defect or feature that would have both Percentage and Intrusion. Hence, if Percentage, the Start position would be 29 for two characters (99% max), and if Intrusion, the Start position would also be 29 but zero filled (20 inches would be 0020, for instance). If it is anticipated that there would be no intrusion

greater than 99 inches (which is likely) then the Start position for Intrusion could be 31, as the resulting output file position would be the same but just without the two preceding zeros.

Example of Piping.Dat Data File on Diskette

Note: The 0 of 0H* and 0D1 is line character 1 and is a zero.

```
0H1ASI/DG      ASG0001 0         0         00002325021521X                  6
0H20601001136HENDRIX AVENUE               LLOYD STREET BASIN
0H3232502152100000000000000232502153107070000000000
0H4FD0012    CVC -  0202986Z
0H500008          WRONG FINISH MH ON VIDEO.
0H6 1 -                                              0084   ZZ
0D10900   000.0  ST
0D10900   000.0  MH             23250215201 (BURIED)
0D10900   000.0  WL         05
0D10906   004.3  JN  00612
0D10920   009.6  B      1101    REPAIRED
0D10926   011.7  DE         10  RUBBLE
0D10933   013.3  B      1101
0D10943   017.8  CN  01201
0D10943   017.8  GO             SHAFT MADE TO ACCOMODATE CN
0D10960   024.0  JN  00602      CAPPED OFF
0D10976   034.9  B      1101    REPAIRED
0D11010   037.0  JN  00602      SW
0D11030   052.6  JN  00610      SW
0D11050   074.1  B      1101    REPAIR
0D11050   074.1  RF
0D11056   079.0  JN  00602      SW
0D11076   096.3  CN  00411
0D11086   098.3  DC         0015X 15
0D11103   110.4  CLJ    10
0D11140   116.7  CNI 00610  0003
0D11203   143.3  CN  00402
0D11230   170.2  CNI 00610  0003LIVE FW
0D11233   174.7  CL     12
0D11243   180.4S1FL     12
0D11256   182.1  BJ     1201
0D11260   199.3  BJ     1101
0D11270   199.9  H      06
0D11280   206.7  JDL
0D11280   206.7  PC         0015X 4FT
0D11306   221.7  CN  00610
0D11306   221.7  V
0D11316   224.2  MC             V.C.
0D11316   224.2  PC         0015X 2FT
0D11326   238.4  BJ     1112
0D11356   266.9  BJ     1112
0D11366   279.3  JDM
0D11373   281.3  DE         10  RUBBLE
0D11383   283.6  JDL
0D11390   284.5  B      1203
0D11390   284.5S4D          10
0D11400   294.0C4D          05
0D11406   298.6F4D          05
0D11406   298.6  MH             23250215301
0D11406   298.6  FH
```

+ + + END OF SECTION 02655 + + +

SECTION 02663

HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.01 SCOPE

A. The Project involves the construction of two (2) parallel 18-inch High Density Polyethylene (HDPE) pipes of approximately 280 plan linear feet that will contain medium voltage conduit ductbanks by Horizontal Directional Drilling (HDD). This section covers the work necessary for installing the HDPE pipeline for the subaqueous creek crossing by the horizontally drilled, directionally controlled method. Furnishing the HDPE pipe, appurtenances, and other related work is included in Section 02664, Specifications for High Density Polyethylene Pipe.

B. The Scope of Work includes drilling the borehole, procurement of piping, pullback operations and testing. After successful pressure testing, the Contractor shall cap the ends of the pipeline and demobilize from the site. The Contractor shall provide all materials, labor, equipment, and incidentals required to complete the Work as shown on the Drawings and specified in this section.

C. Related work specified elsewhere:

02664 High Density Polyethylene Pipe

16111 Conduit

16119 Underground Ducts and Utility Structures

1.02 CONTRACTOR QUALIFICATIONS

A. Installation of pipeline by the horizontally drilled, directionally controlled method shall be only by a CONTRACTOR with a nominated resident superintendent having a minimum of five (5) year experience in directional drilling. The Superintendent shall have successfully completed a minimum of three (3) directionally drilled HDPE pipe installations, 18-inches or greater in diameter and in excess of 250 ft in length. CONTRACTOR will furnish the ENGINEER with a list of references substantiating this requirement.

1.03 SUBMITTALS

A. The CONTRACTOR shall prepare a schedule for the Work and submit it to the ENGINEER for approval in accordance with General Conditions Section 28. The schedule shall include all major tasks including the following:

1. Pipe fabrication.

2. Pipe delivery.

3. Rig mobilization and setup.

4. Pipe assembly.

5. Target dates for entry onto west shore and east shore construction.

6. Target dates for blockage and/or crossing of public/private roadways and anticipated extension of time for each occurrence.

7. Pilot hole drilling.

8. Pre-reaming.

9. Pipe pulling.

10. Pipe testing and pretesting.

11. Restoration and demobilization.

12. Target date for exit from shore sites.

13. Disposal of Slurry.

B. At least five (5) days prior to mobilizing equipment, the CONTRACTOR shall submit his detailed installation plan to the ENGINEER for review. The plan shall include a detailed plan and profile of the bore and be plotted at a scale no smaller than 1-inch equals 20 feet horizontally and 1-inch equals 10 feet vertically. This plan must also include calculations showing anticipated maximum pipe stresses during pulling, overpulling lengths, safe pull force, the maximum pull force the HDD machine is capable of, required drilling fluid pressures, and safety factors for potential drilling fluid blowout. A minimum of 20-ft of ground cover must be maintained under Peachtree Creek. All bending radii shall be in accordance with manufacturer's recommendations.

C. Composition. The composition of all drilling fluids used shall be submitted

to the ENGINEER for review prior to utilization. No fluid will be utilized that does not comply with permit requirements and environmental regulations.

D. The pipe string out and construction areas obtained may necessitate laying up the pipe strings in more than one length. Therefore, welding "on the fly" may be considered as a construction method. If proposed by the CONTRACTOR, such welding must be submitted with full details of methods and performance for approval by the ENGINEER at least seven (7) days in advance of proposed operations for approval. CONTRACTOR bears sole risk and responsibility for proving the acceptability of such welding and associated work.

SECTION 2 – MATERIALS

2.01 GENERAL

A. The CONTRACTOR shall provide all materials, equipment and labor for completing the subaqueous crossing and for adequate protection of the Work.

2.02 MATERIALS

A. High Density Polyethylene Pipe: HDPE Pipe shall be in accordance with Section 02664, Specification for High Density Polyethylene Pipe.

B. The Contractor shall provide all new materials for construction of the Work.

SECTION 3 - EXECUTION

3.01 INSTALLATION

A. General: The CONTRACTOR shall install the subaqueous section of the pipeline by the horizontally drilled, directionally controlled method of construction. The horizontally drilled, directionally controlled method shall consist of the drilling of a small diameter pilot hole in a vertical arc from one bank of the river to the other followed by an enlarged diameter hole for the HDPE pipeline insertion. The exact method and techniques for completing the directionally drilled crossing will be determined by the CONTRACTOR, subject to the requirements of these Specifications.

B. Instrumentation: The CONTRACTOR will at all times provide and maintain instrumentation which will accurately locate the pilot hole and measure drilling fluid flow discharge rate and pressure. The OWNER/ ENGINEER will have access to these instruments and their readings at all times.

C. Tolerances:

1. HDPE pipe installed by the horizontally drilled directionally controlled method must be located in plan as shown on the Drawings. The CONTRACTOR shall plot the actual horizontal and vertical alignment of the pilot bore at intervals not exceeding 25 feet. This "as-built" plan and profile shall be updated as the pilot bore is advanced. The CONTRACTOR shall employ experienced personnel to operate the directional drilling equipment and, in particular, the position monitoring and steering equipment. No information pertaining to the position or inclination of the pilot bore shall be withheld from the ENGINEER. At the completion of the pilot hole the CONTRACTOR shall provide the ENGINEER with the coordinates for the pilot hole. The CONTRACTOR shall employ an independent certified CONTRACTOR to verify the final location of the pilot hole, at no expense to the OWNER.

2. The entry point location of the pilot hole shall initially penetrate the ground surface at the exact location shown on the Plan & Profile Drawings. The CONTRACTOR will stake this location in the field.

3. The exit point shall be located within 5 feet (1.5 m) along the length of the pipe (but no closer to the river) and 2 feet (0.6 m) on either side perpendicular to the pipe at the exit point location shown. If the pilot bore fails to conform to the above tolerances, the ENGINEER may, at his option, require a new pilot boring be made. The CONTRACTOR will stake this location in the field.

4. A pilot bore which fails to meet the above requirements may be acceptable provided the CONTRACTOR can provide the OWNER with satisfactory construction and permanent easements. The costs of providing such additional easements shall be borne by the CONTRACTOR. The OWNER shall be sole judge as to easement acceptability.

5. The CONTRACTOR shall at all times handle the pipe in a manner that does not overstress the pipe. If the pipe is buckled or otherwise damaged, the damaged section shall be received and replaced by the CONTRACTOR at his expense.

D. Temporary Trench:

1. Temporary Trench may be installed within the Right-of-Way shown on the drawings, subject to terms of the Right-of-Way permits, agreements and/or deeds and applicable provisions below:

a. Trenching shall be performed in accordance with the Contract Documents.

b. Erosion Control shall be installed in accordance with Contract Documents.

c. CONTRACTOR shall restore the area to a condition suitable for additional construction activities.

3.02 DRILLING MUD AND CUTTINGS

A. Disposal. Disposal of drilling fluids shall be the responsibility of the CONTRACTOR and shall be conducted in compliance with all relative environmental regulations, right-of-way and work space agreements and permit requirements. All costs related to disposal shall be borne by the CONTRACTOR.

B. Inadvertent Returns. Drilling fluid returns at locations other than the entry and exit points shall be minimized. Prior to cleaning-up any inadvertent returns the CONTRACTOR shall notify the OWNER/ENGINEER and all appropriate regulatory agencies. Clean-up of inadvertent returns shall be at no additional cost to the OWNER.

3.03 TESTING

A. After installation, the pipe shall be pressure tested in place as specified in the Contract Documents. The CONTRACTOR shall also pressure test pipe segments before pulling.

B. The Contractor shall fill the pipeline with water 24 hours prior to conducting post installation pressure testing.

3.04 CONSTRUCTION LAYOUT

A. Work and staging areas are indicated by locations of manholes MH-R2 and MH-R3 on electrical Drawings. Contractor shall coordinate work activities with Owner to prevent operational interruption. Additionally, the Contractor shall coordinate construction activities related to construction of the horizontal directional drill so as not to conflict with all other construction activities. No claim or additional compensation will be paid to the Contractor because of delay due to conflict with other construction activity at the site.

3.05 REAM AND PULL BACK

A. Prereaming. Prereaming operation shall be conducted at the discretion of the

horizontal drilling CONTRACTOR. All provisions of this specification relating to simultaneous reaming and pulling back operations shall also pertain to prereaming operations. Maximum vertical bending radius of alignment is 75 feet, or as otherwise recommended by the pipe manufacturer.

B. Pulling Loads. CONTRACTOR shall be responsible for determining pulling loads required for his method of installation. Such loads shall be minimized as required to prevent failure of the pipeline during installation. Pulling load during pullback of the 18" HDPE pipeline shall be limited to 50,000 lbs The Contractor shall use a breakaway connection to the pipeline that will protect the pipeline from being subjected to tensile forces that would damage the pipeline during installation.

C. Torsional Stress. A swivel shall be used to connect the pipeline pull section to the reaming assembly to minimize torsional stress imposed on the section.

D. Buckling Stress. CONTRACTOR shall fill the pipe with water, as installation proceeds, as required to prevent buckling and reduce buoyancy.

E. Pull Section Support. The pull section shall be supported as it proceeds during pull back so that it moves freely and is not damaged.

F. Pull Section Length. If space allows, the pull section shall be installed in one continuous length with no tie in welds. If space is not available, tie-in welds shall be minimized and fully inspected by radiographic means prior to installation.

3.06 COORDINATION OF WORK

A. The CONTRACTOR shall have the option of securing additional construction easements or easements in different locations if he wishes or feels the easements provided by the OWNER are inadequate for his construction method. In this case, the CONTRACTOR shall notify the ENGINEER of his intention to do secure additional easements. The cost of negotiating and obtaining these easements shall be borne by the CONTRACTOR. All permanent and construction easements must meet the OWNER's approval.

B. Drilling Water. Water required for drilling and hydrostatic testing is not available from municipal water supplies at the site. The Contractor shall secure adequate supply of water for drilling. Additional costs and securing permission to use water from any other source is the responsibility of the CONTRACTOR.

1. The Contractor shall verify that water used in drilling and hydrostatic testing operations is of suitable quality including, but not limited to:

a. Water used is fresh water.

b. Water has a pH of 7.

c. Water does not contain fish, animals, tree leaves, limbs, or other wildlife or plant life.

d. Water is free of chlorine and other chemicals that would be detrimental to mixing of drilling fluid.

2. If water is not of sufficient quality, the Contractor shall be responsible for providing suitable water in sufficient quantity to complete construction and testing operations. Costs for providing water shall be included in the cost of the horizontal directional drill installation.

3.07 OVERPULLING

A. After the HDPE pipeline has been pulled into the reamed pilot hole, the pipe shall be pulled so that an additional 5 m (16 feet) of pipeline has been pulled out of the pipeline exit point (Drill Rig Side) and 15 m (50 feet) of pipeline is exposed on the end of the bore at the pilot hole exit point. The Contractor shall leave the drill rig connected to the pipeline for 24 hours after completion of the drill.

3.08 COMPLETION OF DIRECTIONAL DRILLING

A. If the directionally drilled pipeline is not installed or the CONTRACTOR abandons the effort, he will forfeit all payments for the applicable item.

B. Completion and successful testing of the approved pipeline will entitle the CONTRACTOR to full payment for the applicable bid item in the proposal.

C. In the event of failure to install the directional drilled pipeline, the CONTRACTOR shall retain possession of the HDPE pipe and remove it from the site. The bore hole beneath land shall be completely filled with grout or sand to prevent future settlement. If the HDPE pipe cannot be withdrawn, it shall be cut off at least 3 feet below the ground and capped with a blind flange. The annular space between the pipe and the bore hole shall be filled or grouted for a minimum length of 25 feet at the expense of the CONTRACTOR.

D. The Contractor shall grout the ends of the HDPE after installation with flowable fill to the limits shown on the Drawings.

3.09 RESTORATION

A. Comply with requirements of the Contract Documents.

B. Promptly replace damaged pavement.

C. The Contractor shall restore area around entry and exit pits as soon as Work is completed.

D. The Contractor shall fill to previous existing ground elevation and grade any areas where settlement occurs due to subsidence.

E. The Contractor shall ensure area is suitable for additional construction activities after demobilizing from the project site.

F. The Contractor shall leave the ends of the pipeline after installation sticking out of the ground. The end points shall be capped or plugged as applicable. Before capping or plugging, the Contractor shall ensure all dirt, debris, and other items are cleaned from the inside of the pipe.

+++END OF SECTION 02663+++

SECTION 02664
HIGH DENSITY POLYETHYLENE PIPING

PART I GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment and incidentals required for the complete installation of High Density Polyethylene (HDPE) pipe and accessories as shown on the Drawings and as specified herein.

1.2 QUALITY ASSURANCE

A. Reference Standards: The design, manufacturing and assembly of elements of the products herein specified shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or otherwise specified.

1. AMERICAN WATER WORKS ASSOCIATION (AWWA) C906 For Polyethylene (Pe) Pressure Pipe And Fittings, 4 In. Through 63 In. For Water Distribution.

2. ASTM A193-Specification for Alloy-Steel and Stainless Steel Bolting Material for High- Temperature Service.

3. ASTM A194-Specification for Carbon and Alloy Steel Nuts for Bolts for High - Pressure and High- Temperature Service.

4. ASTM A240 - Heat-Resisting Chromium and Chromium- Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

5. ASTM D1248 - Specification for Polyethylene Plastics Molding and Extrusion Materials.

6. ASTM D1505- Test Method for Density of Plastics by the Density-Gradient Technique.

7. ASTM D1598 - Test Method for Time-To-Failure of Plastic Pipe under Constant Internal Pressure.

8. ASTM D1599 - Test Method for Short-Time Hydraulic Failure Pressure of Plastics Pipe, Tubing, and Fittings.

9. ASTM D2290 - Test Method for Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method.

10. ASTM D3261 - Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (Pe) Plastic Pipe and Tubing.

11. ASTM D3350 - Standard Specification for Polyethylene (PE) Plastics Pipe and Fittings Materials.

12. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe based On Outside Diameter.

13. PPI TR-3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Material.

14. PPI TR-4 - Recommended Hydrostatic Strengths and Design Stresses for Thermo-Plastic Pipe and Fittings Compounds.

15. NSF STANDARD #14 - Plastic Piping Components and Related Materials.

B. Qualifications

1. The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications.

2. The manufacturer shall be open for inspection of their production and quality assurance facilities by the owner and their authorized representatives.

1.3 SUBMITTALS

A. Shop drawings

1. Pipe lay schedules.

2. Make and model of butt fusion equipment.

B. Details of specials and fittings.

C. Copy of the manufacturer's quality control check of pipe material and production.

D. An affidavit of compliance with AWWA standard C906.

E. Installation manual which includes guidelines for pipe handling, joining, installation, and testing of hope.

F. Daily test strap results. See paragraph 11.a.3 of this specification.

1.4 TRANSPORTATION AND HANDLING

A. Each piece of pipe and fitting shall be clearly marked to indicate length of pipe and dimension ratio.

B. The pipe and fitting manufacturer shall package products for shipment in a manner suitable for safe transport on commercial carriers. When delivered, a receiving

inspection shall be performed by the contractor, and any shipping damage reported immediately to the engineer and to the pipe and fitting manufacturer within 48 hours. Damaged pipe may be rejected by the engineer. Field repairs of pipe and fittings is not permitted, with the exception that portions of straight pipe which is damaged may be cutoff provided this alteration does not affect the lay schedule and is in accordance with the manufacturer's established procedures. Pipe and fittings shall be handled in accordance with the manufacturer's requirements and those of this specification.

1.5 STORAGE AND PROTECTION

A. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

1.6 PREQUALIFICATION

A. The following manufacturers are acceptable:

1. HDPE Pipe and fittings:

A. Performance Pipe Division - Chevron Chemical Company

B. CSR Polypipe Industries, Inc.

C. or approved equal

2. Butt fusion equipment:

A. McElroy Manufacturing, Inc.

B. or approved equal

PART 2 PRODUCTS

2.1 MATERIALS

A. Pipe and Fittings

1. Conform to AWWA C906K PE 3408 HDPE Material Meeting ASTM D3350 cell classification 34534c. Use 30” OD HDPE, minimum SDR rating of 11, to provide an approximately minimum inside diameter of 18”.

2. HDPE material shall have a minimum hydrostatic design basis (HDB) of 1600 PSI at 73 degrees F when tested in accordance with PPI TR-3 and shall be listed in the name of the pipe and fitting manufacturer in PPI TR-4.

3. Production Of Pipe Shall Be Approved By The National Sanitation Foundation

(NSF).

4. Molded fittings shall be manufactured in accordance with ASTM D3261 (Butt Fused) and shall be so marked.

5. All pipe and fittings shall be designed to withstand the stresses created by the maximum internal pressure and the earth backfill load resulting from the existing or proposed ground over the pipe, whichever is greater plus a single H-20 truckload with impact in accordance with AASHTO specifications, all acting simultaneously.

6. Permanent identification of pipe and fittings shall be provided by co-extruding color stripes into the pipe's outside surface. The stripping shall be the same material as the pipe material except for color stripes into the pipe's outside surface. The stripping shall be the same material as the pipe material except for color. Stripes shall appear along the pipe at a maximum of 90 degrees increments around the circumference of the pipe. In addition, printline markings shall include a production code identifying the location and date of manufacture. The color of the identification striping shall be RED for electrical conduit service. Painted or printed stripping on the outside of the pipe shall not be acceptable.

7. Incoming polyethylene materials shall be inspected for density per ASTM D1505, melt rate per ASTM D1248, and containment. All incoming polyethylene materials shall be certified by the supplier. These certifications shall be verified by the hope pipe manufacturer prior to processing into finished pipe or fittings. Outgoing materials shall be inspected by the pipe manufacturer for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. The pipe manufacturer shall perform tests of density, melt flow rate, carbon content, and carbon dispersion. Representative samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst per ASTM D-1599 or ring tensile per ASTM D-2290. Molded fittings production shall be subject to x-ray inspection for voids, and tests for knit line strength. All fabricated fittings shall be inspected for fusion quality and alignment. The pipe and fitting manufacturer shall maintain permanent QC and QA records. Certified copies of the quality control data taken during product manufacture shall be supplied to the owner upon request.

B. Joints:

1. The standard joint of pipe and fittings shall be plain end capable of butt fusion.

2. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the outside diameter and minimum wall thickness of ASTM f-714 for the same size of pipe.

3. Fitting markings shall include a production code identifying the location and

date of manufacture.

4. Fittings shall be manufactured in the same production facility where the HDPE pipe is produced. Field fabricated fittings are not allowed.

C. Flanges:

1. Flanged ends where connections are to be made with other pipe materials and mainline valves.

2. Outside diameter of HDPE flange adapters shall be equal to or greater than the mating flange in dimensions and shall be drilled with the corresponding bolt pattern and size of the mating flange.

3. All flanges shall meet the applicable requirements of AWWA C906, ANSI B16.1 For 125 PSI standard template. Flanges shall contain a stainless steel lapjoint flange.

D. Bolts and Nuts For Flanges:

1. Bolts and nuts for flanges located in enclosed vaults and structures shall be stainless steel.

2. Bolts and nut for buried and submerged flanges shall be Type 316 stainless steel conforming to ASTM A193, Grade 88M for bolts, and ASTM A194, Grade 87. Nuts shall comply with ASTM A194, Grade 2H.

3. Bolts shall extend through the lap- joint flange, HDPE flange adapter, and the mating flange.

2.2 EQUIPMENT

A. Butt fusion equipment:

1. Provide units equal to those specified.

2. Equipment to contain stops to prevent excessive pressure on pipe ends during fusion process.

3. Equipment to hone pipe ends prior to fusion process.

4. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D1598.

PART 3 EXECUTION

3.1 BUTT FUSION JOINTS

A. The pipe manufacturer's fusion processes shall be followed at all times as well as the recommendations of the fusion machine manufacturer.

B. The wall thickness of the adjoining pipes shall be the same at the point of fusion

C. The first fusion joint at the day's start of each work crew shall be a trial fusion. The trial fusion shall be allowed to cool completely, per the pipe manufacturer's published installation guidelines. Fusion test straps of 12" or 30 times the wall thickness in length (greater of the two), and 1" or 1.5 times the wall thickness in width (greater of the two), shall be cut out of the cooled joint. The contractor is to bend the test strap until the end

D. Of the strap touches. If the fusion fails at the test joint, a new fusion shall be made and retested. Butt fusion of pipe to be installed shall not commence until the trial fusion has passed the bent strap test. Results of each test shall be made available to the engineer.

E. Prior to heating of the joint each pipe section to be butt fused will require the ends to be honed in the fusion machine to assure the ends will mate at the fusion point. The pipe ends shall be pushed together in the fusion machine to make a visual check of the compatibility and alignment of the two ends.

F. The contractor shall adhere to the manufacturer's procedures and recommended heating time for the pipe ends based upon pipe diameter and ambient temperature. A visual inspection shall be made immediately upon removal of the heating element to verify blistering of the pipe has not occurred.

G. Upon completion of the fusion process for each joint, the pipe shall not be removed from the fusion machine until the pipe has cooled in accordance with the pipe manufacturer's published installation guidelines.

3.2 FLANGED JOINTS

A. Bolt holes of flanges shall straddle the horizontal and vertical centerlines of the pipe. Clean flanges before installation. Clean flange bolts and nuts by wire brushing. Lubricate bolts with vegetable based oil only.

B. Insert nuts and bolts (or studs), finger tighten, and progressively tighten diametrically opposite bolts uniformly around the flange to the proper tension.

C. Execute care when tightening joints to prevent undue strain upon adjoining valves or equipment.

3.3 INSPECTION AND TESTING

A. Pneumatic air testing shall be allowed.

3.4 INSTALLATION

A. Pipe shall have a SAFE PULL FORCE of 170,000 lbs. That value does not include the frictional resistance force between the pipe OD and the borehole. Determination of the friction force is dependent on the drilling fluid mixture, radius of the borehole, and should be determined by the Contractor.

B. Pipe shall not bend with any radius below 75 feet.

+ + + END OF SECTION 02663+ + +

SECTION 02665
DUCTILE IRON PIPE
TRANSMISSION WATER MAINS
AND ACCESSORIES

PART I GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment and incidentals required for the complete installation of water mains and accessories as shown on the Drawings and as specified herein. The Work of this Section also includes, but is not limited to, hydraulic testing and disinfection of the completed water mains after installation.

B. This Section includes ductile iron pipe and fittings ranging in size from 4-inches in diameter through 64-inches in diameter.

C. Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. Latest revisions of all standards are applicable.

D. Galvanized pipe and fittings shall not be used as any part of the Water Transmission and Distribution System, nor shall it be used to join any appurtenances to the System.

1.2 QUALITY ASSURANCE

A. Reference Standards: The design, manufacturing and assembly of elements of the products herein specified shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or otherwise specified.

1. ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. ANSI/AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings
3. ANSI/AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
4. ANSI/AWWA C115/A21.15 – Flanged Ductile-Iron Pipe with Ductile- Iron or Gray-Iron Threaded Flanges
5. ANSI/AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe
6. ANSI/AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast
7. ANSI/AWWA C153/A21.53 – Ductile-Iron Compact Fittings for Water Service
8. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
9. ANSI /AWS D11.2 – Guide for Welding Iron Castings
10. AWWA C651 – Disinfecting Water Mains

B. (Not Used)

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data and engineering data, including shop drawings.
2. Evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two (2) years.
3. Written certification that all products furnished comply with all applicable requirements of these specifications.

B. For pipe 24-inches in diameter or greater, submit shop drawings to the Engineer for review showing a complete laying plan of all pipe, including all fittings, adapters, valves and specials along with the manufacturer's drawings and specifications indicating complete details of all items. The pipe details shall include stationing, pipe class or design and supporting computations; and laying schedule which specifies pipe class, class coding, pipe stationing for all changes in grade or horizontal alignment, transition stations for various pipe classes and the limits of each reach of restrained joint pipe. The above shall be submitted to the Engineer for review before fabrication and shipment of these items.

1.4 TRANSPORTATION AND HANDLING

A. Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings and accessories. Make equipment available at all times for use in unloading. Do not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification. Pipe handled on skids shall not be rolled or skidded against the pipe on the ground.

B. Handle pipe, fittings, and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front end loader. Do not use material damaged in handling. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior coatings or internal lining of the pipe.

1.5 STORAGE AND PROTECTION

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tier shall be kept off the ground on timbers, rails or concrete. Pipe in tiers shall be alternated: bell, plain end; bell, plain end. At least two rows of timbers shall be placed between tiers and chocks, affixed to each other in order to prevent movement. The timbers shall be large enough to prevent contact between the pipes in adjacent tiers.

D. Stored mechanical and push-on joint gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

E. Mechanical joint bolts shall be handled and stored in such a manner that will ensure proper use with respect to types and sizes.

1.6 WATER MAIN LOCATION

A. The minimum depth of cover over the pipe shall be four (4) feet and the maximum cover shall be five (5) feet. Any deviations must be approved by the Engineer.

B. The installation of the water main parallel to another utility in the same vertical plane is not permitted, i.e., "stacking of utilities is not permitted.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C151/A21.51. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings. All pipe shall have a minimum pressure rating as indicated in the following table and corresponding minimum wall thickness, unless otherwise specified or shown on the Drawings:

Pipe Sizes (inches)	Pressure Class (psi)
4 - 12	350
14 - 18	350
20	300
24	250
30 -60	200

B. Flanged pipe minimum wall thickness shall be equal to Special Class 53. Flanges shall be furnished by the pipe manufacturer.

C. Fittings shall be ductile iron and shall conform to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 with a minimum rated working pressure of 250 psi.

D. Joints

1. Unless shown or specified otherwise, joints shall be push-on or restrained joint type for pipe and standard mechanical, push-on or restrained joints for fittings. Push-on and mechanical joints shall conform to ANSI/AWWA C111/A21.11.

2. The only acceptable restrained joint systems are identified in the table below. No field welding of restrained joint pipe will be allowed.

Acceptable Restrained Joints				
Pipe Dia. (inches)	**ACIPCO**	**U.S. Pipe**	**McWane**	**Generic***
4 – 12	Fast-Grip Flex Ring	Field Lok TR Flex	Push-On Restrained Joint Type A	MJ with Retainer Gland
16 – 24	Fast-Grip Flex Ring	Field Lok TR Flex	Push-On Restrained Joint Type A	MJ with Retainer Gland
30 – 36	Flex Ring	TR Flex	Push-On Restrained Joint Type B	MJ with Retainer Gland
42 – 60	Flex-Ring	TR Flex	N/A	MJ with Retainer Gland

* Fittings and valves only, and only where specifically allowed.

3. Restrained joint pipe (RJP) on supports shall have bolted joints and shall be specifically designed for clear spans of at least 36 feet.
4. Flanged joints shall meet the requirements of ANSI B16.1, Class 125.

E. Gaskets: Gaskets for the various types of joints shall be as follows:

1. Gaskets for mechanical joints shall be made of vulcanized styrene butadiene (SBR) as specified in ANSI/AWWA C111/A21.11 unless specified otherwise. Reclaimed or natural rubber shall not be used. Gaskets shall be free from porous areas, foreign material and other defects that make them unfit for the use intended.
2. Gaskets for flanged joints shall be made of synthetic rubber, ring type or full face type and shall be 1/8-inch thick. Gaskets shall conform to the dimensions specified in ANSI/AWWA C111/A21.11.
3. Gaskets for push-on and restrained joints shall be in accordance with the pipe manufacturer's design dimensions and tolerances. Gaskets shall be made of vulcanized styrene butadiene (SBR) as specified in ANSI/AWWA C111/A21.11 unless specified otherwise.

F. Bolts and Nuts

1. Provide the necessary bolts for connections. All bolts and nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A external and 2B internal fit.
2. Bolts and nuts for mechanical joints shall be tee head bolts and nuts of high- strength

low-alloy steel having a minimum yield strength of 45,000 psi. Dimensions of bolts and nuts shall be in accordance with the dimensions shown in ANSI/AWWA C111/ A21.11.

3. Flanged joints shall be bolted with through stud or tap bolts of required size as directed. Bolt length and diameter shall conform to ANSI/AWWA C115 for Class 125 flanges shown in ANSI/ASME B16.1.
4. Bolts for exposed service shall be zinc plated, cold pressed, steel machine bolts conforming to ASTM A307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A563. Zinc plating shall conform to ASTM B633, Type II.
5. Bolts for submerged service shall be stainless steel machine bolts conforming to ASTM A193, Grade B8. Nuts shall be heavy hex, stainless steel conforming to ASTM A194, Grade 8.

G. Mechanical joint glands shall be ductile iron.

H. Welded Outlets: Welded outlets may be provided in lieu of tees or saddles on mains with a diameter greater than or equal to 24-inches. The pipe joint on the outlet pipe shall meet the joint requirements specified above. The minimum pipe wall thickness of the parent pipe and the outlet pipe shall be Special Thickness Class 53 (Pressure Class 350 for 60 and 64-inch sizes). The welded outlet shall be rated for 250 psi working pressure. Each welded outlet shall be hydrostatically tested at 500 psi. The welded outlet shall be fabricated by the manufacturer of the parent pipe. The maximum outlet diameters shall not exceed those listed in the table below:

Parent Pipe Diameter, Inches	Maximum Outlet Diameter, Inches
24	16
30	20
36	24
42	30
48	30
54	30
60	30
64	30

I. Thrust collars shall be welded-on ductile iron body type designed to withstand thrust due to 250 psi internal pressure on a dead end from either direction on that pipe size. The thrust collars shall be continuously welded to the pipe by the pipe manufacturer.

J. Solid sleeves shall be used to connect plain end ductile iron pipe. Solid sleeves shall meet the requirements of ANSI/AWWA C110/A21.10 for long pattern and have a minimum pressure rating of 250 psi. Solid sleeves shall have mechanical or restrained joints as specified in this section or as shown on the Drawings. Solid sleeves shall be used only in

locations shown on the Drawings or at the discretion of the Engineer. Solid sleeves shall be manufactured by American Cast Iron Pipe Company or U. S. Pipe.

K. Pipe stubs for all structure connections shall not exceed 2-feet in length. Caps shallbe furnished where required.

M. Cement Lining

1. Interior surfaces of all ductile iron pipe and fittings shall be cleaned and lined with a cement mortar lining applied in conformity with ANSI/AWWA C104/A21.4. If lining is damaged or found faulty upon delivery, the damaged pipe sections shall be repaired or removed from the site as directed by the Engineer.

2. The minimum lining thickness shall be as shown in the following table. Lining shall be square and uniform with regard to the longitudinal axis of the pipe.

Pipe Diameter (Inches)	Minimum Lining Thickness (Inches)
3 - 12	1/8
14 - 24	3/32
30 - 64	1/8

N. Pipe Coating: Unless otherwise specified, pipe and fittings shall be coated with a 1 mil asphaltic coating as specified in ANSI/AWWA C151/A21.51.

O. Polyethylene Encasement: Ductile iron pipe shall be encased with polyethylene film where shown on the Drawings, specified or directed by the Engineer. Polyethylene film shall be as specified in Section 02616.

P. Pipe Insulation: Where a water main is exposed to the elements because the pipe is above ground, the Engineer shall determine whether the pipe is to be insulated or not. Where insulation is to be furnished and installed it shall conform to the following:

1. Insulating material shall be 3-inch thick polyurethane pipe covering formed to fit the pipe diameter.

2. Outer covering shall be 0.016-inch thick aluminum chiller jacket with moisture shield and secured with stainless steel wire or stainless steel straps.

Q. Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

2.2 PIPING APPURTENANCES

A. Mechanical Joint Restraint

1. Design

a. Restraint devices for pipe sizes 3 inches through 48 inches in diameter shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.

b. Restraint devices shall have a working pressure rating of 350 psi for 3-inch

through16-inch diameter pipe and 250 psi for 18-inch through 48- inch diameter pipe. Ratings shall be for water pressure and shall include aminimum safety factor of 2 to 1 for all pipe diameters.

2. Material
   a. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
   b. Ductile iron gripping wedges shall be contoured to fit on the pipe and shall be heat treated within a range of 370 to 470 BHN.
   c. Dimensions of the glands shall be such that they can be used with the standard mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C 153/A21.53, latest editions.
3. Approvals
   a. Restraint devices shall be listed by Underwriters Laboratories (3-inch through 24-inch size) and approved by Factory Mutual (3-inch through 12-inch size).
   b. Mechanical joint restraint shall be Megalug Series 1100 as manufactured by EBAA Iron Inc., Uni-Flange Series 1400, as manufactured by Ford Meter Box Company or approved equal.

B. Tapping Saddles: Tapping saddles are not allowed.

C. Expansion Joints shall be Redflex type J-1 as manufactured by the Red Valve Company or approved equal.

D. Restrained Flange Adaptors shall be the series 2100 MegaFlange Restrained Flange Adaptor as manufactured by EBAA Iron, Inc. or approved Equal

E. Detection Tape: Detection tape shall be composed of a solid aluminum foil encased in a protective plastic jacket. Tapes shall be color coded in accordance with APWA color codes with the following legends: Water Systems, Safety Precaution Blue, “Caution Water Line Buried Below”. Colors may be solid or striped. Tape shall be permanently printed with no surface printing allowed. Tape width shall be a minimum of 2-inches when buried less than 10-inches below the surface. Tape width shall be a minimum of 3-inches when buried greater than 10-inches and less than 20-inches. Detection tape shall be equal to Lineguard Type III Detectable or Allen Systems Detectatape.

PART 3 EXECUTION

3.1 LAYING AND JOINTING PIPE AND ACCESSORIES

A. Lay all pipe and fittings to accurately conform to the lines and grades as shown on the Drawings or as established by the Engineer.

B. Pipe Installation

1. Proper equipment, tools and facilities shall be provided for the safe performance of the Work. All pipe, fittings, valves and hydrants shall be lowered carefully into the trench by means of slings, ropes or other suitable tools or equipment in such a manner as to

prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.

2. All pipe, fittings, valves, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.
3. All lumps, blisters and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit or any foreign materials before the pipe is laid. No pipe containing dirt shall be laid.
4. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing or other materials shall be placed in the pipe at any time.
5. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.
6. It is not mandatory to lay pipe with the bells facing the direction in which work is progressing.
7. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade, shall not be permitted.
8. Provide detection tape for all pipe greater than 12-inches in diameter. Detection tape shall be buried 4 to 10-inches deep. Should detection tape need to be installed deeper, the Contractor shall provide 3-inch wide tape. In no case shall detection tape be buried greater than 20-inches from the finish grade surface.

C. Alignment and Gradient

1. Lay pipe straight in alignment and gradient or follow true curves as nearly as practicable. Do not deflect any joint more than the maximum deflection recommended by the manufacturer.
2. Maintain a transit, level and accessories at the work site to lay out angles and ensure that deflection allowances are not exceeded.

D. Expediting of Work: Excavate, lay the pipe, and backfill as closely together as possible. Do not leave unjointed pipe in the trench overnight. Backfill and compact the trench as soon as possible after laying and jointing is completed. Cover the exposed end of the installed pipe each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe or accessory, close the end with a suitable plug, either push-on, mechanical joint, restrained joint or as approved by the Engineer.

E. Joint Assembly

1. Push-on, mechanical, flange and restrained type joints shall be assembled in accordance with the manufacturer's recommendations.
2. The Contractor shall inspect each pipe joint within 1,000 feet on either side of main line valves to insure 100 percent seating of the pipe spigot, except as noted otherwise.
3. Each restrained joint shall be inspected by the Contractor to ensure that it has been "homed" 100 percent.
4. The Contractor shall internally inspect each pipe joint to insure proper assembly for pipe 24-inches in diameter and larger after the pipe has been brought to final alignment.

F. Cutting Pipe: The Contractor shall cut the pipe and bevel the end, as necessary, to provide the correct length of pipe necessary for installing the fittings, valves, accessories and closure pieces in the correct location. Only push-on or mechanical joint pipe shall be cut. Cement lining shall be undamaged.

G. Polyethylene Encasement: Installation shall be in accordance with ANSI/AWWA C105/A21.5 and the manufacturer's instructions. All ends shall be securely closed with tape and all damaged areas shall be completely repaired to the satisfaction of the Engineer.

3.2 THRUST RESTRAINT

A. Provide restraint at all points where hydraulic thrust may develop.

B. Retainer Glands: Provide retainer glands where shown on the Drawings. Retainer glands shall be installed in accordance with the manufacturer's recommendations, particularly, the required torque of the set screws. The Contractor shall furnish a torque wrench to verify the torque on all set screws which do not have inherent torque indicators.

C. Harnessing

1. Provide harness rods only where specifically shown on the Drawings or directed by the Engineer.
2. Harness rods shall be manufactured in accordance with ASTM A36 and shall have an allowable tensile stress of no less than 22,000 psi. Harness rods shall be hot dip galvanized or field coated with bitumastic before backfilling.
3. Where possible, harness rods shall be installed through the mechanical joint bolt holes. Where it is not possible, provide 90 degree bend eye bolts.
4. Eye bolts shall be of the same diameter as specified in ANSI/AWWA C111/A21.11 for that pipe size. The eye shall be welded closed. Where eye bolts are used in conjunction with harness rods, an appropriate size washer shall be utilized with a nut on each end of the harness rod. Eye bolts shall be of the same material and coating as the harness rods.

D. Thrust Collars: Collars shall be constructed as shown on the Drawings.

E. Concrete Blocking

1. Provide concrete blocking for all bends, tees, valves, and other points where thrust may develop, except where other exclusive means of thrust restraint are specifically shown on the Drawings.

2. Concrete shall be as specified in Section 03300, Cast-in-Place Concrete.
3. Form and pour concrete blocking at fittings as shown on the Drawings and as directed by the Engineer. Pour blocking against undisturbed earth. Increase dimensions when required by over excavation.

3.3 SURFACE PREPARATION AND SHOP PAINTING

A. All exposed, ferrous piping not specified to be galvanized or otherwise coated shall be cleaned and shop primed or coated in accordance with the requirements of Section 09900, Painting.

B. (Not Used)

3.4 FIELD PAINTING

A. Following installation and testing, all exposed piping, including insulated piping, shall be field primed and painted in accordance with the requirements of Section 09900, Painting. Stainless steel fittings shall not be painted.

B. (Not Used)

3.5 PIPING IDENTIFICATION

A. Piping Systems. Identification of piping systems shall conform to ANSI A13.1, Scheme for the Identification of Piping Systems, unless otherwise specified herein.

B. Process Piping Code. All exposed pipe shall be identified by color and labeling to show its function. Stencil-painted labels and arrows showing the direction of flow shall be installed every 20 feet or each change of direction at each valve, and on each side of wall penetrations. Piping which is not painted shall be provided with 6-inch-wide color bands as specified. Color bands of an approved tape may be used on PVC, FRP and stainless steel pipe and other pipe which does not readily accept painted finish. The color, banding and labeling shall conform to the schedule in Section 09900, Painting.

C. Process Valve Identification. After the painting of process piping is complete, the Contractor shall stencil the tag numbers of all valves numbered on the Process and Instrumentation Drawings, on the pipe adjacent to the valve for pipe 2 inches and over. Characters shall be 2 inches high minimum and shall be oriented to be visible from the valve operating position. When the valve has extended operator shaft or chain operator, the number shall be placed at both the operating position and at the valve, if practicable; this requirement does not apply if the valve is buried or in a pit. Valves in pipes under 2 inches shall have characters as large as the pipe will permit or at the Engineer's option on an adjacent surface. Characters shall be preferably white; however, if this would not provide sufficient contrast to the pipe, the Engineer may select another color. Paint used shall be of the same type and quality as that used for painting the pipe.

3.6 INSPECTION AND TESTING

A. All sections of the water main shall be hydrostatically pressure tested in accordance with AWWA C600 and these Specifications. A section of main will be considered ready for testing after completion of all thrust restraint and backfilling.

B. Water used for flushing and testing mains and other construction purposes will be made available to the Contractor as specified in Section 01040.

C. Each segment of water main between main valves shall be tested individually.

D. Test Preparation

1. For water mains less than 24-inches in diameter, flush sections thoroughly at flow velocities, greater than 2.5 feet per second, adequate to remove debris from pipe and valve seats. For water mains 24-inches in diameter and larger, the main shall be carefully swept clean, and mopped if directed by the Engineer. Partially open valves to allow the water to flush the valve seat.

2. Partially operate valves and hydrants to clean out seats.

3. Provide temporary blocking, bulkheads, flanges and plugs as necessary, to assure all new pipe, valves and appurtenances will be pressure tested.

4. Before applying test pressure, air shall be completely expelled from the pipeline and all appurtenances. Insert corporation stops at high points to expel air as main is filled with water as necessary to supplement automatic air valves. Corporation stops shall be constructed with a meter box as shown on the Drawings.

5. Fill pipeline slowly with water. Provide a suitable pump with an accurate water meter to pump the line to the specified pressure.

6. The differential pressure across a valve or hydrant shall equal the maximum possible, but not exceed the rated working pressure. Where necessary, provide temporary backpressure to meet the differential pressure restrictions.

7. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure.

E. Test Pressure: Test the pipeline at 250 psi measured at the lowest point for at least two hours. Maintain the test pressure within 5 psi of the specified test pressure for the test duration. Should the pressure drop more than 5 psi at any time during the test period, the pressure shall be restored to the specified test pressure. Provide an accurate pressure gauge with graduation not greater than 5 psi.

F. Testing Allowance

1. Testing allowance shall be defined as the sum of the maximum quantity of makeup water that must be added into the pipeline undergoing hydrostatic pressure testing, or any valved section, in order to maintain pressure within 5 psi of the specified test pressure for the test duration plus water required to return line to test pressure at the end of the test. Leakage shall be the total cumulative amount measured on a water meter.

2. The Owner assumes no responsibility for leakage occurring through existing valves.

G. Test Results: No installed pipe shall be accepted if the quantity of makeup water exceeds the limits determined by the following formula:

$$L = \frac{SD\,(P)^{1/2}}{}$$

148,000

Where:
L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

As determined under Section 5 of ANSI/AWWA C600.

H. If the water main section being tested contains lengths of various pipe diameters, the allowable leakage shall be the sum of the computed leakage for each diameter. The leakage test shall be repeated until the test section is accepted. All visible leaks shall be repaired regardless of leakage test results.

I. After a pipeline section has been accepted, relieve test pressure. Record type, size and location of all outlets on record drawings.

J. At the conclusion of the work, the Contractor shall thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stone, pieces of wood or other material which may have entered the pipeline during the construction period.

K. The Contractor shall be responsible for legal disposal of all water used for flushing and testing.

+ + + END OF SECTION 02665 + + +

SECTION 02667
STEEL PIPE

PART I GENERAL
1.01 SCOPE

A. The Work included under this section includes providing all labor, materials, equipment, tools, and incidentals required for replacement of the 78" pipe at the raw water intake and replacement of portions of the existing steel pipe near the flow control valve near Chattahoochee WTP. Work also includes hydraulic testing of the completed-piping after installation.

B. The Contractor shall be responsible for the detailed design, installation, and commissioning of the pipe sections shown on the Drawings. These Specifications together with the Contract Drawings form the basis for the minimum performance requirements of the water transmission mains and accessories. In the event of a conflict the most stringent requirement shall apply.

C. No separate payment shall be made to the Contractor for the cost of design or the submittal of design calculations.

1.02 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the general standards listed below and other ANSI, ASTM and AWWA specifications referenced herein. The standards are referenced in the Specification and are applicable as noted in this document. Reference standards specific to each piping material are included in paragraphs 1.02.B, C, D and E below. Exceptions shall be shown on the Drawings or detailed in this Section.

1. General Standards

    a. American Society of Non-Destructive Testing: SNT-TC-1A - Personnel Qualification and Certification of Non-Destructive Testing.

    b. ASTM International (ASTM):

        1) C150 - Standard Specification for Portland Cement.

        2) E329 - Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

        3) G62 - Test Methods for Holiday Detection in Pipeline Coatings

    c. American Water Works Association (AWWA): AWWA C651 - Disinfecting Water Mains.

    d. Steel Structures Painting Council: SSPC-SP6 – Commercial Blast Cleaning

    e. Georgia Department of Transportation (GDOT): Standard Specifications for Construction of Transportation Systems

2. (Not Used)

B. Pipe Manufacturer (General)

1. Pipe manufacturer shall be experienced in manufacturing pipe and fittings of required diameters, lengths and individual materials and wall thicknesses required for the project.
2. Pipe manufacturer shall demonstrate current production capability for volume of Work required.
3. Manufacturer's experience shall include successful manufacturing of pipe to the referenced AWWA standards for a period of at least five (5) years at the proposed manufacturing facility.
4. Not used
5. Manufacturers of steel pipe shall be required to meet one the following requirements: Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification or ISO 9001:2000 Certification.

C. Steel Pipe

1. Reference Standards: Comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.
   a. American Society of Mechanical Engineers (ASME):
      1) B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
      2) B36.10M - Welded and Seamless Wrought Steel Pipe.
      3) BPVC SEC V - Nondestructive Examination.
      4) BPVC SEC VIII, Div. 1, Rules for Construction of Pressure Vessels.
      5) BPVC SEC IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. American Water Works Association (AWWA):
      1) C200 - Steel Water Pipe - 6 in. (150 mm) and Larger.
      2) C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger-Shop Applied.
      3) C206 - Field Welding of Steel Water Pipe.
      4) C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm).
      5) C208 - Dimensions for Fabricated Steel Water Pipe Fittings.
      6) C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
      7) C210 - Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

8) C213 - Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
9) C214 - Tape Coating Systems for the Exterior of Steel Water Pipelines.
10) C215 - Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines.
11) C216 - Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
12) C217 - Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections, and Fittings for Steel Water Pipelines.
13) C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
14) C221 - Fabricated Steel Mechanical Slip-Type Expansion Joints.
15) C222 - Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
16) C602 - Cement-Mortar Lining of Water Pipelines in Place – 4 in. (100 mm) and Larger.
17) Manual M11, Steel Pipe - A Guide for Design and Installation.

c. American Welding Society (AWS):
1) A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2) A3.0 - Standard Welding Terms and Definitions.
3) B2.1 – Specification for Welding Procedure and Performance Qualification
4) D1.1 - Structural Welding Code – Steel.
5) QC 1 - Standard for AWS Certification of Welding Inspectors.

d. ASTM International (ASTM):
1) A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
2) A1018/A1018M - Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils Hot Rolled, Carbon, Structural, High-Strength and Low-Alloy, Columbium or Vanadium and High-Strength Low-Alloy with Improved Formability.

e. International Institute of Welding (IIW).

f. International Organization for Standardization (ISO): ISO 9001:2000, Quality Management Systems—Requirements

g. NSF International (NSF):
1) 60 - Drinking Water Treatment Chemicals - Health Effects.
2) 61 - Drinking Water System Components - Health Effects.

h. Steel Pipe Fabricators Association (SPFA).

2. Certified Welding Inspector (CWI) for Shop and Field Welding
   a. In accordance with AWWA C200 for Shop and AWWA C206 for Field.
   b. In accordance with AWS QC 1, with knowledge of appropriate welding code for the Work.
   c. After receiving CWI qualification, CWI shall have at least 5 years of professional experience related to welding inspection similar to the Work.
   d. Responsibilities in addition to AWWA C200 and AWWA C206 shall include:
      1) Verify conformance to use of specified materials and their proper storage.
      2) Monitor conformance to approved Welding Procedure Specification (WPS).
      3) Monitor conformance to approved Nondestructive Testing (NDT) procedure specifications.
      4) Monitor conformance of Welder/Welding Operator Performance Qualification (WPQ).
      5) Provide 100 percent visual inspection before, during, and after shop and field welding.
      6) Supervise NDT personnel and evaluate test results.
      7) Maintain records and prepare report confirming results of inspection and testing.
3. Nondestructive Quality Control Personnel
   a. In accordance with requirements of Recommended Practice No. SNT-TC-1A, Level II.
   b. After receiving Nondestructive Testing (NDT) qualification, NDT personnel shall have at least 5 years of professional experience related to NDT inspection similar to the Work.

1.03 DESIGN REQUIREMENTS

A. Contractor Design Responsibilities: The Contractor shall have design responsibilities (via the pipe manufacturer) for the pipeline materials provided under these Specifications. These design responsibilities shall include:

1. Design pipe barrel according to the requirements detailed in these Specifications and meeting the installed conditions shown on the Drawings. The Contractor shall account for all loadings in the calculations. Criteria for calculations shall include internal pressure, external loadings, buoyancy due to groundwater conditions, soil drag forces, deflections during handling, thermal stresses, thrust forces and trench conditions.
2. Design pipeline appurtenances and fittings (using the criteria above) at locations shown on the Drawings. Criteria shall also include pipe in casings and tunnels, buried crossings, vaults, air release valves, manholes, valve bypass piping and blow-offs.

3. Design thrust restraint according to the requirements detailed in these Specifications and the field conditions shown on the Drawings. Thrust blocking will not be allowed and all restraint shall be provided by tied pipe joints, unless otherwise shown on the Drawings.
4. Development of the pipe laying plan. The Contractor shall verify that the alignment can be achieved by the provision of pipe fittings and allowable deflections and shall submit a detailed pipe schedule or lay-down drawings for review.
5. In the case of a conflict between the installed conditions shown on the Drawing and the performance requirements of these Specifications, the more stringent design criteria shall apply.

B. Service Conditions: Minimum design and material requirements for nominal pipe diameter of 64-inches are provided in these Specifications. Even where pipe class or wall thickness is indicated, the Contractor shall design piping systems based on the factors specified in the design requirements. The following service conditions apply to all pipe materials in these specifications. Parameters that are specific to individual pipe materials are specified in paragraphs 2.01.A, 2.02.A, and 2.03A of this Section.

	RIPS
Service Life (years)	100
Working Pressure (psi):	54
Surge Pressure (psi - above working):	81
Pressure Class (psi):	100
Hydrostatic Field Testing (psi):	100
Vacuum Condition (psi):	-14.7
Max. Field Welded Joint Installation Temp. (F):	80
Minimum Water/Service Temp.(F):	40
Thermal Loading (Delta T):	40
Minimum Depth of Cover:	4-feet 6-inches Unless shown otherwise on the Drawings
Traffic Loading Condition:	HS 20
Max. Modulus of Soil Reaction:	100 psi
Construction Traffic Loading:	None

C. Thrust Restraint Design:

1. Thrust restraint calculations shall be performed for all fittings, tees, valves, and dead ends.
2. Wall penetrations at valve vaults and junction boxes shall be restrained by the use of wall pipes.
3. The Contractor shall use the dead end assumption at both sides of valves.

4. Where shown on Drawings, valve vaults and junction boxes shall account for the thrust of the vault/box bearing on the surrounding soil in the thrust restraint calculations.
5. The Contractor shall consider high groundwater conditions in the thrust calculations for creek crossings, wetlands, floodplain, low points in the alignment and adjacent to the Chattahoochee River and any additional areas identified on the Drawings.
6. No lateral resistance from the bearing resistance of soil shall be used when calculating restrained lengths.
7. Calculations for the coefficient of friction between the pipe wall and the pipe bedding material shall be submitted for review by the Engineer.
8. The following criteria shall be applied in the development of restrained joint lengths:

   Safety Factor on Thrust Restraint Calculated length: 1.5

Thrust Load for Fittings:	By AWWA M11 (Eqn. 13-4)
Required Restraint Length:	By AWWA M11 (Eqn. 13-6)
Maximum Soil Bearing Capacity for Thrust:	Not Allowed
Min. Thrust Force for All Restrained Pipe:	250 psi x pipe area
Max. Soil Friction Angle:	30 degrees
Max. Allowable Soil Weight for Calculations:	120 lbs./cu. ft

   Soil Drag:
   By design grade.

   Groundwater Table:
   Design for conditions provided in the geotechnical report, if available.

   Coefficient of Friction for Pipe / Soil Interaction:
   Submit for review with references.

D. Strength of Restrained Joints: The Contractor (via the pipe supplier) shall submit to the Engineer for review loadings, allowable stresses, and proof test of design test data for restrained joints. These requirements shall apply to all pipe materials.
   1. Loading Calculations
      a. Structural Load Path: Submit free body diagrams for each type of joint showing the path of load transmission from one pipe to another via a restrained joint and identify each component in the load path.
      b. Loads: Submit calculations of axial loading cases (Thermal and thrust loads are not additive, greatest loading case shall govern pipe and joint design), including:
         1) Thermal + Poisson (at test pressure) + Soil Drag Loading: Welded joints shall be designed to resist thermal forces for a temperature change of 40 degrees F. Mechanically restrained gasketed joints may be considered as not transmitting thermal or Poisson load from one pipe to another.

2) Thrust (PA) + Soil Drag Loading: All restrained joints shall be designed to resist forces resulting from the field test pressure (Pt) across the cross sectional area of the pipe.

2. Allowable Stress Calculations: Submit calculations for allowable stresses and verify that the loading conditions can be met by the manufacturer's design:

   a. Pipe Barrel: Allowable stress in the pipe barrel shall be no greater than 0.5 times the yield strength of the pipe barrel material for working pressure plus surge pressure.

   b. Single Fillet Welded Field Joints: Allowable stress in single fillet welded joints shall meet the requirements of the following welding codes:

      1) AWS D1.1 for steel sheet materials 1/8-inch thickness and greater

      2) ASME BPVC SEC VIII, Div. 1

   a. Double Fillet Welded Field Joints: Allowable stress in fillet double welded joints shall meet the requirements of the following welding codes:

      1) AWS D1.1 for steel sheet materials 1/8-inch thickness and greater

      2) ASME BPVC SEC VIII, Div. 1

3. Proof of Design Testing

   b. Required Tests: Proof of Design Tests (or previously performed Proof of Design Tests that were witnessed and certified by an independent testing laboratory) shall be required for each restrained joint configuration for each diameter of pipe to be supplied for under these Specifications.

   c. Test Conditions:

      1) Restrained joints shall be proof tested to at least 100 psig.

      2) During the test, the pipe sections joined by the restrained joints shall be otherwise unanchored longitudinally, and free to move in the axial direction.

E. Pipe Trench and Bedding: The pipe bedding condition and trench construction shall be considered part of the piping design. All pipe trench work, bedding, and backfill (regardless of pipe material) shall be as follows:

1. Trench Stabilization: If soft sub-grade conditions are encountered, the Contractor shall stabilize the trench below the pipe zone with well-graded clean gravel or crushed rock, compacted in 6-inch lifts.

2. Pipe Zone: The pipe shall be bedded in Group 1 graded aggregate material in accordance with GDOT Section 815.2.01, with at least 12% of material by weight passing a 200-sieve. Place pipe on a minimum of 8 inches compacted pipe zone material, as measured below the widest part of the pipe joint. Pipe zone material shall be consolidated to 12 inches above the top of pipe (after removal of trench boxes) and compacted to 95% Standard Proctor. Pipe zone material shall be compacted to 95% of theoretical dry density as determined by GDOT test method GDT 7 and tested once per day. If material fails the GDT 7 test, the Contractor shall test pipe zone material

for the previous day's work in 100 linear foot increments and replace material which does not meet the Specification.

3. Protection of Coatings: The Contractor shall protect pipe coatings from damage during the installation of pipe zone material.
4. Trench Backfill: Fill above the pipe zone shall be pipe zone Material or Class 1 roadway foundation backfill material conforming GDOT Section 812.2.01, with at least 12% of material by weight passing a 200-sieve. Trench backfill execution shall be according to GDOT Section 207 – EXCAVATION AND BACKFILL FOR MINOR STRUCTURES. Backfill shall be compacted to 95% of theoretical dry density as determined by GDOT test method GDT 7 and tested once per day. If material fails the GDT 7 test, the Contractor shall test trench backfill material for the previous day's work in 100 linear foot increments and replace material which does not meet the Specification.
5. Trench Width: All trenches shall have vertical walls. The minimum width of the trench shall be equal to the outside diameter plus 24-inches or as needed to obtain proper compaction of pipe zone material around haunches of pipe. The maximum width of trench shall be equal to the outside diameter plus 64-inches. These trench requirements are to be maintained throughout the project and can only be modified with the specific approval of the Engineer.
6. Not used.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. All submittals shall be delivered in both hard copy and electronic format (such as *.PDF or *.DWG files) and shall be titled with the date, description, and version of the submittal. In addition, the following specific information shall be provided for all materials:

1. Complete product data and engineering data, including shop drawings.
    a. Pipe barrel, fitting, specials and thrust design calculations for all load combinations. Submit thrust calculations for all pipe restraint lengths, as well as joint strength calculations. Design calculations shall be signed and sealed by a Registered Professional Engineer licensed to practice in the State of Georgia. Further details of material specific submittals are included in paragraphs.2.01.B, 2.02.B, and 2.03.B of this Section. All pipe design services shall be performed by the pipe manufacturer.
    b. All variables, assumptions, and design criteria shall be clearly defined in pipe barrel, fitting, specials, and thrust design calculations. All materials manufacturing tolerances that are allowed by underlying standards shall be explicitly disclosed and included into all design calculations. Missing definitions will be cause for rejection of the submittal.
2. Evidence that the manufacturer has successfully manufactured pipe to the specific AWWA standard submitted for a period of at least five (5) years at the proposed

manufacturing facility. In lieu of the minimum experience requirement, the Contractor shall submit an action plan that conforms to paragraph 1.02.B of this Section.

3. Written vendor certifications to the Engineer that all products furnished comply with all applicable requirements of these Specifications.
4. Manufacturer's instructions on transportation, handling and storage.
5. Information on coatings, linings, and base materials. Special requirements for protection of weathering and UV damage shall also be provided.
6. Test documentation forms and results for factory and field testing.

B. Warranties

1. Manufacturer shall certify (for the project specified herein regardless of any previous submittals) that design, materials, and required installation practices will result in finished system with a 100-year service life.
2. The Contractor shall transfer to the Owner the following notarized warranties at the end of construction period:
   a. One (1) year warranty on correction to defects.
   b. Two (2) year warranty on labor, workmanship and materials.
   c. Warranty periods shall begin following completion of the project and receipt of final payment.

C. Field Hydrostatic Testing Plan

1. Submit at least 15 days prior to testing and at a minimum, include the following:
   a. Testing dates
   b. Piping systems and section(s) to be tested
   c. Method of isolation
   d. Method of conveying water from source to system being tested
   e. Calculation of maximum allowable leakage for piping section(s) to be tested
2. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new in a manufacturer sealed package, no certificate is required.

D. Not used.

E. Marking Plan and Laying Schedule

1. Marking plan and details for entire pipeline section showing dimensions, pipe joints, fittings and special fitting pressure rating and thickness, size, coating and lining data and other pertinent information.
2. The laying schedule shall be prepared based on the contract drawings and shall show the direction of pipe laying, pipe class, stations, elevations, fittings, and all elements.

3. The submittals shall also include drawings of fitting combinations, specials, ties at wall penetrations, blow-off outlets, air vents, and valve connections.
4. The above shall be submitted to the Engineer for approval before manufacture and shipment. The location of all pipes shall conform to the locations shown on the Drawings except for resolution of identified utility conflicts.

1.05 TRANSPORTATION, HANDLING, AND STORAGE

A. General Instructions

1. The Contractor shall furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings, valves, and accessories. The Contractor shall make equipment available at all times for use in unloading. The Contractor shall not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification.
2. The Contractor shall handle pipe, fittings, valves, and accessories carefully to prevent shock or damage. The Contractor shall handle pipe by forklift or front end loader. The Contractor shall not use material damaged in handling. Special care shall be taken to protect exterior coatings, including shading to protect coatings that may be damaged by the sun. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior coatings or internal lining of the pipe.

B. Steel Pipe

1. Pipe Marking:
    a. Legibly mark installation sequence number on pipe, fittings, and specials in accordance with piping layout.
    b. Special pipe sections, fittings and compound bends shall be marked at each end with notation “TOP FIELD CENTERLINE” in accordance with AWWA C208 so end rotations can be easily oriented in field.
2. Delivery:
    a. Securely bulkhead or otherwise seal ends of pipe, specials, and fittings prior to loading at the manufacturing site.
    b. Pipe ends shall remain sealed until installation.
    c. Damage to pipe, fittings, or specials, including linings and coatings, found upon delivery to the project site shall be repaired to Engineer’s satisfaction and applicable AWWA standards, or removed from site and replaced.
3. Storage:
    a. Support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
    b. Support on sand or earth berms free of rock exceeding 3 inches in diameter.
    c. Storage practices shall be modified as required to achieve installation pipe temperature per paragraph 3.02.C.6 of this Section.

PART 2 PRODUCTS
2.01 STEEL PIPE AND FITTINGS

A. Design Requirements: Design AWWA C200 piping in accordance with AWWA M11 and AWWA C208 with exceptions as noted in this Section. Performance criteria are as shown on the Drawings, in paragraph 1.03 of this Section, and as supplemented by the following:

1. Unrestrained Joint: Rubber Gasket Carnegie Bell and Spigot or Rolled Groove Joint
2. Field Installed Restrained Joint: Welded Lap Joints
3. Settlement Joint at Valve Vaults: Bolted Sleeve-Style Coupling with Joint Harness
4. Minimum Yield Strength of Steel: 36,000 psi
5. Minimum Tensile Strength of Steel: 53,000 psi
6. Maximum Allowable Hoop Stress at Surge Pressure (300 psig): Less than or equal to 0.5 times Yield Strength or 0.35 times Tensile Strength (whichever ever is less)
7. Maximum Allowable Longitudinal Stresses for restrained pipes (except for thermal stress) shall be allowable hoop stresses multiplied by a Joint Efficiency Factor, 0.60 for Double Welded Lap Joints, and 0.50 for Single Welded Lap Joints.
8. Thermal Stress: The sum of forces Thermal + Poisson + Soil Drag, where thermal stress is the majority component, shall be limited by 75% of steel yield strength and the joint efficiency reductions required above.
9. Allowable Vertical Deflection: 3% of pipe diameter
10. Interior Mortar Lining Thickness: 0.50-inch

B. 78” Steel Pipe Coupling:

1. Coupling shall be AWWA C219 rated, Victaulic Style 230 Bolted Split Sleeve Coupling System, or equal.
2. Gaskets shall be EPDM.
3. Hardware shall be Zinc Plated Carbon Steel.
4. Coupling shall be Fusion Bonded Epoxy Coated, Corvel 10-7208 or equal

C. 42” and 60” Steel Pipe Couplings:

1. Couplings shall be AWWA C219 rated, Victaulic Style 232 Restrained Bolted Split Sleeve Coupling System, Type 3, or equal.
2. Gaskets shall be EPDM.
3. Hardware shall be Zinc Plated Carbon Steel.
4. Coupling shall be Fusion Bonded Epoxy Coated, Corvel 10-7208 or equal.
5. Coupling system shall include restraint rings to be welded to the pipe exterior at the connection points allowing the coupling housing to straddle the restraint rings and engage

the joint, providing thrust restraint. Contractor to coordinate as needed to ensure the rings are provided and installed properly as part of the complete coupling system

D. Submittals: In addition to the submittals required in paragraph 1.02 of this Section, the following submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1. Design: Pipe material design calculations shall be submitted based upon the manufacturing or installation tolerance limit which represents the maximum loading (or minimum material strength) condition. Detailed calculations shall be according to AWWA M11and shall include the following:
    a. Determination of pipe wall thickness to resist of external loads
    b. Determination of pipe wall thickness to resist internal loads
    c. The greater of a) or b) above shall govern design
    d. Barlow Formula for wall thickness for internal pressure
    e. Spangler Formula for pipe wall thickness determination for buried pipe deflection
    f. Minimum Handling Formula for pipe wall thickness determination
    g. Soil Buckling Formula for pipe wall thickness determination
    h. Mitered Bend formula for wall thickness determination
2. Fabrication Details: The following submittals shall be required in addition to the strength design calculations:
    a. Material list and steel reinforcement schedules for materials specified.
    b. Design calculations for fittings and specials including opening reinforcement details of collars, wrappers, and crotch plates.
    c. Pipe and fitting details for temporary and permanent facilities indicating:
        1) Cylinder thickness.
        2) Manufacturing tolerances.
        3) Maximum angular deflection limitations of field joints.
        4) Closure sections and cutoffs for field length adjustment.
        5) Bulkheads, including details for removal of test bulkheads and repair of lining.
        6) Weld lead outlets and plugs.
        7) Stulling size, spacing, and layout.
    d. Welded joint details including:
        1) Butt joints.
        2) Miter ends cuts for alignment conformance.

3) Lap joints.

4) Deep bell lap joints required for control of temperature stresses.

5) Butt strap joints.

e. Temperature Control Procedure for Welded Steel Pipeline Segment: Submit procedure for a typical restrained pipeline segment that includes methods that will be utilized to achieve the maximum temperature installation limit for temperature control joints. The Procedure may include, but not limited to:

1) Detailed temperature measurement protocol and device data sheet

2) Storage yard, trench, or pipe shading

3) Water application

4) Backfill sequencing and backfill amendments

5) Contingency measures for pipe that does not cool as anticipated

6) Traffic management around open temperature control joint trench

7) Example time and event sequence of temperature control measures, such as measures employed during shipment, storage, placement, welding, backfill, etc.

f. Welding Data (Shop and Field Welding):

1) Show on a weld map complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for Welding Procedure Specification (WPS) and Nondestructive Examination (NDE) numbers in tail of welding symbol.

2) Distinguish between shop and field welds.

3) Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for all welds.

4) For pipe fittings, provide a joint weld beveling diagram. Refer to AWS D1.1, Annex G Local Dihedral Angle that can be used to calculate bevels for weld joint details of intersecting pipes.

5) Welding and NDE symbols shall be in accordance with AWS A2.4.

6) Welding terms and definitions shall be in accordance with AWS A3.0.

g. Product Data for the following:

1) Pipe Material Data: Includes chemical and physical test reports showing data consistent with specified requirements for each heat of steel proposed for use.

2) Coatings and Linings: Includes technical data sheets itemizing technical and performance information that indicates compliance with this Specification. Include manufacturer’s name, product number or trade name, and thickness.

3) Rubber Gasket Joint: Include details with dimensions, fabrication tolerances for both bell and spigot ends, material of construction, and performance history with test data.

h. Certificates:

1) Manufacturer's Certificate of Compliance that products furnished meet requirements of this Specification.

2) Lining Materials: Certificate that lining system is currently approved for potable water contact in accordance with NSF 61 and satisfies current applicable governmental health and safety requirements for use in potable water.

i. Pipe Manufacturer's written Quality Assurance/Control Plan.

j. Statements of Qualification:

1) Pipe manufacturer.

2) Evidence of Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9001:2000 Certification

3) Fittings and specials fabricator.

4) Welders or Welding Operators:

a) Name of welder.

b) Welding procedures/positions for which welder is qualified to weld.

c) Assigned certification stamp number.

d) Certification date.

e) Current certification status.

k. Certified Welding Inspector.

l. Non Destructive Test Quality Control Personnel.

m. Procedures for Shop and Field Welding: At a minimum include a complete welding code paper trail with linkage to Shop Drawings that includes the following:

1) Written Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR).

a) Provide complete joint dimensions and details showing bevels, groove angles, root face, and root openings for all welds.

b) Notch-tough welding shall be required for pipe greater than 0.375-inch thickness. For shop welding, address supplementary essential variables in addition to essential variables as indicated in ASME Section IX, QW-251.2. For field welding, heat-input, control PQR essential variables as indicated in AWS D1.1 shall be included. For shop and field welding, provide heat-input table on WPSs for welder guidance.

c) PQRs for notch-tough welding shall document heat-input control by monitoring volts, amps, and travel speed or time-rate of change of weld metal volume as calculated by measuring change in electrode length over a period of time. Charpy V-notch tests shall be conducted on weld metal and heat affected zone. Test coupons shall be oriented transverse to final direction of rolling. Full size Charpy specimen test acceptance shall be same as base metal specified herein. In all size materials, use the largest Charpy feasible. If metal thickness not adequate for full size Charpy specimen, reduced section Charpy specimen test will be acceptable if scaled linear with size.

2) Written Nondestructive Testing (NDT) procedures.

3) Current Welder/Welding Operator Performance Qualification (WPQ).

4) Written description of proposed sequencing of events or special techniques such as:

a) Controlling pipe wall temperature stress during installation.

b) Minimizing distortion of steel.

c) Shop-Applied Cement-Mortar Lining: Include description of machine to be used and list of similar projects where machine was used. Identify pipe size and total footage.

d) Monitoring pipeline temperatures during installation.

n. Written weld repair procedures for the Work.

o. Field coating application and repair.

p. Field lining application and repair.

q. Written consumable control procedure for welding materials demonstrating:

1) How consumables will be stored to comply with manufacturer's written instructions.

2) How consumables will be dried in ovens prior to use.

3) How consumables which become wet will be reconditioned.

3. Reports:

a. Source Quality Control Test Reports:

1) Hydrostatic testing.

2) Destructive weld testing.

3) Nondestructive weld testing.

4) Steel impact testing using Charpy V-notch method.

5) Coating and lining factory Site visit letter by qualified manufacturer's technical representative.

b. Coating and lining: Site visit letter by qualified technical representative. Applicator's quality control records, including environmental conditions, dry film thickness, and adhesion tests, when requested by Engineer.

c. Cement-mortar lining compressive strength tests in accordance with AWWA C205.

d. Cement-mortar coating absorption tests in accordance with AWWA C205.

4. Manufacturer's Certificate of Compliance, in accordance with Manufacturer's Field Services, stating that inspections and specified tests have been made and that results thereby comply with requirements of Article Source Quality Control.

E. Pipe: Pipe shall conform to requirements of AWWA C200 and shall be as supplied by American Steel Pipe (ACIPCO), Northwest Pipe Company, or proven equal.

1. Minimum Elongation in 2-inch Gauge Length: 21%

2. Weldability: Maximum carbon equivalent of 0.45, as measured using AWS D1.1/D1.1M, Annex XI , Guideline on Alternative Methods for Determining Preheat formula: CE=C+((Mn+Si)/6))+(Cr+Mo+V)/5+(Ni+Cu)/15

3. Pipe shall be pressure vessel quality as follows:

a. Coils:

1) Continuous cast process, fully-killed, fine grained practice conforming to physical, manufacturing, and testing requirements ASTM A1018/A1018M, SS.

2) Grades of steel for coils shall be:

a) A1018, SS Grade 36, Type 1

b) A1018, SS Grade 36, Type 2

c) A1018, SS Grade 40

3) Steel chemistry shall be:

a) Carbon: 0.20 percent maximum

b) Manganese: 1.35 percent maximum

c) Aluminum: 0.020 percent minimum

d) Phosphorus: 0.025 percent maximum

e) Sulfur: 0.015 percent maximum

b. Plate:

1) Plate shall conform to ASTM A20, fine-grained practice conforming to physical, manufacturing, and testing requirements of ASTM A516/A516M, Grade 70.

2) Steel Chemistry shall conform to ASTM A516/A516M, Grade 70. Steel plates that are 0.75 inch thick or greater shall be normalized.

c. Charpy V-notch Acceptance Criteria: Transverse specimen orientation, full size specimens, 25-foot pounds energy at test temperature of 30 degrees F test outside diameter wrap of two coils minimum per heat load.

4. Steel pipe wall thickness determined by requirements of this Specification shall be net of any allowable negative manufacturing or material tolerances.
5. Minimum steel cylinder wall thickness shall be the greater of:
   a. 0.1875-inches
   b. Outer Diameter / 200
   c. The thickness required by structural design calculations specified in this Section.

F. Pipe and Fitting Linings:
1. General:
   a. Notify Engineer at least 3 days prior to application of lining products
   b. Holdback of lining from field welded joints shall be 8-inches from lap-welded and gasketed joints.
   c. Cement for mortar lining shall meet NSF 61.
2. Shop Applied Cement-Mortar Lining:
   a. Lining shall be applied centrifugally in conformance with AWWA C205. Thickness shall be 0.5-inches.
   b. Lining machine shall be type that has been used successfully for similar work and approved by Engineer.
   c. Maintain pipe in round condition during lining operation and thereafter by suitable bracing or strutting.
   d. Provide polyethylene or other suitable bulkhead on ends of pipe and on special openings to prevent drying out of lining. Bulkheads shall be substantial enough to remain intact during shipping and storage until pipe is installed.
   e. Pipe shall be left bare where field joints occur.
   f. Ends of lining shall be left square and uniform. Feathered or uneven edges will not be permitted.
3. Field-Applied Cement-Mortar Lining;
   a. Hand-applied mortar shall be used at the interior of all pipe joints.
   b. Materials shall conform to AWWA C602.
   c. Do not use pozzolanic material in mortar mix.
   d. Admixtures shall contain no calcium chloride.

G. Pipe and Fitting Coatings:
1. General:

a. Notify Engineer at least 3 days prior to application of coating products.

b. Holdback of coating from field-welded joints shall be 3-inches from lap-welded and gasketed joints.

c. Furnish inspection devices that are calibrated and in good working condition for detection of holidays and measurement of coating film thickness and adhesion testing.

d. Unless otherwise indicated, coat exterior surfaces of pipe and fittings passing through structure walls from center of wall or from wall flange to end of underground portion.

2. Tape Coating:

a. Coating system for straight pipe shall conform to AWWA C214:

1) Primer layer.

2) Filler tape for irregular surfaces and welded joints, extruded butyl rubber compound compatible with primer and tape.

3) Weld stripping tape, if required (25 mils).

4) Inner layer, corrosion protection tape (20 mils).

5) Middle layer, mechanical protection tape (30 mils).

6) Outer layer, mechanical protection tape (30 mils) with ultraviolet light stabilizers.

7) Total system thickness shall be 72 mils minimum, 80 mils nominal, not including filler tape or weld stripping tape.

8) System shall be supplied by single manufacturer.

9) Perform following to reduce potential for development of voids under tape coating at weld seams:

a) Prior to application of tape coating system, grind welds smooth within 18 inches of pipe end, in accordance with AWWA C214.

b) Weld Strip Tape:

i. 4-inches wide, minimum, and 25-mils thick

ii. Coat weld seams with weld strip tape prior to application of inner wrap.

iii. Center weld strip tape over seam.

iv. Apply pressure to strip tape with multiple-pressure roller to ensure adhesion to pipe surface.

v. Product: Polyken 933 or Tek-Rap 280

c) Inner wrap and outer wrap shall be applied using neck-down amount recommended by tape manufacturer to conform tape to weld seam.

10) Abrasive blasting, priming, and inner tape application shall be done during same working day for each pipe section.

11) Successful application and service history on pipe fabricated in accordance with AWWA C200.

b. Coating system for fittings and specials shall conform to AWWA C209. System shall consist of primer and two layers of wrap. Outer wrap shall be white. The materials shall be as follows:

1) Primer layer.

2) Filler tape for irregular surfaces and welded joints, extruded butyl rubber compound, Type II per AWWA C209, compatible with primer and tape.

3) Inner layer, corrosion protection tape (50 mils).

4) Outer layer, mechanical and ultraviolet light protection tape (30 mils).

5) Total system thickness shall be at least 80 mils not including filler tape.

6) Supplied by same manufacturer as for straight pipe materials.

c. Coating system for field-welded joints shall be tape coating conforming to AWWA C209 or heat shrink sleeves per AWWA C216. Tape thickness shall be 80 mils, nominal.

H. Fittings:

1. Fabrication:

a. Fittings shall be shop fabricated. No field fabrication will be allowed, unless approved by the Engineer.

b. Fittings shall be fabricated from materials or straight pipe in full conformance with requirements of these Contract Documents and dimensions of AWWA C208, unless otherwise indicated.

2. Crotch Plate: Fabricate from fine grain, pressure vessel steel conforming to ASTM A516/A516M, Grade 70, and as follows:

a. Plates shall be normalized.

b. Sulfur content shall not exceed 0.005 percent. Carbon shall not exceed 0.20 percent. Manganese shall not exceed 1.20 percent.

c. Charpy V-notch tests in direction transverse to final rolling shall be performed per ASTM A370 on full size specimens of coupons taken from each plate. Acceptance shall be 25 foot-pounds at 30 degrees F

d. Carbon equivalent shall not exceed 0.45 percent.

3. Wall Thickness:

a. Refer to ASME B36.10M for definitions of wall thickness for standard weight pipe and nominal pipe size (NPS).

b. Reinforce to withstand either internal pressures, both circumferential and longitudinal, or external loading conditions, whichever is greater.

4. Elbows, Unless Otherwise Indicated:

a. Minimum Radius: 1.0 times pipe diameter or as indicated on the Drawings

b. Minimum Bend Wall Thickness: Greater of Table 1 above or as calculated for straight pipe under internal pressure multiplied by the following stress intensities: For "n" greater than 2.5 the stress intensity factor may be ignored as indicated in AWWA C208.

Bend Radius Multiplier "n"	AWWA C208 Bend Stress Intensity
1.0	1.67
1.5	1.33
2.0	1.22
2.5	1.17
3.0	1.13
3.5	1.11
4.0	1.10
4.5	1.08
5.0	1.07
5.5	1.07

c. Maximum Miter Angle: 11-1/4 degrees on each section resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.

d. Bevels: Vary bevels on miters to provide a constant weld groove angle. For a 11-1/4 degree miter, (22.5 degrees miter weld) bevels must vary from 18.75 degrees on OD of bend to 41.25 degrees on ID of bend to provide a constant 60 degree groove angle for CJP welding.

e. Complete joint penetration (CJP) welds on miter welds.

5. Outlets:

a. Larger than 24 Inches: Fabricate from ASTM A106, Grade B, standard weight pipe.

b. Fabricate collar or wrapper reinforcement using same steel as specified for main pipe barrel.

I. Joints:

1. Shop Welded Joints:
   a. Fabricate in accordance with AWWA C200 as modified herein.
   b. Complete joint penetration (CJP) butt joints shall be used for longitudinal, girth, and spiral welds.
   c. Lengths of pipe shall not be shop-joined using lap joints.
2. Field Welded Lap Joints:
   a. Restrained joints shall be lap welded slip joints.
   b. Double fillet lap joints in preparation for field welding shall be in accordance with AWWA C200.
   c. Mark pipe or provide stops at equal intervals around inside circumference of bell ends to indicate location at which spigot end has reached maximum penetration into bell. Remove stops after joint has been fixed in place.
   d. Double welded lap joints and butt-strap joints shall be tapped and drilled for testing in accordance with AWWA C206 to air-test the joints.
3. Testing: Each joint shall be tested by the Contractor at the time of installation. The joints may be tested either with feeler gauges in accordance with paragraph 3.02 of this section, or with air testing.
4. Rubber Gasket Joints:
   a. General:
      1) Joints shall be in accordance with AWWA C200.
      2) Clearance between bell and spigot shall, when combined with gasket groove configuration and gasket itself, provide watertight joints under operating conditions.
      3) Unrestrained joints for 24-inch to 60-inch nominal pipe diameters shall be rubber gasket Carnegie bell and spigot joints, or rolled groove joints.

J. Gaskets:

1. Gaskets shall be in accordance with AWWA C200.
2. Clearance between bell and spigot shall, when combined with gasket groove configuration and gasket itself, provide watertight joints under operating conditions.
3. Contractor shall furnish sufficient feeler gauges for use throughout the complete project.

PART 3 EXECUTION

3.01 EXISTING UTILITIES AND OBSTRUCTIONS

A. Field Alignment Changes:

All alignment changes arising from utility conflicts in the field shall be the responsibility of the Contractor. The Contractor shall locate utility conflicts prior to acceptance of pipe material on site.

1. Minor Alignment Changes:

   Alignment changes of less than five (5) feet vertical or horizontal from the Drawings that can be controlled by allowable pipe deflections, and the addition or subtraction of trench depth shall be considered minor alignment changes and will be treated as field changes. These alignment changes can be approved by the Engineer in the field with a written "field variance" and detailed submittals will not be required. Only changes where there is no chance of violating thrust restraint design assumptions or pipe wall thickness design assumptions may be considered minor alignment changes. The Contractor shall record the change on as-built drawings.

3.02 LAYING AND JOINTING PIPE AND ACCESSORIES

A. General:

1. Sleeve-type mechanical pipe couplings shall conform to the requirements of applicable AWWA standard.
2. Unless otherwise specified, buried mechanical couplings and valves shall be field coated as shown on the Drawings, specified in these Specifications, or as directed by the Engineer.
3. Anchorage shall be provided as shown on the Drawings, specified in these Specifications, or as directed by the Engineer.
4. Proper equipment, tools and facilities shall be provided for the safe performance of the Work. All pipe, fittings, valves, and hydrants shall be lowered carefully into the trench by means of slings, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.
5. All pipe, fittings, valves, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.
6. All lumps, blisters, and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit or any foreign materials before the pipe is laid. No pipe containing dirt shall be laid.
7. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing, or other materials shall be placed in the pipe at any time.

8. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.
9. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade, shall not be permitted.
10. The Contractor shall provide detection tape for all pipe. Detection tape shall be buried four (4) to ten (10) inches deep below the road-base material. Should detection tape need to be installed deeper, the Contractor shall provide three (3) inch wide tape. In no case shall detection tape be buried greater than twenty (20) inches below the road base material.
11. Installation
    a. General:
        1) Provide and use proper equipment, tools, and facilities for safe and proper prosecution of Work.
        2) Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings.
        3) Do not drop or dump pipe materials into trench.
    b. Cleaning Pipe and Fittings:
        1) Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
        2) Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.
    c. Cutting Pipe:
        1) General: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
        2) Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
        1) Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.
    d. Field Welding:
        1) Field welding of bars for restrained joint systems will not be allowed.
        2) (Not Used)
    e. Polyethylene Encasement: Polyethylene shall be installed around pipe utilizing Method A as specified in Section 02616.

B. Welded Steel Pipe:

1. Installation
    a. Joints and related work for field assembly of fittings and specials shall conform to requirements for straight pipe, unless otherwise shown.
    b. Make minor field adjustments by pulling standard joints.
    c. Maximum Allowable Angle: 75 percent of manufacturer's recommended or angle that result from 3/4-inch pull out from normal joint closure, whichever is less.
    d. Maximum Allowable root opening: 1/8-inch between faying surfaces of bell and spigot at field weld location.
    e. Horizontal deflections or fabricated angles shall fall on alignment, as shown.
    f. Vertical deflections shall fall on alignment, and pipe angle point locations shall match those indicated on Drawings.
    g. Pipe 30-inches in Diameter and Larger:
        1) Assure that maximum penetration of spigot end into bell end is achieved through use of shop-welded tabs on inside circumference of bell end or other method approved by Engineer.
        2) Remove welded metal tabs prior to welding inside of joint.
        3) Maintain stulling in place until pipe is backfilled.
2. Welding
    a. Conform to AWS D1.1/D1.1M, AWWA C206, approved welding procedures, and referenced welding codes. In case of conflict AWS D1.1 shall govern.
    b. Preheat and interpass temperature requirements for unlisted base metals shall be determined according to AWS D1.1/D1.1M, Annex XI Guideline on Alternative Methods for Determining Preheat.
    c. Rejected or defective welds shall be repaired or redone, and retested until sound weld metal has been deposited in accordance with appropriate welding codes.
3. Repair of Shop-Applied Coatings
    a. Exterior surfaces of steel pipe, specials, and fittings shall be inspected upon delivery to Job Site and just prior to backfilling trench.
    b. Repair of Tape Coating:
        1) Repairs shall be in accordance with AWWA C209 and AWWA C214, as applicable, except as modified herein.
        2) Repair areas where tape coating is visually damaged or where electrical holiday testing indicates defects. Repair tape system shall consist of field primer and 4- or 6-inch wide repair tape.
        3) Number of tape repair layers shall either be two or four, depending on depth of coating damage. Minimum number of repair tape layers shall be two where only existing outer coating or middle wraps were damaged. Where coating damage

extends to inner wrap or base metal, number of repair tape layers shall be four. Thickness of repair coatings shall equal or exceed thickness of factory-applied coatings.

4) Clean and prepare pipe surface, remove damaged coating layers, and apply primer and repair tape in accordance with tape manufacturer's written instructions. Extend repair coating minimum of 4 inches in all directions onto undamaged coatings. When damaged area is wider than repair tape width, provide minimum of 4-inches coverage in all directions by lapping first tape layer with additional repair tape layers.

5) If area of tape, 6-inches or larger, is damaged through to inner wrap or to metal, apply repair tape in a cigarette wrap around entire pipe circumference. Overlap wrap ends minimum of 6 inches and point downward at spring line.

6) Completed tape repair shall adhere tightly to factory coating and present smooth, unwrinkled appearance.

7) Field coatings shall have complete holiday detection and repair of defects.

8) Repair of Cement Mortar Coating: Field repairs shall be made in accordance with AWWA C205.

9) Repair of Polyurethane Coating: Field repairs shall be made in accordance with AWWA C222.

4. Coating of Field-Welded Pipe

a. Using Tape Wrap:

1) Field-welded joints shall be coated with tape wrap in accordance with AWWA C209, or heat-shrink sleeves in accordance with AWWA C216. Tape thickness shall be 80 mils, nominal.

2) Preparation:

a) Roughen surface of epoxy coatings where they are overlapped with tape. Overlap of tape onto other coatings shall be 12 inches, minimum.

b) Pipe at field joints shall be prepared in accordance with requirements stated herein for shop-coated pipe, except that shop-blasted surfaces that have been coated with storage primer may be power tool cleaned instead of abrasive blast cleaned. Pipe ends that exhibit rust or are otherwise not effectively protected with storage primer shall be abrasive blasted to SSPC-SP6.

b. Using Heat Shrink Sleeves:

1) Apply in accordance with AWWA C216 and sleeve manufacturer's written instructions.

2) Cover pipe surfaces not coated by shop-applied coating system.

3) Clean and prepare pipe surface in accordance with AWWA C216.

4) Clean 8 to 10 inches onto shop-applied coating as recommended by sleeve manufacturer.

5) Preheat pipe and apply sleeve in with manufacturer's recommended heating equipment.

6) Holiday test completed sleeve installation and repair defects in accordance with AWWA C216 and manufacturer's written instructions.

5. Lining Application at Joints

   a. Cement-Mortar Lining: For pipe with shop-applied cement-mortar lining, place lining at joints in accordance with AWWA C205.

   b. Polyurethane Lining: Conform to AWWA C222, as modified herein. Abrasive blast exposed metal at field-welded joints to Near White Metal (SSPC-SP-10). Brush blast shop-applied polyurethane to roughen surface prior to application of joint coating.

6. Field Quality Control

   a. Field Welding:

      1) All welds (100-percent inspection) shall be VT inspected by Contractor's CWI and marked to indicate acceptance or rejection

      2) Test butt strap or double welded lap joint welds by pressurizing connection between the two fillet welds in accordance with AWWA C206.

      3) Apply air or other Engineer approved gas into connection between the two fillet welds.

      4) Paint welds with soap solution.

      5) Mark leaks indicated by escaping gas bubbles.

      6) Close threaded openings with flush pipe plugs or by welding them.

   b. Inspect 10 percent of all butt joint welds with full circumference RT.

   c. Inspect at least 10 percent of all lap joint welds PT or MT

   d. Weld Acceptance:

      1) If, in the opinion of Engineer, inspections indicate inadequate quality of welds, the above percentage of welds inspected shall be increased.

      2) Welds to be inspected, if less than 100 percent rate, shall be selected at random by Engineer.

      3) VT: Perform VT per AWS D1.1/D1.1M Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.

      4) UT: Perform UT of CJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.13.1.

      5) RT: Perform RT of CJP butt joint welds in accordance with AWS D1.1/D1.1M, Paragraph 6.12.1.

      6) PT or MT:

         a) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.10.

b) Acceptance shall be in accordance with VT standards specified above.

7) Remove in manner that permits proper and complete repair by welding.

8) Caulking or peening of defective welds is not permitted.

9) Retest unsatisfactory welds.

e. Submit test results to Engineer.

f. Engineer will conduct random nondestructive inspections of field-welded joints. Inspections will be of an appropriate type for weld being evaluated. Possible types of inspection include, but are not limited to, radiographs, magnetic particle, and ultrasonic. Testing will be performed and evaluated per AWS D1.1/D1.1M for Statically Loaded Nontubular Connections. Provide CWI access to the Work.

3.03 ALIGNMENT AND GRADIENT

A. Minimum pipe cover shall be 4-feet unless otherwise indicated on the Drawings.

B. Maintain pipe grade between invert elevations to provide minimum clearance at air valve locations from existing ground surface to top of pipe as shown on the Drawings.

C. Install air valves as shown and field verify intervening low points. When field conditions warrant, exceptions may be made upon approval of Engineer.

D. Deviations exceeding 6 inches from specified line or 1 inch from specified grade will not be allowed without express approval of Engineer.

E. Pipeline sections that are not installed to elevations shown or installed as approved by Engineer shall be reinstalled to proper elevation.

3.04 EXPEDITING OF WORK

A. The Contractor shall excavate, lay the pipe and backfill as closely together as possible. The Contractor shall not leave un-jointed pipe in the trench overnight. The Contractor shall backfill and compact the trench as soon as possible after laying and jointing is completed.

B. The Contractor shall cover the exposed end of the installed pipe each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe or accessory, the Contractor shall close the end with a suitable plug, either push-on, mechanical joint, restrained joint, or as approved by the Engineer.

3.05 THRUST RESTRAINT

A. The Contractor shall provide restraint at all points where hydraulic thrust may develop. Restrained joint lengths shall be as calculated by the Contractor according to paragraph 1.03 of this Section and as approved by the Owner by submittal.

B. (Not Used)

3.06 CATHODIC PROTECTION SYSTEM – NOT USED

3.07 PIPE INSPECTION AND ACCEPTANCE

A. Joint Inspection

1. The Contractor shall notify the Engineer at least 48 hours prior to the anticipated completion of a full pipe section between isolation valves. Once the section is completely installed, the Contractor shall participate in a joint inspection walkthrough with the Engineer or his appointed agent.
2. For unrestrained gasketed joints, the Contractor shall demonstrate the soundness of each joint to the inspector using a feeler gauge. The Engineer shall witness each joint test. The Contractor may grout joints with mortar lining (where required) as the feeler gauge tests are completed for that joint.
3. For welded steel joints, the Contractor shall verify prior to closure that weld inspection has been performed for all welded joints in that section according to the requirements of paragraph 3.02.C.7 of this Section.
4. If the Contractor has provided double gasketed joints fitted for air-pressure testing, the joints shall be tested according to AWWA C206 during the joint inspection walkthrough. This test will be required at the time of joint inspection regardless of any earlier testing to verify weld soundness.
5. The Contractor shall remove all construction debris, shipping braces, trash, rocks, and soil from the subject pipe section at the completion of the joint inspection walkthrough. Loose dirt shall be swept from the pipe, and the pipe shall be ready for final acceptance inspection, section closure, and subsequent filling.

C. Final Acceptance Inspection and Closure of Pipe Sections

1. The Contractor shall allow sufficient time for the mortar in newly grouted joints to cure before conducting the final acceptance inspection.
7. After the joint mortar is cured, the Contractor shall participate in the final acceptance inspection walkthrough with the Engineer. After completion of the final acceptance inspection, the Engineer or his appointed agent shall confirm to the Contractor in writing that the pipe section is accepted and ready for closure.
8. The Contractor shall then close and seal the pipe section, preventing reentry of personnel or the introduction of debris and contaminants to the pipe.

3.08 HYDROSTATIC TESTING

A. The Contractor may install double gasketed testable joints for the purpose of air-pressure testing of joints in lieu of full hydrostatic testing. Double gasketed or double welded joints shall be air tested. Pipe sections tested in this way will not be required to comply with paragraph 3.08.F.1, Hydrostatic Testing, but will be required to comply with all other requirements of this section, including paragraph 3.08.G, Leakage.

B. All sections of the water main subject to internal pressure shall be pressure tested in accordance procedures outlined in AWWA C600 and these Specifications. A section of main will be considered ready for testing after completion of all thrust restraint and backfilling.

C. Water used for flushing and testing mains and other construction purposes shall be made available to the Contractor as specified.

D. Each segment of water main between main valves shall be tested individually.

E. Test Preparation:

1. Cleaning procedures shall meet the procedures in AWWA C651. Procedures for cleaning shall include sweeping and vacuuming of debris, low-pressure washing and mopping of pipe lining.
2. The Contractor shall partially operate valves and hydrants to clean out seats.
3. The Contractor shall provide temporary blocking, bulkheads, flanges, and plugs as necessary, to assure all new pipe, valves, and appurtenances will be pressure tested.
4. The Contractor shall fill pipeline slowly with water. The Contractor shall provide a suitable pump with an accurate water meter to pump the line to the specified pressure at a filling velocity not to exceed 0.25 foot per second.
5. The differential pressure across a valve or hydrant shall equal the maximum possible, but not exceed the rated working pressure. Where necessary, the Contractor shall provide temporary backpressure to meet the differential pressure restrictions.
6. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure.

F. Hydrostatic Testing:

1. High Pressure Test: The Contractor shall test the pipeline at one-hundred (100) psi measured at the lowest point for at least two (2) hours. The Contractor shall maintain the test pressure within five (5) psi of the specified test pressure for the test duration. Should the pressure drop more than five (5) psi at any time during the test period, the pressure shall be restored to the specified test pressure. The Contractor shall provide an accurate pressure gage with graduation not greater than five (5) psi.

G. Leakage:

1. Leakage shall be defined as the sum of the quantity of water that must be pumped into the test section, to maintain pressure within five (5) psi of the specified test pressure for the test duration plus water required to return line to test pressure at the end of the test. Leakage shall be the total cumulative amount measured on a water meter.
2. The City assumes no responsibility for leakage occurring through existing valves if the Contractor chooses to test against an existing valve.
3. Test Results: No test section shall be accepted if the leakage exceeds the limits established for each of the materials:
    a. Steel Pipe: Maximum allowable leakage for pipe with O-ring rubber gasket joints shall not exceed 1.0 gallons per inch of diameter per fractional mile per 2 hours. There is no allowable leakage for pipe with welded joints. Where the pipeline combines welded and gasketed joints, the percentage of gasketed joints to total joints multiplied times the allowable leakage formula for gasketed joints shall apply.

H. Completion: After a pipeline section has been accepted, the Contractor shall relieve test pressure. The Contractor shall record type, size, and location of all outlets on the Record Drawings.

+ + + END OF SECTION 02667 + + +

SECTION 02700
REMOVING AND REPLACING PAVEMENT

PART 1 GENERAL

1.01 SCOPE

A. The work under this Section includes, but it is not necessarily limited to, the removal and replacement of all asphalt paving materials as necessary for the completion of the Work.

B. This section also includes pavement milling and application of a new surface course over the entire width of existing pavement or to other widths as directed by the Engineer.

C. Not Used.

D. Not Used.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Batch design.

2. Density and viscosity tests on each run.

3. Weight slips for pavement base and asphalt paving materials.

B. Provide certificates stating that materials supplied comply with Specifications. Certificates shall be signed by the asphalt producer and the Contractor.

1.03 CONDITIONS

A. Weather Limitations

1. Apply bituminous tack coat only when the ambient temperature in the shade has been at least 40 degrees F for 12 hours immediately prior to application.

2. Do not conduct paving operations when surface is wet or contains excess moisture that would prevent uniform distribution and required penetration.

3. Construct asphaltic courses only when atmospheric temperature in the shade is above 40 degrees F, when the underlying base is dry and when weather is not rainy.

4. Place base course when air temperature is above 40 degrees F and rising. Do not place base on a frozen or muddy subgrade.

B. Grade Control: Establish and maintain the required lines and grades for each course during construction operations.

C. Traffic Control

1. The Contractor shall maintain vehicular and pedestrian traffic during paving operations and as required for other construction activities.

1.04 QUALITY ASSURANCE

A. All work under this Section shall be performed in accordance with the current Georgia Department of Transportation Standard Specifications.

B. The Contractor shall use only materials which are furnished by a bulk asphalt concrete producer regularly engaged in production of hot-mix, hot-laid asphalt concrete and shall be a GDOT approved facility.

1.05 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to gain the approval of the Engineer at no additional cost to the City.

1.06 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with the requirements of the General Conditions.

B. The City's independent testing laboratory shall take samples and perform tests in accordance with the Georgia Department of Transportation Standard Specifications

PART 2 PRODUCTS

2.01 MATERIALS

A. General: All materials and products for the work under this Section shall conform to the current Georgia Department of Transportation Standard Specifications except as otherwise specified herein.

B. Graded Aggregate Base: Graded aggregate base shall be Class A meeting the requirements of the Georgia Department of Transportation Specification Section 815.01. Graded aggregate base shall be compacted to a minimum of 95% Standard Proctor Density (ASTM D698).

C. Prime Coat: Prime coat shall be in accordance with Section 412 of the Georgia Department of Transportation Standard Specifications.

D. Base: The base for all paved roadways shall conform to the requirements of the Georgia Department of Transportation Specifications for the hot mix asphalt Section 828, Type "B".

E. Tack Coat: Tack coat shall conform to Section 413 of the Georgia Department of Transportation Standard Specifications.

F. Surface Course

1. The surface course for all pavement not within GDOT right-of-way, including prime and tack coat, shall conform to the requirements of the Georgia Department of Transportation Specifications for Asphaltic Concrete, Section 828, Type "E".

2. Surface course for pavement within GDOT right-of-way shall be 12.5 mm Superpave as specified in Section 828 of the GDOT Standard Specifications.

G. Special Surfaces: Not Used.

2.02 PAVEMENT MARKINGS (Not Used)

PART 3 EXECUTION

3.01 REMOVING PAVEMENT

A. General: Remove existing pavement and base as necessary for trench excavation and installation of pipeline and appurtenances.

B. Remove and replace pavement and base beyond pipeline trench to outer edge of existing pavement if remaining existing pavement width is 24-inches or less from side of trench to outer edge of pavement or roadway.

C. Marking: Before removing any pavement, mark the pavement neatly paralleling pipelines and existing street lines.

D. Saw Cutting: Under no circumstances shall the Contractor be allowed to remove concrete or asphalt without prior saw cutting. Asphalt pavement shall be saw cut along the marks

using suitable equipment. The saw cutting shall be deep enough to produce an even, straight cut.

E. Machine Pulling: Do not pull pavement with machines until the pavement is completely broken and separated from pavement to remain.

F. Damage to Adjacent Pavement: Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement.

3.02 TYPES OF PAVEMENTS

A. General: All existing pavement removed, destroyed or damaged by construction shall be replaced with the same type and thickness of pavement as that existed prior to construction, unless otherwise directed by the Engineer. Materials, equipment and construction methods used for paving work shall conform to the Georgia Department of Transportation specifications applicable to the particular type required for replacement, repair, or new pavements.

B. Graded Aggregate Base: Aggregate base shall be constructed in accordance with the requirements of the Georgia Department of Transportation Standard Specifications. The maximum thickness to be laid in a single course shall be 6-inches compacted. If the design thickness of the base is more than 6-inches, it shall be constructed in two or more courses of approximate equal thickness. After the material placed has been shaped to line, grade, and cross section, it shall be rolled until the course has been uniformly compacted to at least 100 percent of the maximum dry density when Group 2 aggregate is used, or to at least 98 percent of maximum dry density when Group 1 aggregate is used.

C. Concrete Pavement: Concrete pavement or base courses shall be replaced with concrete. The surface finish, joint pattern and joint sealant of the replaced concrete pavement shall conform to that of the existing pavement. The surface of the replaced concrete base course shall be left rough. The slab depth shall be equivalent to the existing concrete pavement or base course, but in no case less than 6-inches thick. Transverse and longitudinal joints removed from concrete pavement shall be replaced at the same locations and to the same types and dimensions as those removed. Concrete pavements or concrete base courses shall be reinforced. Reinforcing bars and concrete shall conform to the requirements of Section 03200, Concrete Reinforcement and Section 03300, Cast-In-Place Concrete. Concrete for pavement shall be 3000 psi.

D. Asphaltic Concrete Base, Bituminous Tack Coat, and Surface Course: Asphaltic concrete base, tack coat, and surface course construction shall conform to Georgia Department of Transportation Standard Specifications. The pavement mixture shall not be spread until the designated surface has been previously cleaned and prepared; surface is intact, firm, properly cured, dry and the tack coat has been applied. Apply and compact the base in maximum layer thickness by asphalt spreader equipment of design and operation approved by the Engineer. After compaction, the black base shall be smooth and true to established

profiles and sections. Apply and compact the surface course in a manner approved by the Engineer. Immediately correct any high, low, or defective areas by cutting out the course, replacing with fresh hot mix, and immediately compacting to conform and thoroughly bond to the surrounding area.

E. Surface Treatment Pavement: Bituminous penetration surface treatment pavement shall be replaced with the thickness indicated on the Drawings.

F. Gravel Surfaces: Existing gravel road, driveway and parking area replacement shall meet the requirements of graded aggregate base course. This surfacing may be authorized by the Engineer as a temporary surface for paved streets until replacement of permanent pavement is authorized.

3.03 TEMPORARY ROADWAY SURFACES

A. After installation of pipeline and appurtenances, the trench shall be backfilled in accordance with the requirements of Section 02225, Trench Excavation and Backfill.

B. The Contractor shall be required to install and maintain temporary roadway surfaces over all roadway cuts at the end of each day's work if the road is to be opened for traffic when work is not in progress. Temporary roadway surfaces shall consist of either temporary cold asphalt patch, aggregate base course or steel plates over the trench. The surface to be installed shall be selected by the Contractor and approved by the Engineer.

1. Temporary Patch Paving: Temporary patch paving shall be placed on the aggregate base course and shall conform to the existing road surface. Prior to installation of permanent pavement, the temporary patch, and aggregate base course, if necessary, shall be removed to the required depth and leveled to allow for permanent pavement replacement of the thickness as shown on the Drawings.

2. Aggregate Base Course: Aggregate base course surface shall conform to the existing road surface and shall be maintained at grade, dust free, by the Contractor. Prior to installation of permanent pavement, the aggregate base course shall be removed to the required depth and leveled to allow for permanent pavement replacement of the thickness as shown on the Drawings.

3.04 STEEL TRAFFIC PLATES

A. Following completion of pipeline installation including backfilling but prior to replacement of pavement, steel plates may be used to temporarily carry vehicular traffic if approved by the Engineer. Requirements for utilization of steel plates shall be as follows:

1. Steel plates shall not be allowed in GDOT right of way where the posted speed limit is 45 mph or greater.

2. Trench shall be backfilled and compacted to within ten (10) inches from top of existing pavement prior to placing the steel plate.

3. Steel plates shall meet ASTM structural specifications having "A36" designation with minimum yield stress of 36 ksi (ksi = kilopounds per square inch).

4. Steel plates shall extend a minimum of 12-inches beyond all edges of the trench.

5. In streets and roads where the posted speed is 44 mph or less, asphaltic patching material (cold mix) shall be used to secure the steel plate around its edges. The asphaltic concrete shall be compacted to form ramps with a minimum 12-inch taper to cover all edges of the steel plate.

6. Not Used.

7. No plate shall be allowed over a trench having a width greater than 48 inches when adequate soil conditions are present. When the trench is greater than 48 inches, the entire lane containing the trench shall be closed. Before closing a lane, a Lane Closure Permit shall be obtained from the City of Atlanta, Department of Public Works, Bureau of Traffic and Transportation. At least 24 hours prior notification is required for the Lane Closure Permit.

8. The width of a trench is measured normal to the length of the trench. The largest reading of the measurements is the determining factor for width. For a series of steel plates on any continuous trench, all plates shall have the same thickness.

9. All necessary warning signs, barricades, and lights shall be adequately provided and placed for the safety of the public and in full conformity with the latest edition of the MUTCD at no additional cost to the City.

10. Trench shall be fully covered with a minimum of twelve (12) inches of asphalt taper on all sides of the plate.

11. Upon the completion of the work and removal of the steel plates, the existing surface shall be cleaned and pavement replaced as specified hereinafter.

B. (Not Used)

3.05 TESTING OF SUBGRADE

A. Trench backfill shall be compacted for the full width and depth of the trench as specified in Section 02225, Trench Excavation and Backfill.

B. Upon completion of backfilling and compaction of the backfill, the Contractor shall arrange to have the compaction tested by an independent testing laboratory approved by the Engineer. Compaction testing shall be as specified in Section 02225.

C. After compaction testing has been satisfactorily completed, replace all pavements, sidewalks, and curbs and gutters removed.

D. Tests repeated because the compacted backfill, subgrade or base does not meet the specified compaction shall be paid for by the Contractor and will not be reimbursed by the City.

3.06 PAVEMENT REPLACEMENT

A. Limits of Pavement Replacement

1. Existing Raw Water Intake Access Road

   a. The existing street pavement or surface shall be milled for the full width of the affected travel lane where indicated on the Drawings. The depth of milling shall be at least 3 and 1/2 inches.
   b. Milling shall be performed as specified in Section 432 of the GDOT Standard Specifications.
   c. 3 and 1/2 inch thick pavement shall be applied over entire milled area to restore the existing roadway to the same elevation that existed prior to construction.

B. Preparation of Subgrade

1. If the temporary aggregate base surface is to be replaced, it shall be removed and the graded aggregate base surfacing for unpaved streets or the base for the bituminous surface shall be placed.

2. Following this preparation, the graded aggregate base shall be primed with a suitable bituminous material and surfaced with the proper type of bituminous surface treatment.

3. Where the paved surface is to be replaced with asphaltic concrete pavement, concrete pavement or with a concrete base and a surface course, the temporary aggregate base surface and any necessary backfill material, additional existing paving and new excavation shall be removed to the depth and width shown on the Drawings. All edges of the existing pavement shall be cut to a straight, vertical edge. Care shall be used to get a smooth joint between the old and new pavement and to produce an even surface on the completed street. Concrete base slabs and graded aggregate bases, if required, shall be placed and allowed to cure for three days before bituminous concrete surface courses are applied. Expansion joints, where applicable, shall be replaced in a manner equal to the original joint.

C. Pavement Placement and Resurfacing

1. After all pipe line installations are complete and subgrade has been placed as specified in Paragraph 3.06.B above, apply tack coat and surface course as specified herein.

2. Resurfacing limits shall be perpendicular to the road centerline.

3. Where pavement is damaged with potholes, the Contractor shall remove all existing loose pavement material and fill the hole with black base, as specified, to the level of the existing pavement.

4. Placement of pavement shall conform to the Standard Details shown on the Drawings and GDOT standard specifications.

3.07 ADJUSTING EXISTING STRUCTURES

A. Existing manholes, inlets, valve boxes etc. within the limits of construction, which do not conform to the finished grade of the proposed pavement or the finished grade designated on the Drawings shall be cut down or extended and made to conform to the finished grade. The materials and construction methods for this work shall be approved by the Engineer.

B. (Not Used)

3.08 SIDEWALK, WHEELCHAIR RAMP AND CURB AND GUTTER REPLACEMENT (Not Used)

3.09 TRAFFIC DETECTION LOOPS (Not Used)

3.10 PAVEMENT MARKINGS (Not Used)

3.11 INSTALLATION

A. Asphaltic construction shall be performed in accordance with Section 400 of the Georgia Department of Transportation Standard Specifications.

B. Place each course in the required quantities so that when compacted, they will conform to the indicted grade, cross section and minimum thickness as specified or as indicated on the Drawings (see section 3.01-3.06).

3.12 CLEANING AND PROTECTION

A. Prior to acceptance of the work of this Section, clean the pavement and related areas in accordance with the requirements of the General Conditions of the Contract Documents. The Contractor shall remove all surplus excavation materials and debris from the street surfaces and rights-of-way and shall restore street, roadway or sidewalk surfacing to its original condition.

B. (Not Used)

3.13 APPROVAL AND ACCEPTANCE

A. Pavement restoration shall meet the requirements of the regulatory agency responsible for the pavement. Obtain agency approval of pavement restorations before requesting final payment.

B. Obtain the Engineer's approval of restoration of pavement, such as private roads and drives that are not the responsibility of a regulatory agency.

C. Should any pavement restoration or repairs fail or settle during the life of the Contract, including the bonded period, promptly restore or repair defects.

D. Prior to acceptance and approval of any asphaltic concrete binder and/or topping which is installed for the purpose of City maintenance, a representative of the City of Atlanta's Department of Traffic and Transportation may require one or all of the following tests: 1) coring, 2) extraction, 3) compaction and 4) density. The frequency and location of these tests will be at the discretion of the Engineer.

3.14 MAINTENANCE

A. The Contractor shall maintain the surfaces of roadways and pavements replaced until the acceptance of the Project. Maintenance shall include replacement, scraping, reshaping, milling, overlapping, and re-rolling as necessary to prevent raveling of the road material, the preservation of smooth surfaces and the repair of damaged or unsatisfactory surfaces, to the satisfaction of the Engineer.

B. Maintenance shall also include sprinkling as may be necessary to abate dust from the gravel surfaces.

+ + + END OF SECTION 02700 + + +

SECTION 02711
CHAIN LINK FENCE AND GATES

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to furnish and install chain link fence, gates and appurtenances as shown on the Drawings and as specified herein. Chain link fence shall be of the types indicated as follows:

1. Zinc-coated steel fence fabric with galvanized steel posts, rails, caps, hardware and fittings.

2. Polyvinylchloride (PVC) coated steel fence fabric with vinyl coated and factory-painted steel posts, rails, caps, hardware and fittings in a color to be determined by the Owner.

B. Fencing and gates shall be installed in the locations as shown on the Drawings or as directed by the Engineer, in complete conformity with the manufacturer's written recommendations and as specified herein.

C. The Contractor shall also furnish all labor, materials, equipment and miscellaneous items as necessary for the removal and re-installation of existing chain link fence and gates as required for construction of the project.

D. Security fencing for the Contractor is at Contractor's option and is not included as part of the work specified in this Section.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer’s product data.

2. Detailed shop drawings of the fence and gate layout, including installation details of the fencing, posts, gates, hardware and accessories.

3. If PVC coated fencing is indicated or specified, manufacturer’s color chart of available colors and physical sample of the selected color.

B. (Not Used)

1.03 DELIVERY AND HANDLING

A. Deliver materials with the manufacturer's tags and labels intact.

B. Handle and store materials in such a manner that will avoid damage.

1.04 TRANSPORTATION AND HANDLING

A. Provide transportation and handling in accordance with the requirements of Section 01610 of these Specifications.

B. (Not Used)

1.05 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.

1. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2. ASTM A121 – Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

3. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric

6. ASTM A510 – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

7. ASTM A653 – Standard Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

8. ASTM A824 – Standard Specification for Metallic Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence

9. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled Carbon, Structural, High-Strength, Low-Alloy, High-Strength Low-Alloy with Improved Formability and Ultra-High Strength

10. ASTM F567 – Standard Practice for Installation of Chain-Link Fence

11. ASTM F626 – Standard Specification for Fence Fittings

12. ASTM F668 – Standard Specification for PolyvinylChloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric

13. ASTM F900 – Standard Specification for Industrial and Commercial Swing Gates

14. ASTM F934 – Standard Specification for Standard Colors for Polymer-Coated Chain-Link Fence Materials

15. ASTM F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

16. ASTM F1664 – Standard Specification for PolyvinylChloride (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence

17. ASTM F1665 – Standard Specification for PolyVinylChloride (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence

B. Chain Link Fence Manufacturers Institute (CLFMI): CLFMI Publication,"Standards for Chain Link Fence Installation"

C. Federal Specifications:

1. RR-F-191/2C – Fencing, Wire and Post, Metal (Chain Link Fence Gates) (Detail Specification)

2. RR-F-191/4C – Wire and Post, Metal (Chain Link Fence Accessories) (Detail Specification)

PART 2 PRODUCTS

2.01 GENERAL

A. Fencing shall include fabric, covering, framework, barbed wire and supporting arms, concrete footings, gates, hardware and all appurtenances and accessories required for a complete installation.

B. Height of fence shall be as shown on the Drawings.

2.02 MATERIALS

A. Chain Link Fence Fabric

1. Zinc Coated Steel Fence Fabric: Fabric shall be 9 gauge wire, woven to 2-inch squares and shall be galvanized in accordance with ASTM A392, Class 2.

2. PVC Coated Steel Fence Fabric

   a. Fabric shall be 9 gauge wire, woven to 2-inch squares.
   b. Fabric shall be PVC coated in accordance with ASTM F 668.
   c. Color shall be selected by the Owner from manufacturer's standard colors as specified in ASTM F934.

3. Selvages

   a. Selvages shall be twisted and barbed at top and bottom when barbed wire is used.
   b. Selvages shall be knuckled at top and bottom when barbed wire is not used unless otherwise indicated.

B. Pipe Framework for Zinc Coated Steel Fabric: Posts and rails shall be standard weight galvanized steel pipe conforming to ASTM F1083. Sizes and weights shall be as follows:

1. End, corner and pull posts shall be 2.875-inches outside diameter galvanized pipe weighing not less than 5.79 pounds per linear foot.

2. Line Posts: Line posts shall be 2.375-inches outside diameter galvanized pipe weighing not less than 3.65 pounds per linear foot.

3. Gate Posts:

   a. Gate posts for gate leaves up to 6-feet wide shall have an outside diameter of 2.875-inches, weighing not less than 5.79 pounds per linear foot.
   b. Gate posts for gate leaves from 6-feet to 13-feet wide shall have an outside diameter of 4.00-inches, weighing not less than 9.11 pounds per linear foot.

4. Rails and braces shall be 1.660-inches outside diameter galvanized pipe weighing not less than 2.27 pounds per linear foot. Posts shall include galvanized bolted fittings to properly secure rails and braces to posts.

C. Pipe Framework for PVC Coated Fabric

1. Posts and rails shall be vinyl-clad steel with color coated polyvinylchloride chemically bonded to standard weight ASTM F1083 galvanized steel pipe by electrostatically applied powder coating process. Protective vinyl coating thickness shall be 10 to 14 mils.

2. Color shall match fence fabric color.

D. Tension Wire: Tension wire for top and bottom edge support of fence fabric shall be No. 7 gauge steel zinc-coated wire conforming to ASTM A824 with a minimum tensile strength of 80,000 psi. For PVC coated fabric, provide tension wire coated with PVC, conforming to ASTM F1664. PVC coating shall match fence fabric in color.

E. Post Caps and Fittings

1. Post caps and fittings shall be manufacturer's standard, pressed steel or malleable iron post caps, fittings and accessories, meeting the requirements of ASTM F626 and Federal Specification RR-F-191/4C, galvanized for zinc coated steel fencing, and PVC coated by the thermal-fusion-bond process in color matching posts for PVC coated fencing.

2. Post caps shall be designed to fit securely over the posts to exclude water and to carry the top rail and extension arms, where indicated.

3. All other required fittings and hardware shall be provided to fasten to the pipe posts or concrete in the manner indicated.

F. Truss Rods: Truss rods shall be alloy steel rods conforming to ASTM A510, with a minimum tensile strength of 80,000 psi and a minimum diameter of 5/8-inch. Provide rods with threaded ends and self-tightening galvanized turnbuckles and anchor plates. Secure anchor plates to posts and gate frames by welding.

G. Stretcher Bars: Provide one-piece lengths equal to the full fabric height with a minimum cross section of ¼-inch by ¾-inch. Provide one stretcher bar for each gate and end post and two for each corner and pull post.

H. Stretcher Bar Bands: Provide galvanized heavy pressed steel or malleable iron bands with a minimum cross section of 1/8-inch by ¾-inch, spaced not more than 15-inches on center, to secure stretcher bars to end, corner, pull and gate posts.

I. Accessories

1. Provide miscellaneous materials and accessories, including nuts and bolts, clips, tie wires (9 gauge), anchors and fasteners as required for a complete installation. All items shall be galvanized in accordance with ASTM A123 or ASTM A153 as applicable.

2. Accessories for PVC fencing shall be vinyl coated or painted to match color of fence fabric.

J. Barbed Wire Extension Arms

1. Barbed wire extension arms shall be pressed steel conforming to ASTM A653, hot-dip galvanized after fabrication, complete with provision for anchorage to end, corner or line posts and for attaching three rows of barbed wire to each arm.

2. Arms shall be 45 degree angle or vertical as shown on the Drawings, for three strands of barbed wire. Arms shall be attached to posts or integral with post top weather cap. Intermediate arms shall have holes for passage of top tension wire.

3. Arms shall be capable of withstanding 300 pounds downward pull at outermost end of arm without failure.

4. Extension arms for PVC coated fencing shall be vinyl-coated or painted to match color of fence fabric.

K. Barbed Wire: Barbed wire shall be double strand 12 gauge steel wire, with 14 gauge barbs in a 4-point pattern on 5-inch centers. Wire shall conform to ASTM A121, Type Z (galvanized). For PVC coated fabric, provide barbed wire coated with PVC conforming to ASTM F1665. PVC coating shall match fence fabric in color.

L. Gates: Gates shall be swinging type or sliding type as shown on the Drawings, furnished complete with all hardware and accessories as required for a complete installation.

1. Gate Frames: Gate frames shall be fabricated from zinc-coated steel pipe members to match zinc-coated fencing having a minimum outside dimension of 1.90-inches and weighing not less than 2.72 pounds per linear foot.

2. Fabrication: Conform to the applicable requirements of ASTM F900, Federal Specification RR-F-191/2C and the following:

   a. Assemble gates by welding or with fittings and rivets for rigid connections. Use same fabric as for fence. Install fabric with stretcher bars at vertical edges and wire ties at top and bottom edges. Attach stretcher bars to gate frames at not more than 15-inches on center. Attach hardware with rivets or by other means that will provide security against removal or breakage.
   b. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories.
   c. Provide diagonal cross bracing consisting of minimum ½-inch diameter adjustable length truss rods on gates where necessary to provide frame rigidly without sag or twist.
   d. Where barbed wire is indicated above the gates, extend end members of gate frames 12-inches above frame and prepare to receive 3 strands of barbed wire. Provide clips for securing barbed wire to extensions.
   e. For PVC coated fencing, gate components shall be PVC coated or painted in color matching fence fabric.

3. Gate Hardware

    a. Swinging Gates: Provide gate hinges, latch, stop and keeper for each gate leaf, conforming to the applicable requirements of ASTM F900 and Federal Specification RR-F-191/2C. Provide latch with provision for locking gate with a padlock.
    b. Sliding Gates: Provide manufacturer's standard rubber tired rollers and roller track for floor supported sliding gates. Include intermediate rollers or casters where required to prevent gate sag or deflection. Provide locking device and padlock eyes as part of latch for locking gate with a padlock,

M. Pipe Sleeves: Furnish pipe sleeves for fence post embedment in concrete curbs, barriers and walls. Pipe sleeves shall be fabricated from steel pipe conforming to ASTM A53 and galvanized in accordance with ASTM A123, sized to receive and support fence posts.

2.03 GROUND RODS

A. Ground Rods: Shall be 5/8-inch in diameter and 8 feet in length unless shown otherwise on the Drawings. Ground rods shall be galvanized steel. Galvanizing shall have a minimum coating of 2 oz. per square foot in accordance with ASTM A153.

B. (Not Used)

2.04 CONCRETE AND GROUT

A. Provide concrete and non-shrink grout for footings for fence posts. Concrete shall be 3000 psi and shall be furnished in accordance with the requirements of Section 03300, Cast-in-Place Concrete. Grout shall be as specified in Section 03600, Grout.

B. (Not Used)

PART 3 EXECUTION

3.01 INSTALLATION

A. Fence installation shall not be started before final grading is completed, with finish grade elevations established, unless otherwise directed by the Engineer.

B. Install fencing and gates in accordance with the requirements of ASTM F567 and CLFMI Standards for Chain Link Fence Installation. Site fabricate as required to complete the installation.

C. Excavation: Drill holes of diameters and spacings shown, for post footings in firm, undisturbed or compacted soil.

1. If not shown on the Drawings or stated in the Specifications, excavate holes to the minimum diameters as recommended by fence manufacturer.

2. Unless otherwise indicated, excavated hole depths shall be approximately 3-inches lower than the post bottom, with bottom of posts set not less than 36-inches below the surface when in firm, undisturbed soil.

3. If rock is encountered near the surface, drill into rock at least 12-inches for line posts and at least 18-inches for end, pull, corner, and gate posts. Drill hole at least 1-inch greater diameter than the largest dimension for the post to be placed. If rock is below soil overburden, drill to full depth required. Penetration into rock need not exceed the minimum depths specified above.

D. Setting Posts: Remove loose and foreign materials from sides and bottoms of holes and moisten soil prior to placing concrete.

1. Center and align posts in holes 3-inches above bottom of excavation.

2. Place concrete around posts in a continuous pour and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold in position during placement and finishing operations. Allow concrete to attain at least 75 percent of its minimum 28 day compressive strength, but in no case sooner than five days after placement, before rails, tension wires, barbed wire or fabric is installed. Do not stretch and tension fabric and wires and do not hang gates until the concrete has attained its full design strength.

3. Trowel finish tops of footings and slope or dome to direct water away from posts. Extend footings for gate posts to the underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.

4. Keep exposed concrete surfaces moist for at least seven days after placement or cure with membrane curing materials or other acceptable curing methods.

5. Grout-in posts set into sleeved holes, concrete construction or rock excavations with non-shrink Portland cement grout or other acceptable grouting material.

6. Distance between end, pull and corner or angle post assemblies shall not exceed 500 feet for chain link fence in a straight line; and 250 feet for chain link fence in a curved line.

E. Top Rails: Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

F. Center Rails: Provide center rails where indicated. Install in one piece between posts and flush with post on fabric side, using offset fittings where necessary.

G. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.

H. Tension Wire: Install tension wires by weaving through the fabric and tying to each post with not less than 6 gauge galvanized wire or by securing the wire to the fabric.

I. Chain Link Fabric: Pull fabric taut and tie to posts, rails and tension wires. Install fabric on security side of fence and anchor to framework so that fabric remains in tension after pulling force is released.

J. Repair damaged coatings in the shop or during field erection by recoating with manufacturer's recommended repair compound, applied in accordance with the manufacturer's directions.

K. Stretcher Bars: Thread through or clamp to fabric 4-inches on center and secure to posts with metal bands spaced 15-inches on center.

L. Barbed Wire: Install three parallel wires on each extension arm. Pull wire taut and fasten securely to each extension arm. Extension arms shall overhang the outside of the fence at a 45 degree angle. The topmost strand of barbed wire shall be 12-inches above the top of the fabric.

M. Tie Wires: Use U-shaped wire appropriate for the diameter of pipe. Attach pipe and fabric firmly with tie wire ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing.

N. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

O. Gates

1. Gate assemblies shall be of the length, height and type as shown on the Drawings.

2. Gate frames shall be welded or with fittings and rivets and shall be coated after assembly. The fabric shall be the same as that used for the fence and shall be rigidly attached to the frames. Frames shall be suitably braced and trussed.

3. Three strands of barbed wire shall be provided on the top of the gate.

4. Swinging gate assemblies shall be furnished with offset hinges to allow the gate to swing open 180 degrees. Provide a minimum of 3 hinges on each gate leaf.

5. Gate assemblies shall be provided with a combination spring latch and plunger rod of approved design for padlocking.

6. Furnish designated gates with galvanized steel stop/hold open device with catch or plunger rod of standard manufacture and approved design.

P. Electrical Ground

1. Wherever a power line carrying more than 600 volts passes over the fence, a ground rod shall be installed. The ground rod shall be installed at the nearest point directly below the point of crossing. Where possible, the rod shall be driven into the ground for a full eight feet of penetration. In rocky soil, the rod may be driven slanted so as to provide 18-inches of cover at the tip.

2. If solid rock is encountered, two ground rods may be installed at the nearest post on each side of the power line crossing where soil conditions will permit. A length of No. 6 bare copper seven strand wire shall be attached between the fence and the ground rod with suitable clamps.

3.02 REMOVAL AND REPLACEMENT OF EXISTING FENCE AND GATES

A. The Contractor shall notify the Engineer prior to removal of any existing fence and gates and present to the Engineer a plan for maintaining the security of the facility or property in the absence of a complete fencing system.

B. No existing fencing shall be removed unless approved by the Engineer.

C. Fence, gates and components that have been removed shall be protected by the Contractor until reinstalled. Fence and gates shall be reinstalled when directed by the Engineer. Any fence, gates or components that have been damaged by the Contractor during removal and storage that are considered unsuitable for reinstallation by the Engineer shall be removed from the site and new fence, gates and components shall be furnished and installed by the Contractor at no cost to the Owner.

D. New fencing, gates and components shall match the existing fence.

3.03 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all debris and equipment. Repair all damage resulting from chain link fence system installation.

B. (Not Used)

+++ END OF SECTION 02711 +++

SECTION 02900
TREES, PLANTS, AND GROUND COVERS

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and plant trees, plants and ground covers as shown on the Drawings and as specified herein.

B. Under this section, the Contractor shall also replace trees, plants and ground covers damaged by his operations. Existing trees, plants and ground covers damaged by the Contractor's operations shall be replaced as directed by the Engineer, to the satisfaction of the Engineer and at no additional cost to the Owner.

C. Work under this Section shall include, but not be limited to:

1. Soil preparation.

2. Planting mixes.

3. Mulch and planting accessories.

4. Furnishing and installing trees, plants and ground covers.

5. Existing tree care.

6. Filling around trees to remain.

7. Maintenance.

1.02 QUALITY ASSURANCE

A. Comply with requirements of Section 02000, Site Work.

B. Plant names shall comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties shall conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

C. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.

D. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project.

E. Stock furnished shall be at least the minimum size as stock to be replaced. Larger stock is acceptable, at no additional cost, and providing that the larger plants will not be cut back to the existing plant size.

F. Provide "specimen" plants with height, shape and character of growth. Tag specimen trees or shrubs at the source of supply. The Engineer will inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval.

G. Plants may be inspected and approved at the place of growth, for compliance with specification requirements for quality, size, and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

H. Contractor shall provide and pay for material testing. Testing agency shall be acceptable to the Engineer. Provide the following data:

1. Test representative material samples proposed for use.

2. Topsoil:

a. pH factor.
b. Mechanical analysis.
c. Percentage of organic content.
d. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

3. Peat Moss:

a. Loss of weight by ignition.
b. Moisture absorption capacity.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Mulch samples.

2. Planting accessories samples.

3. Certification for topsoil source and pH value; peat moss and plant fertilizer.

4. Material test reports.

5. Upon plant material acceptance, submit written instructions recommending procedures for maintenance of plant materials.

B. (Not Used)

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver fertilizer materials in original, unopened, and undamaged containers showing weight, analysis, and name of manufacturer. Store materials in a manner to prevent wetting and deterioration.

B. Take all precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Spray deciduous plants in foliage with an approved "Anti-Desiccant" immediately after digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrival, the certificate shall be submitted to the Engineer.

C. Protect all plants from drying out. If plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss, or in a manner acceptable to the Engineer. Water heeled-in plantings daily. No plant shall be bound with rope or wire in a manner that could damage or break the branches.

D. Cover plants transported on open vehicles with a protective covering to prevent wind burn.

E. Provide dry, loose topsoil for planting bed mixes. Frozen or muddy topsoil is not acceptable.

1.05 PROJECT CONDITIONS

A. Notify Engineer at least 7 working days prior to installation of plant material.

B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.

C. Locate and protect existing irrigation system(s) during planting operations. Repair irrigation system components, damaged during planting operations, at Contractor's expense.

1.06 WARRANTY

A. Warrant plant material to remain alive and be in healthy condition for a period of 1 year after planting and acceptance. Inspection of plants will be made by the Engineer at completion of planting.

B. Replace, in accordance with these specifications, all plants that are dead or, as determined by the Engineer, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence. The cost of such replacement is at Contractor's expense. Warrant all replacement plants for 1 year after installation.

C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting area; acts of vandalism or negligence on the part of the Owner.

D. Remove and immediately replace all plants, as determined by the Engineer to be unsatisfactory during the initial planting installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Plants: Provide plants typical of their species or variety; with normal, densely-developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have a fully developed form without voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.

1. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock". Cracked or mushroomed balls are not acceptable.

2. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.

    a. No plants shall be loose in the container.
    b. Container stock shall not be pot bound.

3. Provide new tree species to match existing tree species. New species shall be provided with a single main trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.

4. Plants planted in rows shall be matched in form.

5. Plants larger than those existing may be used when acceptable to the Engineer. If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.

6. No pruning wounds shall be present with a diameter of more than 1-inch and such wounds must show vigorous bark on all edges.

7. Shrubs and small plants shall meet the requirements for spread as follows:

    a. The measurements for height shall be taken from the ground level to the height of the top of the plant and not the longest branch.
    b. Single stemmed or thin plants will not be accepted.
    c. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground.
    d. Plants shall be in a moist, vigorous condition, free from dead wood, bruises or other root or branch injuries.

B. (Not Used)

2.02 ACCESSORIES

A. Topsoil for Planting Beds and Tree Pits: Fertile, friable, natural topsoil of loamy character, without admixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sands, stones, plants, roots, sticks, and other foreign materials, with acidity range of between pH 6.0 and 6.8.

1. Topsoil that has been stripped and stockpiled on site shall be the topsoil to be utilized on this project. Provide additional topsoil if necessary.

2. Provide topsoil free of substances harmful to the plants which will be grown in the soil. Provide 12-inches of topsoil in all plant beds and tree pits.

B. Planting mixture shall be composed of four (4) parts topsoil, two (2) parts peat moss, one (1) part sand and one (1) part well-rotted manure, mixed together thoroughly, and worked into existing soil.

C. Peat Moss: Brown to black in color, weed and seed free granulated raw peat or baled peat, containing not more than 9% mineral on a dry basis. Provide ASTM D2607 sphagnum peat moss with a pH below 6.0 for ericaceous plants.

D. Fertilizer:

1. Plant Fertilizer Type "A": Commercial type approved by the Engineer, containing 5% nitrogen, 10% phosphoric acid, and 5% potash by weight, 1/4 of nitrogen in the form of nitrates, 1/4 in form of ammonia salt and 1/2 in form of organic nitrogen.

2. Plant Fertilizer Type "B": Approved acid-base fertilizer.

E. Anti-Desiccant: Protective film emulsion providing a protective film over plant surfaces; permeable to permit transpiration. Mixed and applied in accordance with manufacturer's instructions.

1. Premium grade shredded pine bark ¾-inch to 1-1/2-inch diameter. Furnish in 3 cubic feet bags or bulk.

F. Water: Free of substances harmful to plant growth. Hoses or other methods of transportation shall be furnished by the Contractor.

G. Stakes for Staking: Hardwood, 2-inch x 2-inch x 8-feet long.

H. Stakes for Guying: Hardwood, 2-inch x 2-inch x 36-inches long.

I. Guying/Staking/Wire: No. 10 or 12, gage galvanized wire.

1. For large trees (4-inch caliper and greater) use turnbuckles and heavier gage wire as indicated below

a. Stakes for Staking: Hardwood, 4-inches x 4-inches x 8-feet long.
b. Guying/Staking/Wire: No. 6 or 8 gage galvanized wire.

2. Turnbuckles: Galvanized steel of size and gage required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3-inches.

J. Staking and Guying Hose: Two ply, reinforced garden hose not less than ½-inch inside diameter.

K. Tree Wrap: Standard waterproofed tree wrapping paper, 2-1/2-inches wide, made of 2 layers of crepe kraft paper weighing not less than 30 lbs. per ream, cemented together with asphalt. Tree wrap shall be removed at 12 months after installation of plant material.

L. Twine: Two-ply jute material.

M. Soil Separator: Rot resistant polypropylene filter fabric, water permeable, and unaffected by freezing and thawing.

N. Drainage Tile: ASTM F405 corrugated polyethylene drainage tubing, perforated.

O. Drainage Fill: AASHTO M43 #6 (3/8-inch to ¾-inch) clean uniformly graded stone or gravel.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.

B. (Not Used)

3.02 CARE OF TREES TO REMAIN

A. Minor fills of 6-inches or less: Fill with topsoil; hand grade to required finish grade elevation.

B. Moderate fills of 12-inches or less: Place layer of ¾-inch to 1-1/2-inch stone or gravel on grade. Provide aggregate depth 1/2 of fill height, minimum of 3-inches. Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Fill remaining depth with loose topsoil; hand grade to required finish grade elevations.

C. Deep fills over 12-inches: Place layer of ¾-inch to 1-1/2-inch stone or gravel on grade. Extend drainage fill to within 2-inch of required finish grade. Cover drainage fill with polypropylene filter fabric or 1-inch thickness straw choke. Fill remaining depth with loose topsoil; hand grade to required finish grade elevation. Provide tile drainage system and vents as indicated.

D. Deep fills over 18-inches: Place 4-inch depth of 1-inch to 2-inches stone or gravel fill on grade, extending three (3) feet beyond the outer branch drip line around tree branch perimeter. Cover drainage fill with polypropylene filter fabric or 1-inch thickness straw choke. Place 1-inch to 2-inches stone or gravel fill around tree trunk, extending to within 2-inches of required finish grade elevation. Fill remaining depth with loose topsoil; hand grade to required finish grade elevation. Do not place earth fill in contact with tree trunk, maintain 18-inches diameter of drainage fill exposed at finish grade.

3.03 PREPARATION

A. Time of Planting:

1. Evergreen Material: Plant evergreen materials between September 1 and November 1 or in spring before new growth begins. If project requirements require planting at other times, plants shall be sprayed with anti-desiccant prior to planting operations.

2. Deciduous Material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-desiccant prior to planting operation.

3. Planting times other than those indicated shall be acceptable to the Engineer.

B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

C. Locate plants as indicated or as approved in the field after staking by the Contractor. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until alternate plant locations have been selected.

D. Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least 12-inches greater than the diameter of the root system and 24-inches greater for trees. Depth of pit shall accommodate the root system. Provide undisturbed tamped down topsoil to hold root ball at nursery grade as shown on the drawings. Remove excavated materials from the site.

E. Provide pre-mixed planting mixture for use around the balls and roots of the plants consisting of planting topsoil and 1/2 lb. plant fertilizer Type "A" for each cu. yd. of mixture.

F. Provide pre-mixed ground cover bed planting mixture consisting of 3 parts planting topsoil to 1 part peat moss and 1/2 lb. plant fertilizer Type "A" per cu. yd. Provide beds a minimum of 12-inches deep. If slopes are greater than 4 to 1 increase depth to 18-inches.

G. Provide pre-mixed planting mixture for use around the balls and roots of ericaceous plants consisting of 2 part planting topsoil to 1 part sphagnum peat moss and 1/2 lb. plant fertilizer Type "B" per cu. yd. of mixture.

3.04 INSTALLATION

A. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material 2-inches to 3-inches above the finish grade. No filling will be permitted around trunks or stems. Backfill the pit with planting mixture. Do not use frozen or muddy mixtures for backfilling. Form a ring of soil around the edge of each planting pit to retain water.

B. After balled and burlapped plants are set, muddle planting soil mixture around bases of balls and fill all voids. Remove all burlap, ropes, and wires from the tops of balls of trees and remove entirely from all other plant material.

C. Space ground cover plants in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within 12-inches of the trunks of trees and shrubs within planting bed and to within 6-inches of edge of bed.

D. Drain tile: The Contractor shall provide drainage tiles if he encounters standing water in planting pits or conditions warrant. Install drainage tile with perforations down and closed joints, firmly bedded in minimum 4-inch layer of granular fill material. Provide full bearing for each pipe section. Provide continuous slope in the direction of flow.

1. Provide collars and couplings for all in-line joints and elbows for all corners and changes in direction.

2. Provide unperforated run out pipe. Extend drainage tile to out fall indicated and make connection.

3. Obtain required inspections and perform testing before backfilling. Remove obstructions, replace damaged components, and retest system as required. Provide a satisfactory free flowing drainage tile system.

4. Place drainage fill over drain piping after satisfactory testing and acceptance. Compact drainage fill layers not exceeding 6" in loose depth. Exercise care to avoid damage or displacement of installed piping.

    a. Completely cover drain lines to width of at least 6-inches each side of pipe and above top of pipe to within 18-inches of finish grade.
    b. Provide soil separator over drainage fill prior to topsoil fill. Overlap a minimum of 6-inches.

5. Install topsoil fill over compacted drainage fill. Compact topsoil fill in layers not exceeding 6-inches in loose depth. Extend topsoil fill to indicated finish or existing grade elevations.

E. Mulching:

1. Mulch tree and shrub planting pits and shrub beds with required mulching material 3-inches deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.

2. Mulch ground cover beds with mulch 2-inches deep immediately after planting.

F. Wrapping, Guying and Staking:

1. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.

2. Wrap trunks of all trees spirally from bottom to top with specified tree wrap and secure in place.

    a. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
    b. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom. Wrapping and twine to be removed 12 months after installation of plant material.

3. Staking/Guying:

    a. Stake/guy all trees immediately after lawn seeding or sodding operations and prior to acceptance. When high winds or other conditions which may affect tree survival or appearance occur, the Engineer may require immediate staking/guying.
    b. Stake deciduous trees under 3-inches in caliper. Stake evergreen trees under 8-feet tall.
    c. Guy deciduous trees over 3-inches in caliper. Guy evergreen trees over 8-feet tall.

4. All work shall be acceptable to the Engineer.

G. Pruning:

1. Prune branches of deciduous stock, after planting, to balance the loss of roots and preserve the natural character appropriate to the particular plant requirements. In general, remove 1/4 to 1/3 of the leaf bearing buds, proportion shall in all cases be acceptable to the Engineer. Remove or cut back broken, damaged, and unsymmetrical growth of new wood.

2. Multiple leader plants: Preserve the leader which will best promote the symmetry of the plant. Cut branches flush with the trunk or main branch, at a point beyond a lateral shoot or bud at a distance of not less than 1/2 the diameter of the supporting branch. Make cut on an angle.

3. Prune evergreens only to remove broken or damaged branches.

H. Care of Existing Trees:

1. Selectively prune existing trees in designated areas, under Engineer's direction. Remove sucker shoots, dead, rubbing, and damaged branching.

2. Fertilize designated existing trees with 2 to 3 lbs. of Type "A" plant fertilizer per inch of trunk diameter, for trees less than 6-inches in diameter and 3 to 5 lbs. for trees greater than 6-inches in diameter.

    a. Fertilize in early spring before growth begins or in late October.
    b. Fertilize at 2-feet to 3-feet on center in a triangular pattern to a depth of 18-inches within the dripline.
    c. Injection or drilling fertilization methods, when used, shall be acceptable subject to Engineer's approval.

3. Water existing trees every 2 weeks until acceptance. Water thoroughly with a fine mist sprinkler head soaker hose or hose at a low flow rate over the entire drip line area as required to allow water to penetrate to a depth of 12-inches to 18-inches.

I. Tree Relocation:

1. Transplant trees designated for relocation to locations shown on the drawings. Prune, dig, ball and burlap, move and plant in accordance with specified tree planting requirements.

3.05 MAINTENANCE

A. Maintain plantings until completion and acceptance of the entire project.

B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.

1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.

2. Tighten and repair guy wires and stakes as required.

3. Remove tree wrapping and twine 12 months after installation of plant material.

4. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.

5. Water trees, plants, and ground cover beds within the first 24 hours of initial planting, and not less than twice per week until final acceptance.

3.06 ACCEPTANCE

A. Inspection to determine acceptance of planted areas will be made by the Engineer, upon Contractor's request. Provide notification at least 10 working days before requested inspection date. Planted areas will be accepted provided all requirements, including maintenance, have been complied with and plant materials are alive and in a healthy, vigorous condition.

B. Upon acceptance, the Owner will assume plant maintenance.

3.07 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soils, debris, and equipment. Repair damage resulting from planting operations.

B. (Not Used)

+ + + END OF SECTION 02900 + + +

SECTION 02920
SITE RESTORATION

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall provide all, labor, materials, equipment and incidentals required for all site restoration and related operations necessary shown on the Drawings or specified in these Specifications.

B. Restoration activities shall be sufficient to facilitate final site grading, surface restoration, underground piping, structural concreting for buildings and foundations, and other Work necessary to establish the finished site. The site shall left be free of ruts, clean, and stabilized. Sediment basins shall be cleaned to the bottom elevations of the initial construction.

B. This section includes disposition of materials and structures encountered in the Work, all cleanup and any other similar, incidental, or appurtenant operations which may be necessary to properly complete the Work.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. The Contractor shall submit certificates of inspection as required by government authorities. The Contractor shall submit other data substantiating that materials comply with specified requirements.

2. The Contractor shall submit instructions recommending procedures to be established by the City for maintenance of site restoration work for one (1) full year.

B. (Not Used)

1.03 QUALITY ASSURANCE (Not Used)

1.04 SAFETY REQUIREMENTS

A. Hazards Control:

1. The Contractor shall store volatile wastes in covered metal containers, and remove from the site of the Work daily.

2. The Contractor shall prevent accumulation of wastes that create hazardous conditions.

3. The Contractor shall provide adequate ventilation during use of volatile or noxious substances.

B. The Contractor shall conduct cleaning and disposal operations in compliance with local ordinances and environmental laws and regulations.

1. The Contractor shall not burn or bury rubbish and waste materials on the site of the Work without prior written permission from the Engineer.

2. The Contractor shall not dispose of volatile wastes such as mineral spirits, oil, or fuel in open drainage ditches or storm or sanitary drains.

1.05 DELIVERY (Not Used)

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.01 DISPOSITION OF MATERIALS AND STRUCTURES ENCOUNTERED IN THE WORK

A. Existing materials or structures that may be encountered (within the lines, grades, or trenching sections established for completion of the Work), if unsuitable or unacceptable to the Engineer for use in the Work, and for which the disposition is not otherwise specified, shall either be disposed of by the Contractor or shall remain the property of the City as further provided in this section.

B. At the option of the City, any existing materials or structures of "value" encountered in the Work shall remain the property of the City. The term "value" shall be defined by the City.

C. Any existing materials or structures encountered in the Work, and determined not to be of "value" by the City, shall be disposed of by the Contractor, in an approved manner.

3.02 JOB CONDITIONS

A. The Contractor shall determine the locations of underground utilities and perform Work in a manner which will avoid possible damage. The Contractor shall hand excavate, as required. The Contractor shall maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

B. All bare earth areas within the limit of work shall be grassed, mulched, or covered with other plant material as shown on the Drawings.

C. On a continuous basis, the Contractor shall maintain the site of the Work free from accumulations of waste, debris, and rubbish caused by his operations.

D. At completion of the Work, the Contractor shall remove waste materials, rubbish, tools, equipment, machinery, and surplus materials, and clean all sight-exposed surfaces. The Contractor shall leave the site of the Work clean and ready for occupancy or use.

E. The Contractor shall proceed with the complete site restoration work as rapidly as portions of the site of the Work become available, working within seasonal limitations for each kind of site restoration work required. The Contractor will not be allowed to postpone cleanup and seeding or sodding until the end of the Work.

F. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, the Contractor shall notify the Engineer before planting.

G. The Contractor shall install materials during normal planting seasons for each type of site restoration work.

H. The Contractor may, at his option, employ additional measures (other than those specified) to prevent loss of, or damage to the Work resulting from the effects of wind and/or water. No additional compensation will be made for the employment of such additional measures.

3.03 CLEANUP

A. During site restoration work, the Contractor shall keep pavements clean and the site of the Work in an orderly condition.

B. The Contractor shall protect site restoration work and materials from damage due to site restoration operations, operations by other contractors, and trades and trespassers. The Contractor shall maintain protection during installation and maintenance periods. The Contractor shall treat, repair, or replace damaged site restoration work as directed by the Engineer.

C. Immediately upon completion of any section of the Work and before payment therefore has been made, the Contractor shall remove from the site of the Work all construction equipment, temporary structures, and debris, and shall restore the site of the Work to a condition equal to or better than that which existed prior to construction. Waste materials shall be disposed of at locations satisfactory to the City or affected regulatory agencies.

D. The Contractor shall not remove barricades and warning and direction signs until directed by the Engineer.

E. After completion of all Work required by the Contract and before final payment has been made, the Contractor shall make a final cleanup of each separate part of the Work; shall restore all surfaces to a neat and orderly condition; and shall remove all construction equipment, tools, and supplies. Clean out sediment control basins to an elevation one foot below the elevations shown on the Drawings.

3.04 INSPECTION AND ACCEPTANCE

A. When site restoration work is completed, including maintenance, the Engineer will, upon request, make an inspection to determine acceptability.

B. Where inspected site restoration work does not comply with the requirements of the Engineer, the Contractor shall replace rejected work and continue specified maintenance until re-inspected by the Engineer and found to be acceptable. The Contractor shall remove rejected plants and materials promptly from the site of the Work.

+ + + END OF SECTION 02920 + + +

SECTION 02933
SEEDING AND SODDING

PART 1 GENERAL

1.01 SCOPE

A. The work covered by this Section consists of furnishing all labor, equipment and material required to place topsoil, seed, commercial fertilizer, agricultural limestone and mulch material, including seedbed preparation, harrowing, compacting and other placement operations on graded earthen areas as described herein and/or shown on the Drawings.

B. Seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement or sidewalks; all cleared or grubbed areas which are to remain as finish grade surfaces; and on all existing turf areas which are disturbed by construction operations and which are to remain as finish grade surfaces. Areas disturbed by borrow activities shall also be seeded according to these Specifications.

C. The Work shall also include temporary seeding operations to stabilize earthen surfaces during construction or inclement weather and to minimize stream siltation and erosion. Temporary seeding shall be performed at the times and locations as directed by the Engineer.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following information shall be submitted:

1. Prior to seeding operations, labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the Contractor of any responsibility or liability for furnishing seed meeting the requirements of this Section.

2. Prior to topsoil operations, the Contractor shall obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Services or other certified testing laboratory.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Wood cellulose fiber mulch shall be manufactured by Weyerhauser Company or Conway Corporation.

2.02 MATERIALS AND CONSTRUCTION

A. Topsoil

1. Utilizing designated stockpiles or borrow areas on site, the Contractor shall place a minimum of 6-inches of topsoil over all graded earthen areas and over any other areas to be seeded. Sources of topsoil shall be approved by the Engineer prior to disturbance.

2. Topsoil shall be a friable loam containing a large amount of humus and shall be original surface soil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2-inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life.

3. Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, sandy loam or a combination thereof. The pH shall range from 5.5 to 7.0. Topsoil shall contain not less than 5 percent nor more than 20 percent, by weight, or organic matter as determined by loss on ignition of oven dried samples to 65 Degrees C.

B. Seed

1. Seed shall be hulled common Bermuda (Cynodon Dactylon) guaranteed by the dealer to be 98% minimum purity and 90% minimum germination and certified free of giant strain Bermuda.

2. Seed shall be delivered in new bags or bags that are sound and labeled in accordance with the U.S. Department of Agriculture Federal Seed Act.

3. All seed shall be from the last crop available at time of purchase and shall not be moldy, wet or otherwise damaged in transit or storage.

4. Seed shall bear the growers analysis testing to 98 percent for purity and 90 percent for germination. At the discretion of the Engineer, samples of seed may be taken for check against the grower’s analysis.

5. Species, rate of seeding, fertilization and other requirements are shown in Table 02933-1 at the end of this Section.

C. Fertilizer and Liming Materials

1. Fertilizer and liming materials shall comply with applicable state, local and

federal laws concerned with their production and use.

2. Commercial fertilizer shall be a ready mixed material and shall be equivalent to the grade or grades specified in Table 02933-1. Container bags shall have the name and address of the manufacturer, the brand name, net weight and chemical composition.

3. Agricultural limestone shall be a pulverized limestone having a calcium carbonate content of not less than 85 percent by weight.

4. Fertilizer shall be a complete fertilizer, the content of which shall meet the following minimum requirements: 10% nitrogen, 10% phosphoric acid, 10% potash, available materials. Fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the site in original unopened containers bearing the manufacturer's statement of guarantee.

5. Ammonium Nitrate shall be a standard brand and shall be delivered to the site in original unopened containers. It shall contain not less than 33-1/3% Nitrogen.

D. Mulch Material

1. All mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.

2. Mulch shall be composed of wood cellulose fiber, straw or stalks, as specified herein. Mulch shall be suitable for spreading with standard mulch blowing equipment.

3. Straw mulch shall be partially decomposed stalks of wheat, rye, oats or other approved grain crops.

4. Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum or other approved standing field crops.

E. Mulch Binder

1. Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved mulch binder. The mulch binder shall be non-toxic to plant life and shall be acceptable to the Engineer.

2. Emulsified asphalt binder shall be Grade SS-1, ASTM D977. Cutback asphalt binder shall be Grade RC 70 or RC 250.

F. Inoculants for Legumes: All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen fixing bacteria that is adapted to the particular seed involved.

G. Water: Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the Contractor.

H. Sod

1. Sod shall be living, growing sod of Bermuda hybrids "Tifway 419" or Tifgreen 328". This includes sod which is dormant during the cold or dry season and capable of renewing growth after the dormant period. All sod shall be obtained from approved sources. The presence of weeds or other noxious growth or any other foreign material which may be detrimental to the proposed planting will be cause of rejection. At least 85% of the plants in the sod shall be composed of the designated variety of Bermuda grass.

2. The Engineer shall be notified of sources before it is harvested. Approval of such sources shall not be construed as an acceptance of the material. The sod will be subject to inspection while it is being planted and any material which has been permitted to dry out excessively or exposed to extreme heat, or which is not viable, will be rejected.

3. In the harvesting of the sod, grass more than 3-inches tall shall be mowed to a height of 3-inches, raked and removed before sod cutting begins. The sod shall be cut into square or rectangular sections which may vary in length, but which shall be of uniform width and thickness, and shall have at least ½-inch of soil adhering firmly to the roots. Care shall be exercised at all times to retain the soil on the roots of the sod during the process of cutting, transporting and planting. Sod shall be transplanted within 24 hours from the time it is harvested. All sod stored shall be kept moist, shall be protected from exposure to the air and sun and from freezing, and shall not be stored for more than 10 days. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected.

PART 3 EXECUTION

3.01 SECURING AND PLACING TOPSOIL

A. Topsoil shall be secured from areas from which topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the Engineer.

B. The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage and other characteristics as to offer assurance that, when removed the product will be homogeneous in nature and will conform to the requirements of these Specifications.

C. All areas from which topsoil is to be secured, shall be cleaned of all sticks, boards,

stones, lime, cement, ashes, cinders, slag, concrete, bitumen or its residue and any other refuse which will hinder or prevent growth.

D. In securing topsoil from a designated pit, or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such material shall be removed from the topsoil or if required by the Engineer, the pit shall be abandoned.

E. Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed, unless otherwise approved by the Engineer.

F. The areas in which topsoil is to be placed or incorporated shall be prepared before securing topsoil for use.

3.02 SEEDBED PREPARATION

A. Before liming, fertilizing and seeding, the topsoil surfaces shall be trimmed and worked to true line from unsightly variation, bumps, ridges and depressions and all detrimental material, roots and stones larger than 3-inches in any dimension shall be removed from the soil.

B. Not earlier than 24 hours before the seed is to be sown, the soil surface to be seeded shall be thoroughly cultivated to a depth of not less than 2-inches with a weighted disc, tiller, pulvimixer or other equipment, until the surface is smooth and in a condition acceptable to the Engineer.

C. If the prepared surface becomes eroded as a result of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be cultivated for seeding.

D. Ground preparation operations shall be performed only when the ground is in a tillable and workable condition, as determined by the Engineer.

3.03 FERTILIZATION AND LIMING

A. Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve the application rates shown in Table 02933-1 at the end of this Section.

B. Fertilizer shall be spread evenly over the seedbed and shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of 1/2-inch.

C. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment. The seed shall not remain in water containing fertilizer for more than 30 minutes when a hydraulic seeder is used.

D. Agricultural limestone shall be thoroughly mixed into the soil according to the rates in

Table 02933-1. The specified rate of application of limestone may be reduced by the Engineer if pH tests indicate this to be desirable. It is the responsibility of the Contractor to obtain such tests and submit the results to the Engineer for adjustment in rates.

E. It is the responsibility of the Contractor to make one application of a maintenance fertilizer according to the recommendations listed in Table 02933-1.

F. On the approved grade, spread 20 lbs. per 1,000 sq. ft. of 10-10-10 fertilizer into top 3-inches, hand rake and smooth. The surface shall be brought to finish grade requirements, allowance being made for settlement. Finish grades shall be smooth and free from hollows or other inequalities.

G. Three weeks after construction of lawns add ammonium nitrate at the rate of 5 lbs. per 1000 sq. ft. of lawn area, and thoroughly water in.

3.04 SEEDING

A. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the dates shown in Table 02933-1 unless otherwise approved by the Engineer. Seed mixtures may be sown together provided they are kept in a thoroughly mixed condition during the seeding operation.

B. Seed shall be uniformly sown by any approved mechanical method suitable for the slope and size of the areas to be seeded, preferably with a broadcast type seeder, windmill hand seeder or approved mechanical power drawn seed drills. Hydro-seeding and hydro-mulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder for seedings at the proper rate before seeding operations are started and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.

C. Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8-inch by a cultipacker or suitable roller.

D. Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculant in accordance with the manufacturer's mixing instructions.

E. Italian rye grass (Lolium Multiflorum) shall be evenly seeded with a mechanical spreader at the rate of 5 lbs. per 1000 sq. ft. of area, lightly rake, suitably compact and thoroughly water. Before planting the permanent lawn, the rye shall be thoroughly scarified in a manner to incorporate it into the top three inches of the ground.

F. The planting of bermuda grass shall be done only within the season extending from April 15 to August 1.

3.05 MULCHING

A. All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and the air to circulate and at the same time shade the ground, reduce erosion and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.

B. One of the following mulches shall be spread evenly over the seeded areas at the following application rates:

Wood Cellulose Fiber	1,400 pounds/acre
Straw	4,000 pounds/acre
Stalks	4,000 pounds/acre

C. These rates may be adjusted at the discretion of the Engineer at no additional cost to the Owner, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

D. The Contractor shall cover structures, poles, fence and appurtenances if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.

E. Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates in a manner acceptable to the Engineer.

3.06 WATERING

A. The Contractor shall be responsible for maintaining the proper moisture content of the soil to insure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain adequate water content in the soil.

B. Watering shall be accomplished by hoses, tank truck or sprinklers in such a way to prevent erosion, excessive runoff and overwatered spots.

3.07 MAINTENANCE

A. Upon completion of seeding operations, the Contractor shall clear the area of all equipment, debris and excess material and the premises shall be left in a neat and

orderly condition.

B. The Contractor shall maintain all seeded areas without additional payment until final acceptance of the work by the Owner, and any regrading, refertilizing, reliming, reseeding or remulching shall be done at the Contractor's own expense. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is accomplished. Damage resulting from erosion, gulleys, washouts or other causes shall be repaired by filling with topsoil, compacting and repeating the seeding work at the Contractor's expense.

C. Contractor's guarantee of one (1) year shall also cover a fully rooted stand of grass.

TABLE 02933-1

SEEDING REQUIREMENTS

Area	Sowing Season	Species	Seed	Rates per 1,000 Square Feet		
				Fertilizer	Limestone	Maintenance**
Flat to rolling terrain with slopes less than 3:1	3/1 to 4/15	Rebel II Turf-Type Tall Fescue	6-8 lbs.	30 lbs. 6-12-12	200 lbs.	10 lbs. 10-10-10
	9/1 to 11/15	Rebel II Turf-Type Tall Fescue	6-8 lbs.	30 lbs. 6-12-12	200 lbs.	15 lbs. 10-10-10
Embankments with slopes greater than 3:1	3/1 to 6/1	Crownvetch* Kentucky 31 Fescue Weeping Lovegrass	1 lb. 2 lbs. 1/4 lb.	30 lbs. 6-12-12	200 lbs.	10 lbs. 0-20-20
	8/1 to 11/1	Crownvetch* Kentucky 31 Fescue Annual Ryegrass	1 lb. 2 lb. 2 lb.	30 lbs. 6-12-12	200 lbs.	10 lbs. 0-20-20

* Requires inoculation
** Maintenance fertilizer shall be applied in early spring following initial establishment of cover

+ + + END OF SECTION 02933 + + +

SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install the concrete formwork as required by the concrete outlines shown and indicated on the Drawings and specified in this Section. The use of stay in place forms is expressly prohibited.

B. Coordination:

1. Notify other contractors or subcontractors in advance of the trades of the formwork to provide the other trades with sufficient time for the installation of items included in their contracts that must be installed with the formwork.

C. Form Design:

1. Formwork shall comply with ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, Concrete, Concrete Forms, and Shoring. In addition, the form designs shall meet the requirements of ACI 347.

1.02 SUBMITTALS

A. Submit for approval copies of manufacturer's data and installation instructions for proprietary materials, including form coatings and releasing agents, manufactured form systems, ties and accessories.

B. Do not provide submittals for the structural design of forms.

1.03 QUALITY ASSURANCE

A. Design and construct forms to withstand stresses due to weight of fresh concrete, vibration during consolidation and loads of equipment and workmen. Comply with ACI 318.

B. Allowable Tolerances:

1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347.

2. Maximum acceptable deflection is 1/8" in 5'-0" on all flat surfaces (ACI 347 Class A Finish).

C. Notify the Engineer a minimum of 48 hours before closure of forms that would hinder the subsequent inspection to enable the Engineer to inspect the work.

1.04 PRODUCT DELIVERY. STORAGE AND HANDLING

A. On delivery to jobsite, place materials in area protected from weather.

B. Store materials above ground on framework or blocking. Cover wood for forms with protective waterproof covering. Provide for adequate air circulation or ventilation.

C. Handle materials to prevent damage.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. Forms for Exposed Finish Concrete: (Smooth Finish)

1. Unless otherwise shown or specified, construct formwork for concrete surfaces exposed to view in the finished structure, with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as-cast surfaces.
2. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown or specified. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Unexposed Finish Concrete: (Rough Finish)

1. Form concrete surfaces that will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least 2 edges and 1side.

C. Forms for tunnel and shaft linings shall be steel: Refer to Section 02425.

D. Form Ties:

1. Provide factory-fabricated, removable or snap off metal form ties designed to resist lateral pressure of fresh concrete on forms, to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used fortying Forms will be subject to approval of the Engineer.
2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1 1/2 inches from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a hole no larger than 1-inch diameter in the concrete surface.
3. Ties for exterior walls and walls subject to hydrostatic pressure shall have water stops that are integral with the tie, preferably a solid washer at mid-point of the tie.
4. Provide wood or plastic cones for ties, where concrete is exposed in the finished structure.

E. Forms Coatings:

1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 - EXECUTION

3.01 DESIGN OF FORMWORK

A. Formwork shall be in accordance with ACI 347 and as follows:

1. Design, erect, support, brace and maintain formwork so that it shall safely support vertical, lateral, static and dynamic loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place construction that has attained adequate strength for this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.
2. Design forms and falsework to include full allowance for all of live loads, dead loads, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

3. Forms shall conform to shape, lines and dimensions of members indicated and shall be sufficiently rigid and tight to prevent leakage of mortar. Forms shall be properly braced or tied together so as to maintain position and shape. Construct forms so that they can be removed readily without hammering or prying against the concrete. Forms shall be carefully made and accurately placed to obtain correct shape and lines.
4. Joints shall be butted tight. Arrangements of panels shall be orderly and symmetrical, and use of small pieces shall be avoided. Forms shall be chamfered 1-inch for external comers of concrete, including tops of walls, which will be exposed to view in the finished work.
5. Provide adequate formwork in its entirety. Forms shall safely support loads they will sustain and shall maintain their dimensional and surface correctness to produce members required by the Drawings. Form ties shall be spaced close enough to avoid bulges and variations in the required cross-sectional dimensions shown on the Drawings for the members being cast.
6. Box out for chases, recesses or other openings required in the completed work.
7. Install all the items (sleeves, inserts, hangers, anchors, etc.) to be supported by the formwork as required by the work.
8. Install pipe sleeves, wall pipes and wall sleeves, as shown or specified, for all piping penetrating walls and slabs. The use of block-outs in walls is prohibited.
9. Provide a sufficient number of cleanout doors at the base of walls and columns to facilitate cleaning and the application of grout to the base of walls.
10. The use of reinforcing steel, partially embedded in concrete, as toe pins or form spacers is prohibited.
11. Any proposed formwork requiring temporary support using permanent structure walls and slabs shall require analysis and design conducted by the Contractor. Plans and calculations shall be submitted to the Engineer for information only prior to installation of the formwork. The stability and structural integrity of all permanent structural elements shall remain the responsibility of the Contractor until the entire structure is complete, in-place, and accepted.

B. Forms for Exposed Concrete:

1. Do not use metal cover plates for patching holes or defects in forms.
2. Provide sharp, clean comers at intersecting planes, without visible edges of offsets. Provide back joints with extra beams or girts to maintain true, square intersections.

3. Use extra beams walers and bracing to prevent bowing of forms between beams and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
5. Form molding shapes, recessed and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.
6. Chamfer exposed comers and edges.

C. Comer Treatment:

1. Form exposed comers of beams, walls, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Except as specified below for re-entrant or internal comers, exposed comers shall be chamfered.
2. Form chamfers with ¾ by ¾ strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
3. Re-entrant or internal comers and unexposed comers may be formed square.

D. Joints:

1. See Specification Section 03250 and Drawings for treatment of joints. Locate as shown and specified.

E. Cleaning and Tightening:

1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Re-tighten forms immediately after concrete placement as required to eliminate mortar leaks.

3.02 FORM COATINGS

A. Coat form contact surfaces with a non-staining no petroleum form coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces, which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.
B. Volatile organic compound emissions of form releasing agents shall not exceed 2.09 pounds per gallon or that as acceptable in the State, County, or District of their intended use, whichever is more stringent.

C. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

1. Form releasing agents must not impair subsequent treatment of concrete surfaces that depend upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. General:

1. Set and build into the formwork, anchorage devices and other embedded items, shown specified or required by other Section. Refer to paragraph 1.01 herein for the requirements of coordination. Use necessary setting drawings, diagrams, instructions and directions.
2. All embeds should be supported, plumbed and carefully taped or covered to prohibit the infiltration of concrete during the pour.
3. Coat any aluminum or reactive metal inserts, with non-reactive coating to isolate the metal surfaces.
4. Concrete cover for pipes, conduits, and fittings shall not be less than 2 inches for concrete exposed to earth, contained liquids, or weather, nor ¾ inches for concrete not exposed to contained liquids, weather, or in contact with ground.

B. Edge Forms and Screed Strips for Slabs and Sidewalks:

1. Set edge forms or bulkheads and intermediate screed strips for slabs and sidewalks to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.
2. The screeds may not be tack welded to the rebar embeds, or structural steel.

3.04 FIELD QUALITY CONTROL

A. Before concrete placement, the Engineer shall inspect all formwork. No concrete shall be poured without Engineer approval.

B. Before concrete placement, Subcontractor shall check the formwork, including lines, ties, tie cone, and form coatings. Subcontractor shall make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

C. During concrete placement Subcontractor shall check formwork and related supports to ensure that forms are not displaced and that completed Work shall be within specified tolerances.

D. If Subcontractor finds that forms are unsatisfactory in any way, either before or during placing of concrete, placement of concrete shall be postponed or stopped until the defects have been corrected, and reviewed by the Engineer.

3.05 REMOVAL OF FORMS

A. Remove forms and falsework in a manner that will prevent damage to the concrete and not impair the safety of the structure.

B. Do not use pinch bars or similar tools to pry against concrete surfaces.

C. Do not remove forms until concrete has aged as follows:

1. Elevated slabs and beams: 7 days minimum.
2. Grade beams, columns, walls, construction and expansion joint bulkheads and other vertical surfaces: 24 hours minimum.

D. Elevated slabs and beams shall have attained at least 70 percent of the specified 28day strength before form removal. Concrete shall also have sufficient strength to safely support its own weight and construction loads. Determine concrete strength for form removal in conformance with ACI301.

E. Reshore elevated concrete elements immediately upon form removal. Shoring shall remain in place until the concrete has attained the specified 28 day design strength.

F. Maintain shoring of elevated concrete elements which support subsequent construction when the subsequent construction loads exceed the design live load of the elements

3.06 REUSE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

1. Plywood surfaced forms must have smooth clean faces for re-use, and may not have excessive knots or tie hole plugs. They may not be used more than (3) times without an Engineer's inspection and approval.

2. Metal surfaced forms must have a smooth even surface without plate patches.

+ + + END OF SECTION 03100 + + +

SECTION 03200
CONCRETE REINFORCEMENT AND DOWELLING

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install the concrete reinforcement as shown and indicated on the Drawings and specified in this Section, complete in place.

B. Provide and set reinforcement and accessories for electrical work as indicated and specified under electrical work.

C. Provide reinforcing bar dowels to be embedded into concrete elements at top and bottom of CMU walls as indicated and specified. Furnish wall reinforcement for concrete masonry walls for installation.

1.02 SUBMITTALS

A. Shop Drawings

1. All shop drawings shall be of the same size. Reproductions of the Drawings for use as shop drawings are not permitted. Shop drawings shall include placing drawings, bending details, and bar lists with bar marks. All details and notes appearing on the Drawings, giving information for the placing of reinforcing steel, shall be shown on the shop drawings. Shop drawings will not be reviewed without such information.
2. Wall reinforcing shall be shown in elevation.
3. Show location and size of all penetrations greater than 6-inches in diameter or across the opening with the corresponding added reinforcing around the penetrations.
4. Location and arrangement of accessories shall be clearly indicated.
5. All shop drawings shall be checked by the fabricator and Subcontractor before being submitted to the Engineer.
6. Reproduction of the Contract Drawings shall not be used for shop drawings.
7. Review of shop drawings is for bar size, spacing, details and general compliance with the Contract Drawings only. Material quantities, fit, verification of job conditions and coordination with other trades are the responsibility of the General Contractor.
8. Do no begin fabrication of materials prior to review of shop drawings.

B. Mill tests of reinforcing steel shall be submitted prior to use for each 15 tons or less shipped to the site. Tests shall be conducted in conformance with ASTM A615, and methods prescribed herein.

1. Cost of mill tests shall be borne by Subcontractor.
2. Three copies of each test report stating whether the material meets the requirements of the ASTM specifications shall be submitted to the Engineer.
3. Certified copies of the mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced, competent personnel using adequate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the Engineer may require the Subcontractor to furnish, at no additional cost to the Owner, test results from an independent testing laboratory acceptable to the Engineer on mill samples or delivered steel reinforcement.

1.03 QUALITY ASSURANCE

A. The Contractor shall examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

B. Minimum Concrete Cover for Reinforcement: Comply with ACI 350, except as shown on Drawings

C. Splices other than lap splices shall not be used except where permitted in writing by the Engineer.

D. Field bending of reinforcement is prohibited unless reinforcement is indicated or specified to be field bent.

1.04 DELIVERY. STORAGE AND HANDLING

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, length, and other information corresponding to markings shown on placement diagrams. Reinforcement which arrives on the jobsite which is not tagged shall be rejected by the Engineer and removed at the Contractor's expense.

B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars and Dowelling shall conform to ASTM A 615, Grade 60.

B. Mechanical Reinforcing Bar Splice Couplers indicated in the construction drawings shall be integrally forged, with parallel threaded splice bars conforming to ASTM A 615, Grade 60. The Mechanical Splice Coupler shall develop in tension or compression at least 125% the specified Reinforcing Bar yield strength.

C. Steel Wire: Shall conform to ASTM A82.

D. Welded Smooth Wire Fabric: Shall conform to ASTM A185:

1. Furnish in flat sheets, not rolls.

E. Supports for Reinforcement: Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP-l and placed in accordance with CRSI PRE. Precast concrete block supports shall be provided for reinforcing in concrete cast against grade.

2.02 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice" and ACI minimums. In case of fabricating errors, do not re-bend, retemper, heat, deform or straighten reinforcement.

B. Unacceptable Materials: Reinforcement with any of the defects listed below will not be permitted in the Work:

1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
2. Bends or kinks not shown on approved. Shop Drawings.
3. Bars with reduced cross-section due to excessive rusting or other cause.
4. Surface contamination that would affect the bond i.e. grease, dirt, paint, rust etc.
5. Heat deformed or torched bars.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with the applicable recommendations of specified codes and standards, and CRSI "Placing Reinforcing Bars" and ACI requirements for details and methods of reinforcement placement and supports.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement and dowelling against displacement during formwork construction or concrete placement and grouting operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required. No wood blocks allowed for rebar support. Do not tack weld crossing reinforcing bars.

1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 350 at the Pump Station and Tunnel Shaft Transition Box structures. ACI 318 may be used at all other structures. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
2. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16 gauge wire and tie. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.

E. Provide sufficient numbers of supports of strength required to carry reinforcement without sagging. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars. The use of Mechanical Reinforcing Bar Splice Couplers may be used at locations indicated in the construction plans. Any additional locations where Mechanical Splice Couplers are being proposed shall be submitted to the Engineer for approval.

G. Existing concrete, which is shown to remain but is removed in error or must be removed to install new Work, and then to be reinstalled is to be reinforced to the extent as required and approved by the Engineer. This work will be performed with no additional compensation to the Subcontractor.

H. Do not straighten or rebend reinforcing.

I. Reinforcement Around Openings: Place an equivalent area of steel around the pipe or openings and extend on each side sufficiently to develop bond in each bar. See the Details on the Drawings for bar extension length each side of openings. Where welded wire fabric is used, provides extra reinforcing using fabric or deformed bars.

J. Welded Reinforcement: Welding is not permitted.

3.02 INSPECTION OF REINFORCEMENT

A. After the rebar, appliance, anchors and embedments have been installed and checked, the Subcontractor shall review all aspects of the pending concrete pour and initial those items on its pour card. Subcontractor shall notify the Engineer no less than 24 hours prior to the pour, so that the Engineer may check the area to be poured. No concrete shall be placed until this is complete.

B. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by the Engineer. All concrete placed in violation of this provision will be rejected. Rejected concrete shall be removed and replaced at no cost to the City.

+ + + END OF SECTION 03200 + + +

SECTION 03251
CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by Section includes, but is not necessarily limited to, furnishing and install1ing all concrete accessories as indicated on the Drawings, herein specified, and as necessary for the progress and complete performance of this work.

1.02 SUBMITTALS

A. The waterstop manufacturer shall submit documented test results demonstrating that the waterstop will not permit water leakage when subjected to pressure and joint movement.

1.03 QUALITY ASSURANCE

A. The waterstop manufacturer shall demonstrate five years (minimum) continuous, successful experience in production of waterstops.

1.04 STORAGE AND PROTECTION

A. Store waterstops under tarps to protect from oil, dirt, water, and sunlight.

1.05 QUALITY CONTROL

A. Contractor shall establish and maintain records sufficient to furnish evidence of quality of materials, equipment, storage, and workmanship.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Waterstops for construction joints shall be Wirestop Waterstop Type No. FR-6380 manufactured by Paul Murphey Plastics Company, Rossville, Michigan; Vinylex Waterstop Type R6-38T manufactured by Vinylex Corporation, Knoxville, Tennessee; or Greenstreak Waterstop Stop 679 manufactured by Greenstreak, St. Louis, Missouri.

B. Expanding waterstops for construction joints shall be Hydrotite Waterstop Profile
CJ -0725 manufactured by Greenstreak, St. Louis, Missouri or equal.

2.02 MATERIALS AND CONSTRUCTION

A. Waterstops:
   1. Waterstops shall be extruded from an elastomeric plastic compound of which the basic resin shall be prime virgin polyvinyl chloride meeting U.S. Army Corps of Engineers Specification CRD-C572-74. The PVC compound shall not contain any scrapped or reclaimed material or pigment whatsoever.
   2. Provide factory installed hog rings, grommets, or embedded wire loop to facilitate tying off waterstop at 12-inches on center along the length of the waterstop.
   3. Provide factory made PVC waterstop fabrications for all changes of direction, intersections and transitions, leaving only straight butt joint splices for the field.
   4. Expanding waterstops shall be coextruded hydrophilic rubber consisting of a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.
   5. Expanding waterstops shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.
   6. Minimum profile dimensions of expanding waterstop shall be 1/4 x 1-inch.

B. Dovetail Slots:

   1. No. 22 gauge, galvanized steel, 1-inch wide back.
   2. Crimped anchors shall be furnished by other trades whose work abuts concrete.

C. Inserts for General Trades:

   1. Malleable iron, strength as required.
   2. Include bolts, nuts, and washers.

2.03 OTHER MATERIALS

A. All other materials not specifically described, but required for a complete and proper installation of concrete accessories, shall be as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install concrete accessories as indicated on the Drawings, specified in various other Sections and as necessary for the proper and complete performance of this work.

B. Waterstops:

1. Waterstops shall be installed in all construction joints in walls and slabs which are to hold water and also where shown on the Drawings. The waterstop shall extend the entire length of the joint and all splices shall be installed and tested in accordance with the manufacturer's recommendations. Place waterstop to form a continuous watertight diaphragm in joints.
2. Waterstops for all joints shall be continuous around all corners and intersections. For PVC waterstops, provide factory formed corners and intersections where angle intersections occur, and only straight splices shall be made in the field. Splices shall be made in accordance with the manufacturer's recommendations and shall be subject to the approval of the Engineer. Maintain 2-in. [50 mm] minimum clearance between waterstop and reinforcement and embedded items.
3. No holes will be permitted in waterstops.
4. Waterstops shall be securely fastened to formwork or reinforcing steel every 12-inch or less on both edges as required to concrete placement.
5. Expanding waterstops shall be spliced using cyanoacrylate adhesive (super glue) and a band-aid seal of hydrophilic polyurethane sealant.
6. Cut coil ends of expanding waterstops square (or at proper angle for mitered comers) with shears or sharp blade to fit splices together without overlaps.
7. Joinery between PVC and expanding waterstops shall be sealed using hydrophilic polyurethane sealant.
8. Provide concrete surface preparation that is consistent with the manufacturer’s recommendations for expanding waterstops. Coordinate this preparation with other joint preparation shown on the drawings.
9. Install the expanding waterstop in accordance with the manufacturer's recommendations.

+ + + END OF SECTION 03251 + + +

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install the cast-in-place concrete as shown and indicated on the Contract Drawings and as specified in this Section and Section 02425.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.
2. Notify other trades in advance of the placing of concrete to provide the other trades with sufficient time for furnishing of items included in their work that must be installed in the concrete.
3. Required City formal pour card with all required signatures.

C. The following classes of concrete are required. Refer to the drawings for their locations.

1. Class A
2. Class B
3. Class C
4. Class D
5. Class E

1.02 SUBMITTALS

A. Submit for approval a minimum of 30 days prior to performing concrete work the following:

List of concrete materials and concrete mix designs proposed for use. Include theresults of all tests performed to qualify the materials and to establish the mix designs.

a. Indicate the following for each mix design submittal:
   1. Building element designation.
   2. Proportions of cement, fine and course aggregates and water.
   3. Water-cement ratio, design strength, slump and air content.
   4. Type of cement and aggregates
   5. Type and dosage of admixtures.
   6. Documentation of average strength for each type of concrete.

1. Copies of manufacturer's specifications with application and installation instructionsforproprietary materials and items, including admixtures and bonding agents.
2. Work plan and shop drawings for construction of the tunnel plug including formwork, concrete mix design, type of temperature sensor and method of securing sensor within the plug, and method for placement of concrete within the plug.

B. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. Production of concrete to comply withspecified requirements is the responsibility of the Subcontractor. Submit the testing lab's average strength curve from the design mix proportions of the approved materials.

C. Submit notarized certification of conformance to referenced standards to the Engineerand a copy ofthe batch plant's most recent scale calibration.

D. Delivery Tickets: Furnish to Engineer copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C94, Section 14.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the latest edition following, except as otherwise shown or specified:

1. ACI 207, Guide to Mass Concrete
2. ACI 301, Specification for Structural Concrete for Buildings, (includes ASTM Standards referred to herein).
3. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305, Recommended Practice for Hot Weather Concreting.
5. ACI 306, Recommended Practice for Cold Weather Concreting.
6. ACI 308, Standard Practice for Curing Concrete.
7. ACI 309, Recommended Practice for Consolidation of Concrete.
8. ACI 318, Building Code Requirements for Reinforced Concrete.
9. ACI 347, Recommended Practice for Concrete Formwork.
10. ASTM C31, Standard Method of Making and Curing Concrete Test Specimens in the Filed.
11. ASTM C33, Standard Specification for Concrete Aggregates.
12. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

13. ASTM C40, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
14. ASTM C42, Standard Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
15. ASTM C94, Standard Specification for Ready-Mixed Concrete.
16. ASTM C138, Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
17. ASTM C143, Standard Test Method for Slump of Portland Cement Concrete.
18. ASTM C150, Standard for Portland Cement.
19. ASTM C157, Standard Test Method for Length Change of Hardened Cement Mortar and Concrete
20. ASTM C171, (1986) Standard Specification for Sheet Materials for Curing Compounds.
21. ASTM C172, Standard Method of Sampling Freshly Mixed Concrete.
22. ASTM C173, Standard Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
23. ASTM C192, Standard Method of Making and Curing Concrete Test Specimens in the Laboratory.
24. ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
25. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete.
26. ASTM C494, Standard Specification for Chemical Admixtures for Concrete.
27. ASTM C827, Standard Test Method for Early Volume Change of Cementitious Mixtures.
28. Federal Specification CCC-C-467C: Cloth, Burlap Jute or Kenaf.

B. Concrete Testing Service:

1. By Subcontractor's Testing Laboratory:

    a. Subcontractor shall employ, at its own expense, a testing laboratory, approvedby the Engineerand experienced in design and testing of concrete materialsand mixes to perform materialevaluation tests and to design concrete mixes.

        1. Testing agency shall meet the requirements of ASTM E 329.
        2. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information, which may be requested by the Engineer.
        3. Submit certification that the testing laboratory meets the requirements ofASTM E329.

b. Materials and installed Work may require testing and retesting, as directed by the Engineer, at any time during the progress of the Work. Allow free accessto material stockpiles andfacilities at all times. Tests not specificallyindicated to be done at the City's expense, including the retesting of rejectedmaterials and installed Work, shall be done at theSubcontractor's expense.

2. By Independent Testing laboratory

a. Testing for concrete field quality control as specified under Paragraph 3.13 and 3.14 of this Specification shall be performed by an independent testing laboratoryapproved by theEngineer. The cost of all concrete testing for field qualitycontrol shall be paid for by theSubcontractor and shall be included in theSubcontractor's base bid. The Subcontractor shall beresponsible for notifying theindependent testing laboratory to schedule the testing asspecified.

C. Test for Concrete Materials:

1. Submit written reports to the Engineer, for each material selected and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of Subcontractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each materials, and test results. Indicate acceptability of materials for intended use.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant. Obtain aggregate from single source from single manufacturer.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Transporting: Ready-mixed concrete supplier shall have sufficient capacity and adequate facilities to provide continuous delivery at the rate required for continuous placement throughout any sequence of placement.

B. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to insure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

C. Storage of Concrete Materials:

1. Store cement in weather tight buildings or bins which prevent intrusion of moisture or contaminants. Store different types of cement in in separate facilities.
2. Stockpile aggregates to prevent segregation and contamination with other materials. Thaw aggregates before use.
3. Sand shall be drained to a uniform moisture content before use.
4. Store admixtures securely to prevent contamination, evaporation damage or temperature variation in excesses of the range recommended by the manufacturer.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement:

1. Portland cement, ASTM C 150, Type II. Cement shall be supplied from a single manufacturer.
2. Do not use cement which has deteriorated because of improper storage, handling or for any other reason.

B. Aggregates: ASTM C 33 and as herein specified.

1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces. Slag materials are not allowed.
2. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.

    a. Dune sand, bank run sand and manufactured sand are not acceptable.

3. Coarse Aggregate: Clean granitic, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.

C. Water: Clean, potable water free from oils, acids, alkalis, potable, organic materials or other substances that may be deleterious to concrete or steel.

2.02 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers, and use incompliance with the manufacturer's printed instruction. Do not use

admixtures, whichhave not been incorporated and tested in the accepted mixes, unless otherwiseauthorized in writing by the Engineer.

B. Provide admixtures certified by the manufacturer to be compatible with other admixtures.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. Air entraining admixture shall conform to ASTM C 260.

E. Fly ash shall conform to ASTM C 618, Type F.

F. High range water reducer (HRWR) shall conform to ASTM C 494, Type G.

G. Calcium Chloride: Do not use calcium chloride in concrete.

H. Crystalline waterproofing additive shall be manufactured by Xypex or approved equal.

2.03 PROPORTIONING AND DESIGN OF MIXES

A. The following classes of concrete are required.

Class of Concrete	Compressive Strength @ 28 Days	Slump Range Before HR/WR	Slump Range After HR/WR	Maximum W/C Ratio	Coarse Aggregate Size
A	5,000	3” – 5”	6” – 9”	0.45	67
B	4,500	3” – 5”	6” – 9”	0.45	67
C	3,500	3” – 5”	6” – 9”	0.44	67
D	3,000	3” – 5”	6” – 9”	0.44	57
E	5,000	3” – 5”	6” – 9”	0.45	67

1. Fly ash is required in Class A concretes. The fly ash shall not exceed more than 20% of combined weight of fly ash and cement. The fly ash shall not be less than 15% of the combined weight of fly ash and cement. The combined weight of cement and fly ash shall be used as the weight of cement in the determining of the water-cement (w/c) ratio.
2. Fly ash and crystalline waterproofing additive are required in Class A concrete. The dosage quantity of crystalline waterproofing additive shall conform to manufacturer’s recommendation.
3. Slump tests shall be made prior to adding the HR/WR. The HR/WR shall be added to the concrete at the batch plant. The slump range required after the addition of the HR/WRis indicated in the table above. HR/WR shall be capable of maintaining the required slump in excess of 60 minutes of

continuous mixing at 4 to 6 rpm in a truck mixer and workability up to 90 minutes. Upon 72 hours notice, the HRWR manufacturer shall supply jobsite technical service to the Subcontractor. The manufacturer shall be consulted for mix proportions and dosage rates. The initial set shall not be in excess of six hours at temperatures above 50 degrees F. HRWR shall be used with due consideration given to the air temperature at the time of batching and casting.

4. If field experience method is used to select concrete mixes, the proposed mix designs shall be accompanied by complete standard deviation analysis and at least 20 consecutive strength test that represent the proposed mix.
5. The proposed mix design and supporting data shall be submitted, in triplicate, to the Engineer at least 30 days prior to the expected start of concreting operations.
6. Compression test specimens made to verify the mixes shall be made in accordance with ASTM C 192. All compression test specimens shall be tested in accordance with ASTM C 39.
7. Adjustment to Concrete Mixes During Construction: Mix design adjustments may be requested by Subcontractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the owner and as accepted by Engineer. Laboratory test data for revised mix designs shall be performed at the Subcontractor's expense and strength results must be submitted to the Engineer for acceptance before using the revised mixes.
8. Mix design shall be proportioned in accordance with ACI 211.1 making maximumuse of the coarse aggregate. The proportioning shall be based on the requirements ofa well-graded high density plastic workable mix within the slump range and strengths required. The mix shall be based on conventional conveying and shall not be altered for use in pumping. Pumping equipment, if used, shall be of sufficient size and design to pump the mix designed for conventional conveyance.
9. Submit samples, in adequate quantities for each mix design and verification, of all concrete materials to be used on the project to the Subcontractors testing laboratory. Do not use any concrete in this work without acceptance and verification of design mix by the Subcontractors testing laboratory and the approval of the Engineer.
10. If laboratory trial batches are used to select concrete mixes, the Subcontractors testing laboratory shall make strength tests from trial batches in the laboratory using materials and mix designs proposed for use by the Subcontractor. The Subcontractors testing laboratory shall prepare trial batches in accordance with ACI 211.1.
11. Class A and Class E concrete shall have 5 ±1% air content.
12. Class B concrete shall have 5 ±1% air content.
13. Class C concrete shall have 5 ±1% air content.

14. The Subcontractor has the option to use coarse aggregate size 57 or 67 in the Main Tunnel concrete lining.
15. Air entrainment is not required in the Main Tunnel concrete lining.

2.04 CHEMICAL HARDENER

A. Unless otherwise specified, all interior concrete floors shall be treated with a liquid hardener composed of magnesium and zinc fluorosilicates combined with an anionic surfactant for improved wetting penetration. Liquid hardener shall be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent toppings and/or coatings. Liquid hardener shall be suitable for use on new or old concrete floors and shall comply with Corps of Engineer Specification 204.

2.05 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute of Kenaf, weighing approximately 10ounces persquare yard and complying with AASHTO M 182, Class 3.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. 4 mil polyethylene.

C. Curing and Sealing Compound: ASTM C-309.

PART 3 - EXECUTION

3.01 CONCRETE MIXING

A. General:

1. Mixing plants shall comply with ASTM C 94 and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet construction schedule. All plant facilities are subject to inspection by the Independent Testing Laboratory and acceptance of the Engineer.

2. Mixing:

a. Mix concrete with an approved rotating type batch machine.
b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.

c. Replace mixer blades when they have lost 10 percent of their original height.
d. Plant equipment and facilities: Conform to National Ready Mix Concrete Association "Plant and Delivery Equipment Specification".
e. Mix concrete in revolving type truck mixers, which are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
f. Do not exceed the proper capacity of the mixer.
g. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
h. Do not allow the drum to sit while in transit.
i. Mix at proper speed until concrete is discharged.
j. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.
k. The Subcontractor shall ensure that the crystallinewaterproofing additive is uniformly dispersed throughout the concrete in accordance with mixing procedures recommended by the supplier.

3.02 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients, except as noted in Section 02425.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete, and do not add any water at the jobsite.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

F. For Tunnel and Shaft permanent lining, refer to Section 02425.

3.03 CONCRETE PLACEMENT

A. For tunnel and shaft permanent linings, refer to Section 02425.

B. Inspection of Work Before Placing Concrete:

1. Inspect the area to receive concrete for any deficiencies, which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.

2. Do not place in the concrete any item that is not required to be in the concrete by the Drawings and Specifications. Insert all the items shown on the Contract Drawings or specified properly positioned and secured. Openings other than those, which are facilitated by sleeves shall be properly formed and positioned only after approval of the Engineer.
3. Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.
4. Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable sections of the Specifications for that work.
5. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

C. Place concrete continuously so that no concrete will be placed on concrete, which hashardened sufficiently to cause the formation of seams or planes of weakness withinthe section. Deposit concrete as nearly as practical in its final location to avoidsegregation due to rehandling or flowing. Do not subject concrete to any procedure,which will cause segregation.

1. Screed concrete, which is to receive other construction to the proper level to avoidexcessiveskimming or grouting.
2. Do not use concrete which becomes non-plastic and unworkable, or does not meetthe requiredquality control limits, or which has been contaminated by foreignmaterials. Do not useretempered concrete. Remove rejected concrete from the jobsite and dispose of it in an acceptable location.
3. Do not place concrete until all forms, bracing, reinforcement, and embedded itemsare in finaland position and secure.
4. Unless otherwise approved, place concrete only when Engineer is present.

D. Concrete Conveying:

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods, which will prevent segregation and loss of concrete mix materials.
2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.
3. Do not use chutes for distributing concrete unless approved in writing by the Engineer.
4. Pumping of concrete is permitted however, do not use aluminum piping to convey the concrete.

E. Placing Concrete into Forms:

1. Deposit concrete in forms in horizontal layers not deeper than 18 inches and in amanner to avoidinclined construction joints. Where placement consists of severallayers, place concrete at such arate that concrete, which is being integrated withfresh concrete is still plastic with adequatevibration.
2. Do not permit concrete to free fall within the form from a distance exceeding 4 feet. Use "elephant trunks" and tremies to prevent free fall and excessive splashing on forms and reinforcement.
3. Remove temporary spreaders in forms when concrete placing has reached theelevation of suchspreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipmentsupplemented by hand-spading,rodding or tamping. Use equipment and proceduresfor consolidation of concrete inaccordance with the applicable recommendedpractices of ACI 309. Vibration of forms and reinforcing will not be permitted,unless otherwise accepted by the Engineer.
5. Do not use vibrators to transport concrete inside of forms. Insert and withdrawvibratorsvertically at uniformly spaced locations not farther than the visibleeffectiveness of the machine.Place vibrators to rapidly penetrate the layer of concreteand at least 6 inches into the preceding layer. At each insertion, limit the durationof vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
6. Force concrete under pipes, sleeves, openings and inserts from one side until visiblefrom theother side to prevent voids.

F. Placing Concrete Slabs and Sidewalks:

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of expansion joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibratingequipment, so thatconcrete is thoroughly worked around reinforcement and otherembedded items and into comers.
3. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations. Coordinate applying contraction joint, per Section 03250, with finishing operations.

G. Quality of Concrete Work:

1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
2. All concrete for liquid retaining structures, and all concrete in contact with earth, water or exposed directly to the elements shall be watertight.
3. Cut our or chip out and properly replace to the extent ordered by the Engineer or repair to the satisfaction of the Engineer, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering will not be acceptable.
4. All leaks through concrete and cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by the contractor.
5. Repair, removal and replacement of defective concrete as ordered by the Engineer shall be at no additional cost to the City.

H. Cold Weather Placing:

1. Protect all concrete Work from physical damage or reduced strength, which couldbe caused byfrost, freezing actions, or low temperatures, in compliance with therequirements ofACI 306, ACI 306R and as herein specified.
2. When the air temperature has fallen to or may be expected to fall below 40 F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50° F and 70° F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to insure that the ambient temperature does not fall below 30° F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When the average of the highest and lowest ambient temperature from midnight to midnight is expected to be less than 40 degrees F for more than three successive days, deliver concrete to meet the following minimum temperatures immediately after placement. The temperature of concrete placed shall not exceed these values by more than 20 degrees F.
   a. 55 degrees F for sections less than 12 inches in least dimension;
   b. 50 degrees F for sections 12 to 36 inches in the least dimension;
   c. 45 degrees F for sections 36 to 72 inches in the least dimension;
   d. 40 degrees F for section greater than 72 inches in the least dimension.
4. The minimum requirements may be terminated when temperatures above 50 degrees F occur during more than half of any 24 hour duration.
5. Do not use frozen materials containing ice or snow. Ascertain that forms, reinforcing- steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

6. Do not use calcium chloride, salt and other materials containing anti-freeze agents or chemical accelerators, or set control admixtures, unless approved by the Engineer, in mix designs.

I. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI~~305~~301, ACI 305.1, ACI 305R and as herein specified.
2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90° F when the temperature is rising and below 85° F when the temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated by the Engineer in the total amount of mixing water.
3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
4. Wet forms thoroughly before placing concrete.
5. Keep subgrade uniformly moist without standing water, soft spots or dry areas.
6. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
7. Do not use set-control admixtures unless approved by the Engineer in mix designs.
8. Obtain Engineer's approval of other methods and materials proposed for use.
9. Precautions to protect fresh concrete from developing plastic shrinkage cracks must be taken in advance of concrete placement when evaporation rate due to any combination of temperature, humidity, and wind velocity is expected to approach 0.2 lb./sq. ft./hr. as determined by ACI 305R. Acceptable precautions to reduce the rate of evaporation include use of wind breaks, fog spray, covering the polyethylene sheeting, or wet cover.

J. Windy Weather Placement: Comply with ACI 301, ACI 305.1, ACI 305R and as herein specified.

1. Precautions to protect fresh concrete from developing plastic shrinkage cracks must be taken in advance of concrete placement when evaporation rate due to any combination of temperature, humidity, and wind velocity is expected to approach 0.2 lb./sq. ft./hr. as determined by ACI 305R. Acceptable precautions to reduce the rate of evaporation include use of wind breaks, fog spray, covering the polyethylene sheeting, or wet cover.

K. Mass Concrete Placing:

1. Any placement of structural concrete with minimum dimension equal or greater than 3 feet shall be considered mass concrete.
2. A thermal control plan shall be developed to ensure that the maximum temperature in concrete will not exceed 158 degrees Fahrenheit and the temperature difference between center and surface will not exceed 35 degrees Fahrenheit.
3. Mass concrete placed for the tunnel plug shall incorporate a temperature sensor embedded in the middle of the plug prior to concrete placement in order for the Engineer to have access to monitor the internal temperature of the concrete. The temperature sensor reading shall be equivalent to the ambient temperature in the tunnel or a temperature approved by the Engineer prior to performing contact grouting of the tunnel plug.
4. Prior to placing mass concrete for the tunnel plug, the contractor shall sound and scale the exposed rock in the tunnel plug section to remove any loose rock. Any flowing, moving or drippingwater shall be stopped through grouting prior to placing concrete. The Subcontractor shall propose a grouting method which suits his means and methods for approval by the Engineer prior to commencing with grouting.
5. The Subcontractor shall construct the tunnel plug with a continuous concrete placement to avoid cold joints within the concrete. The Subcontractor shall sequence the concrete placement so that the lower sections of the concrete shall have the ability to start initial set and not apply lateral loading on the forms in order to prevent movement of the form work.

3.04 CONSTRUCTION JOINTS

A. For tunnel and shaft permanent linings, refer to Section 02425.

B. Formed Construction Joints in Containment Structures and Where Otherwise Shown: Prior to placing concrete next to the joint, the joint surface shall be thoroughly cleaned and dampened with water. Remove all free water so that the surface of the joint shows signs of drying before placing the adjacent concrete.

C. Construction Joints in Beams, Girders and Slabs: These joints shall be located at points of minimum shear and their locations shall be approved by the Engineer before they are bulk-headed. These joints shall be roughened and thoroughly cleaned of all foreign matter and laitance and dampened with water. Remove all free water and slush with a coat of neat cements grout before placing the adjacent concrete. Place the adjacent concrete before the neat cements grout takes its initial set.

3.05 WATERSTOPS

A. Waterstops shall be provide where specified and as indicated and noted on the Contract Drawings and shall be made continuous throughout their length.

3.06 FINISH ON FORMED SURFACES

A. For tunnel and shaft linings, refer to Section 02425.

B. Smooth Form Finish is required for all concrete surfaces exposed to view in the completed work and inside surfaces of all liquid containment structure walls whether exposed to view or not in the completed work. Accomplish the required patching and the following touch-up:

1. Remove all burrs.
2. Remove all form marks.
3. Smooth out lines of indentations.
4. Remove form ties and fill in indentations.

C. Rough Form Finish shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed. All concrete surfaces which will be covered by earth and which will not be visible in the completed structure (except as noted above for liquid containment structure walls which shall have a Smooth Form Finish), may receive a Rough Form Finish.

3.07 STEEL TROWELED FINISH - FLOOR SLABS

A. Steel troweled finish shall be applied to the surface of all building and liquid containment structure floor slabs and interior equipment pads.

B. Concrete shall be placed, consolidated, struck-off and leveled to the proper elevation. After the surface has stiffened sufficiently to permit the operation and the water sheen has disappeared, the surface shall be wood floated, by hand or power floated, at least twice, to a uniform sandy texture. Floors shall be leveled such that depressions between high spots do not exceed ~~Y4~~ 1/4-inch under a 10 foot straightedge except where drains occur, in which case the floors shall be pitched to the drains as indicated on the Drawings.

C. After the concrete has received a wood float finish, it shall be troweled at least twice to a smooth dense finish. The drying of the surface moisture between floating or troweled shall not be hastened by the dusting on of dry sand or cement. The first troweling shall be done by a power trowel and shall produce a smooth surface relatively free of defects. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks or other imperfections; shall be uniform in texture and appearance, and shall be in true plane within the

tolerance specified. Any deviation from this condition, which remains after the troweling is completed shall be corrected by grinding.

3.08 WOOD FLOAT FINISH

A. A wood float finish shall be applied to all base and top slabs.

3.09 BROOM FINISH

A. Broom finish shall be applied to:

1. All exterior sidewalks, walkways and platforms.
2. All steps and landings, both interior or exterior.

B. The surface shall be given a floated finish as specified above, then finished with a flexible bristle broom or burlap belt drawn across the surface. Surface must be hardened sufficiently to retain the scoring or ridges. Scores or ridges shall be transverse to traffic or at right angles to the slope of the slab.

3.10 PROTECTION

A. Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of slabs will be permitted for the first 14 days after placing of the concrete.

3.11 CURING

A. For tunnel and shaft permanent linings, refer to Section 02425.

B. Curing shall conform to ACI 308 except as modified herein.

C. All Slabs on Grade: After placement and finishing, concrete shall be maintained in a moist condition for at least seven successive days during which the temperature of the concrete is 50 degrees F or above. For temperatures of 50 degrees F and below, curing period shall be 14 successive days. Concrete shall be kept moist by anyone, or combination, of the following methods:

1. Ponding or Immersion: Continually immerse the concrete in water throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.
2. Fog Spraying or Spinkling: Provide uniform and continuous application of water throughout the curing period. Pervious Sheeting: Completely cover surface and edges of the concrete with two thicknesses of wet sheeting.

Overlap sheeting 6-inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3. Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting lot less than 18inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Inspect surface of concrete daily for wetness. The surface shall be kept continuously wet during the curing period.

D. All Other Concrete:

1. After placement, concrete shall be maintained in a moist condition for the same periods as specified above for slabs on grade. For concrete in formed surfaces, keep forms wet with water during the curing period. If forms are removed before the end of the curing period, continue the moist curing in accordance with Paragraph C of this article of these Specifications.

3.12 PATCHING

A. As determined by the Engineer, any concrete, which is out of alignment or level has a defective surface or has defects, which reduce its structural adequacy, shall be considered as not conforming with the Drawings and Specifications and shall be rejected.

B. Do not take any remedial action on concrete with any defect without the permission of the Engineer.

C. Unless the Engineer grants permission to patch the rejected concrete, remove the rejected concrete and replace it with concrete that conforms to the Drawings and Specifications. The location of cut lines and the extent of removal will be determined by the Engineer.

D. If the Engineer grants permission to path the rejected concrete, it shall be done in accordance with the following:

1. Permission to patch rejected concrete will not be a waiver of the Engineer's right to require complete removal of the rejected concrete if the patching does not, in the Engineer's judgement, restore the concrete to the requirements of the Specifications and Drawings.

2. Patching shall be accomplished after the curing is completed.
3. Defective areas shall be chipped away to a depth of not less than 1-inch, in all cases to sound concrete, with edges perpendicular to the surface. Feather edges will not be permitted. Remove all loose material and thoroughly clean the chipped surfaces with a high pressure air hose delivering air at 100 psi. The area to be patched and an area at least 6-inches wide surrounding it shall be dampened. A bonding grout shall be prepared using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surfaces as noted in paragraph 5.
4. The patching mixture shall be made of the same materials and of approximately the same portions as used for the original concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp,loose volume. While Portland cement shall be substituted for a part of the gray Portland cement to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
5. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Finishing tools that produce a finish matching the surrounding shall be used.

E. Tie holes left by withdrawal of rods or the holes lefty by removal of ends of wall ties shall be filled solid with mortar after first being wetted. For holes passing through the wall, a plunger-type grout gun shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing through the walls shall be filled with a small tool that will permit packing the hole solid with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth. Mortar shall consist of one part cement, two and one-half parts sand and no more water than necessary for handling and packing.

3.13 QUALITY CONTOL TESTING

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections as noted below along with inspection schedule items included in the Contract Drawings. Testing agency shall prepare tests and inspection reports and submit to Owner and Owner's Consultants.

B. Quality Control Testing During Construction:

1. Verification of use of required design mixture.
2. Concrete placement, including conveying and depositing.
3. Curing procedure and maintenance of curing temperatures.
4. Perform sampling and testing for field quality control during the placement of concrete, as follows:

a. SamplingFresh Concrete: ASTM C172; make on set of 4 standard cylinders for each compressive strength test, unless otherwise directed.
b. Slump: ASTM C143; one test at point of placement for each set of compressive strength test specimens. Perform additional tests when concrete consistency appears to change.
c. Air Content: ASTM C231; one for each set of compression cylinders cast.
d. Compression Test Specimens: ASTM C31

1. Castand laboratory cure four standard cylinders for each composite sample of 6x12" cylinder specimens or cast and laboratory cure five standard cylinder specimens for each composite sample of 4x8" cylinder specimens.
2. Cast and field cure four standard cylinders for each composite sample of 6x12" cylinder specimens or cast and field cure five standard cylinder specimens for each composite sample of 4x8" cylinder specimens.

e. Compressive Strength Tests: ASTM C39; one set of compression cylinders for each 50 cubic yards of concrete nor less than once for every 5,000 SF of surface area for slabs or wall, of each mix design placed in any one day; each class of concrete shall be tested with at least five strength tests.

1. Test one laboratory-cured specimen at 7 days, and either two 6x12" cylinder specimens or three 4x8" cylinder specimens at 28 days. The remaining laboratory-cured specimen shall be a hold cylinder to be broken at the discretion of the Engineer.
2. Test two field-cured specimens at 7 days and either two 6x12" cylinder specimens or three 4x8" cylinder specimens at 28 days.
3. A compressive-strength test shall be the average compressive strength from two 6x12" cylinder specimens or three 4x8" cylinder specimens obtained from same composite sample and tested at age indicated.

4. Adjust mix if test results are unsatisfactory and resubmit for Engineer's approval.
5. Concrete which does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by the Engineer, at the expense of the Contractor.
6. Test for unit weight of concrete when the first load of each class of concrete is delivered and thereafter at the discretion of the testing laboratory.

f. Concrete Temperature: ASTM C 1064; Test hourly when air temperature is 40 F and below, and when 80 F and above; and each time a set of compression test specimens is made.

C. Periodically inspect the batching plant and file a report with the Engineer stating whether the supplier's equipment and methods meet the requirements of these Specifications.

D. Temperature and Placing Record: Temperature record shall be made each day during the concreting operations. Records shall also include location, quantity and starting and finishing time of placement for all concrete work. Copy distribution shall be as specified above for test reports.

E. All work and reports shall comply with Applicable Industry Standards.

3.14 EVALUATION OF COMPRESSION TESTS

A. Evaluation of compression test results shall be as follows: For each class of concrete, compression strength tests for laboratory-cured cylinders shall be considered satisfactory if the averages of the results of all sets of three consecutive compression-strength tests equal or exceed the 28 day design compression-strength specified; and, no individual cylinder strength test falls below the required compression strength by more than 500 psi. Strength tests of specimens cured under field conditions may be required by the Engineer to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded by the field testing laboratory at the same time and from the same samples as the laboratory-cured specimens.

B. Provide improved means and procedures for protecting concrete when the 28 day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory cured cylinders.

C. Faulty Concrete: Failure to comply with any of the specified conditions shall constitute faulty concrete. Unless otherwise directed by the Engineer, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the Owner.

D. Additional Test: If permitted by the Engineer, additional tests shall be subject to the approval of the Engineer at no expense to the Owner. Load tests, if permitted by the Engineer, shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the Engineer.

E. Neither the results of laboratory verification tests nor any provision in the Contract Documents shall relieve the Subcontractor of the obligation to furnish concrete of the class and strength specified.

3.15 TESTING FOR WATERTIGHTNESS OF SURFACE CONCRETE STRUCTURES

A. Leakage testing shall be carried out in accordance with ACI 350.1 – T*ightness Testing of Environmental Engineering Concrete Structures*. The test criterion shall be HST-NML (no measurable loss) as defined by ACI.

B. All concrete structures designed to contain or convey fluid shall be tested for water tightness by the Subcontractor prior to earth backfilling by filling with water to levels approximately what will be attained during operation and measuring the drop in level due to leakage, if any. These tests shall be made under the direction of the Engineer, and if necessary the tests shall be repeated until water tightness is insured. Perform tests prior to backfilling below grade structures and prior to installations of any coating.

C. Rate of filling shall be limited to minimize shock-effect to new concrete construction. Water shall be held under each condition long enough to satisfy the Engineer that the structures are watertight. Structures shall be free of internal or external water leakage.

D. Leakage shall be located and stopped and the structure again tested until this requirement is met. If the structure does not meet the test, the Subcontractor shall repair or replace at his own expense, such part of the work as may be necessary to secure the desired results, as approved by the Engineer.

+ + + END OF SECTION 03300 + + +

SECTION 03345
CONCRETE FLOOR TREATMENT

PART 1 - GENERAL

1.01 SCOPE

A. Provide surface treatment for dustproofing, hardening, and sealing exposed concrete floors as indicated.

1.02 RELATED WORK

A. Section 03300: Cast-in-Place Concrete

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

1. D4263: Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Submit manufacturer's product data.

2. Submit manufacturer's surface preparation and application instructions.

3. Submit manufacturer's color charts.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Sections 01610 and 01611.

PART 2 - PRODUCTS

2.01 DUSTPROOF/SEALER (DPS)

A. Manufacturers:

1. Armorseal Rexthane 1 manufactured by Sherwin Williams.

2. Duraguard 300HS manufactured by ChemMasters.

3. Eucothane manufactured by the Euclid Chemical Company.

4. Or equal.

B. Provide a high solids, single component, moisture cure urethane with VOC compliance.

C. Provide surface primer in accordance with manufacturer’s printed instructions.

D. Colors as indicated in Finish Schedule.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. General:

1. Prepare concrete surfaces in accordance with manufacturer's printed instructions. Concrete shall be cured for a minimum of 28 days prior to application of floor treatment.

2. Acid etching will not be allowed.

3. Concrete surfaces shall be free of dirt, oil, wax, sealers, grease, rust stains, curing and parting compounds and other foreign matter.

3.02 APPLICATION

A. Dustproof/Sealer (DPS):

1. Perform testing for vapor drive on concrete floors in accordance with ASTM D4263 prior to application. Do not apply dustproof/sealer until test results have been approved by Engineer.

2. Apply primer in accordance with manufacturer’s printed instructions.

3. Give particular attention to priming of concrete substrate and time laps between coats when more than one conditioning coat is required.

4. Mix colored polyurethane dustproof/sealer surface treatment and apply to sound, fully cured, dry and thoroughly clean concrete slabs in strict accordance with manufacturer's printed instructions.

a. Total dry film thickness for both primer and topcoat shall be 4 mils.

+ + + END OF SECTION 03345 + + +

SECTION 03420
STRUCTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

This Section specifies all labor, materials, equipment, and services necessary to provide the structural precast concrete members indicated or specified.

1.02 QUALITY ASSURANCE

A. References: This Section references the following documents. They are a part of this Section insofar as specified and modified herein. In case of conflict between the requirements of this Section and the listed documents, the requirements of this Section shall prevail. Use the latest editions of these documents.

Reference	Title
ACI Standard 318	Building Code Requirements for Reinforced Concrete
ASTM A416	Specification for Uncoated Seven-Wire Stress-Relieved Strand for Precast Concrete
ASTM A320	Specification for Alloy-Steel Bolting Materials for Low Temperature
ASTM D2240	Tests for Rubber Property-Durometer Hardness
ASTM D412	Tests for Rubber Properties in Tension
ASTM C33	Specification for Concrete Aggregates

B. Performance and Design Requirements: Cast and erect members shall conform to tolerances of PCI Standard MNL 16 latest edition except as noted.

C. Testing: Testing shall be in general conformance with testing provisions in Prestressed Concrete Institute "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Product," MNL-116.

D. Manufacturer Qualifications: The precast concrete manufacturing plant shall be certified by the Prestressing Concrete Institute, Plant Certification Program, prior to start of production.

a. Group C, Category C1 - Precast Concrete Products (no prestressed reinforcement), Category C4 - Prestressed Deflected Strand Structural Members.

E. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect Category S2 - Complex Structural Systems.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. The qualified professional engineer, licensed in the state where the project is located, shall be responsible for the design of the complete structural system, including the design of all precast components, connections and lateral-load resisting system.

B. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

C. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Dead Loads: As specified on the Contract Drawings.
2. Concrete Topping Load: As specified on the Contract Drawings.
3. Live Loads: As specified on the Contract Drawings.
4. Snow Loads: As specified on the Contract Drawings.
5. Seismic Loads: As specified on the Contract Drawings.
6. Wind Loads: As specified on the Contract Drawings.
7. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318.

    a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of minus 18 to plus 120 deg F.

8. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions. In addition, the following specific information shall be provided:

1. Product Data: For each type of product indicated
2. Design Mixtures: For each precast concrete mixture. Include compressive strength and water absorption tests.
3. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.

a. Submit shop drawings electronically in PDF format via email for review the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.
b. Only complete shop drawings submittals will be reviewed. Shop drawings no in compliance with the Submittal portion of this document will be rejected. Time required by Wallace Engineering Structural Consultants, Inc. to review shop drawing submittals a second or third time will be billed to the General Contractor at Wallace Engineering Structural Consultants, Inc. hourly rates.
c. Indicate joints, reveals, and extent and location of each surface finish.
d. Indicate separate face and backup mixture locations and thicknesses.
e. Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.
f. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
g. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
h. Include and locate openings larger than 10 inches.
i. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
j. Indicate relationship of precast structural concrete units to adjacent materials.
k. Indicate locations and details of brick units, including corner units and special shapes, and joint treatment.
l. Indicate locations and details of stone facings, anchors, and joint widths.
m. Indicate estimated camber for precast floor slabs with concrete toppings.
n. Indicate shim sizes and grouting sequence.
o. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

4. Erection Drawings:

a. Erection drawings shall consist of the following.

1) Plans and elevations locating and defining all material furnished by manufacturer
2) Sections and details showing connections, cast in items and their relation to the structure
3) Description of all loose, cast in and field hardware.

4) Field installed anchor location drawings.
5) Erection sequences and handling requirements

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement: Portland cement shall be ASTM C150, *'Type II* and conform to Section 03300.

B. Admixtures: Admixtures shall conform to Section 03300.

C. Aggregates: Aggregates shall conform to Section 03300.

D. Water: Water shall conform to Section 03300.

E. Reinforcing Steel: Reinforcing steel shall conform to Section 03200.

F. Shapes, Plates, Anchors and Inserts: Steel shapes, plates, anchors and inserts shall be from material conforming to ASTM A36. Finish shall be manufacturer's standard shop primer or hot dip galvanized if exposed to earth or weather.

G. Grout:

1. Cement grout shall consist of one-part cement to three parts water with sufficient water for workability.
2. Nonshrink grout shall conform to Section 03600.

H. Bearing Pads: Neoprene bearing pads shall conform to requirements of ASTM D2240 and D412, Grade 2 Durometer 60 or higher.

I. Welding Studs: Welding studs shall conform to AWS D1.1.

2.02 CONCRETE ADMIXTURES

A. Concrete shall have a minimum 28-day strength of 7,000 psi.

2.03 MANUFACTURE

A. Manufacturing Procedures: Manufacturing tolerances shall comply with PCI MNL-116.

B. Finishes:

1. Standard Underside: Resulting from casting against approved forms using good industry practice in cleaning of forms, design of concrete mix, placing, and curing. Small surface holes caused by air bubbles, normal color variations, normal form joint marks, and

minor chips and spalls shall be tolerated, but no major or unsightly imperfections, honeycomb, or other defects shall be permitted.

2. Standard Top: Results of vibrating screed and additional hand finishing at projection. Normal color variations, minor indentations, minor chips and spalls shall be permitted. No major imperfections, honeycomb, or defects shall be permitted.

C. Patching: Patching shall be acceptable providing the structural integrity of the product and the appearance are not impaired.

D. Fastenings: Manufacturer shall cast in inserts, bolts, and plates as required for the Project.

PART 3 - EXECUTION

3.01 ERECTION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

B. All members shall be erected in workmanlike manner, using only competent experienced workmen. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

C. All connections shall be made in accordance with the Contract Drawings and the approved shop drawings.

D. Subcontractor shall furnish, erect, and remove all temporary elements required for shoring or bracing of members in place until permanently attached.

E. Members shall be leveled to a tolerance of plus or minus 1/4 inch.

F. All welding shall be performed using only certified welders (certification approved during the preceding 12-month period) in accordance with the Contract Documents and the approved shop drawings.

G. Subcontractor shall take all necessary precautions to protect members from damage after installation. Remove all wedges, spacers, or other setting appliances which are likely to cause straining from joints as soon as practical. Repair or replace any members which do not comply with Contract Documents or approved shop drawings.

H. Install neoprene bearing pads of sizes indicated as detailed necessary for erection

of members. No shims allowed under slab edge at bearing.

3.02 REPAIRS

A. Repair precast structural concrete units if permitted by Architect.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

+ + + END OF SECTION 03420 + + +

SECTION 03600
GROUT

PART 1 - GENERAL

1.01 SCOPE

A. The work covered under this Section includes furnishing all labor, materials, equipment, and incidentals required to provide grout as shown and specified.

B. The types of grout include the following:
   1. Non-shrink, epoxy type.
   2. Non-shrink, non-metallic type.
   3. Ordinary cement-sand.
   4. Refer to Section 03300 for pressure grouting applications.

C. Related Work Specified Elsewhere:

   1. Section 03200, Concrete Reinforcement and Dowelling.
   2. Section 03300, Cast-In-Place Concrete.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

   1. Copies of manufacturer's specifications and installation instructions for all proprietary materials.
   2. Reports and Certificates:

      a. For proprietary materials, submit copies of reports on quality control tests.

      b. For nonproprietary materials, submit certification that materials meet specification requirements.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

   1. ASTM C 150, Portland Cement.
   2. ASTM C 109, Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
   3. ASTM C 191, Time of Setting of Hydraulic Cement by Vicat Needle.
   4. CRD-C 588, Specifications for Non-Shrink Grout.

1.04 PRODUCT DELIVERY. STORAGE AND HANDLING

A. Delivery of Materials: Grout materials from manufacturers shall be delivered in unopened

containers and shall bear intact manufacturer's labels.

B. Storage of Materials: Grout materials shall be stored in a dry shelter and shall be protected from moisture.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Non-metallic, cartridge style, 100 percent solids, high strength epoxy grout.

1. Product and Manufacturer: Speed Bond #1 as manufactured by Prime Resins Inc.
2. Or Equal.

B. Non-Shrink, Non-Metallic Grout:

1. Pre-mixed non-staining cementious grout requiring only the addition of water at the jobsite meeting ASTM C-827 and CRD C-621.
2. Product and Manufacturer:
   a. Sikagrout 212 by Sika Corp.
   b. Masterflow 713 by Master Builders Company.
   c. Non-Ferrous Non-Shrink Grout by the Burke Company.
   d. Non-Shrink, Non-Metalic Grout as manufactured by W. R.Meadows.
   e. Or Equal.

C. Ordinary Cement-Sand Grout:

1. Except where otherwise specified use 1 part cement to 3 parts sand complying with the following:
   a. Cement: ASTM C 150, Type II.
   b. Sand: ASTM C 33.
2. For water repelling and shrinkage reducing requirements use admixtures.
   a. Product and Manufacturer:
      1. Integral Waterpeller by The Euclid Chemical Company.
      2. Omicron, Type OM by Master Builders Company.
      3. Hydrocide Powder by Sonneborn-Contech.
      4. Or Equal.
3. For use at horizontal waterstops only.

D. Water:
1. Use clean, fresh, potable water free from injurious amounts of oils, acids, alkalies or organic matter.

E. Epoxy Resin Adhesive:
1. Two part mix 1:1
2. Manufacturer: Sika Corp - Sikadur 32, Hi-Mod (Horizontal joints), Sikadur 31 Hi-Modgel (Vertical joints) or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:
   1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until Engineer provides clarification.
   2. Drypacking will not be permitted unless approved by the Engineer.
   3. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
   4. Placing grout shall conform to temperature and weather limitations in Section 03300.
   5. Surface to be grouted is to be adequately cured, cleaned dampened and roughened per manufacturer recommendations to insure adequate bonding.

B. Pipe Railings:
   1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink, non-metallic grout. Bevel grout at juncture with post so that moisture flows away from post.
   2. Do not grout railing designated as "removable sections".

C. Grout for Dowelling and Anchor Bolts:
   1. Grout shall be introduced at the bottom of the drill holes using a caulking tube or other injection means. The hole shall be blown out or pumped dry prior to the introduction of grout into the hole. Care shall be taken to adequately fill the hole with grout before the dowel or anchor rod is inserted, to insure complete contact with the anchor for its full length.
   2. A plug shall be placed in the top of the hole to hold the bars securely until the grout sets. Special care shall be taken to insure against any movement of the bars which have been placed.
   3. Epoxy resin Adhesive may be used in accordance with manufacturer's recommended application.

D. Grouting for Waterstops:
   1. Grout for PVC waterstops to be the non-shrink, non-metallic type. Refer to Section 03251 for installation procedures.
   2. Grout from Redi-mix plant conforming to applicable requirements of Section 03300 may be substituted at no additional compensation to the contractor.

E. Grouting for Weir and Slide Gates:
   1. Provide minimum of 1" thickness of non-shrink, non-metallic grout under frames. Gates to be coated with an approved epoxy coating per Section 09900 prior to installing and grouting.

F. Grouting for Bearing Plates and Equipment:
   1. Use non-shrink, non-metallic grout for setting bearing plates and equipment. Provide a minimum grout thickness of 1".

G. Patchwork at Demolition Areas:
   1. Furnish and install non-shrink, non-metallic grout for dry packing as required to patch all mechanical, electrical and miscellaneous penetrations which are either designated to be patched or are the result of abandoned, removed or relocated material and equipment. Prepare surface and place grout as recommended by manufacturer and as specified. Finish grout off flush with existing surface.
   2. Reinforce with approved wire mesh and use approved structural concrete for penetrations larger than 1/2 square feet. Conform to requirements of Sections 03100, 03200 and 03300.

+++ END OF SECTION 03600 +++

SECTION 04200
CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

B. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Embedded flashing.
6. Miscellaneous masonry accessories.

1.03 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days as specified on Contract Drawings.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.05 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing and inspecting agency to perform tests and inspections as noted below along with inspection schedule items included in the Contract Drawings. Testing agency shall prepare tests and inspection reports and submit to Owner and Owner's Consultants. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections.

Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.

2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109 for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.

3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.

4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.06 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Submit shop drawings electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.

2. Only complete shop drawing submittals will be reviewed. Shop drawings not in compliance with the Submittal portion of this document will be rejected. Time required by the Structural Engineer and Architect to review shop drawing submittals a second or third time will be billed to the General Contractor at the Structural Engineer/ Architect hourly rates.

3. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

4. Submit an elevation drawing of each reinforced CMU wall that shows:

   a. Reinforcing bar size, quantity, spacing, length and grade of steel.
   b. Horizontal and vertical locations of all bearing plates and embed plates.
   c. Location of each control joint.
   d. Horizontal and vertical location of all embedded anchors.
   e. Location and length of lap splices.

5. Submit details showing proper location of reinforcing bars (vertical and horizontal), bearing plates, embed plates and anchor bolts.

6. Include masonry notes that concern construction means and methods, grouting procedures, and proper alignment of reinforcing bars (vertical and horizontal), bearing plates, embed plates and anchor bolts.

7. Prepare shop drawings in accordance with ACI 315. Do not use reproductions of Contract Drawings as shop drawings.

8. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Verification: For each type and color of the following:

1. Accessories embedded in masonry.

D. Qualification Data: For testing agency.

E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.
b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.

3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.

6. Joint reinforcement.

7. Anchors, ties, and metal accessories.

F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109 for compressive strength.

2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

G. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

H. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for each type of exposed unit masonry construction as specified by the architect.

2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.

3. Protect approved sample panels from the elements with weather-resistant membrane.

4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

F. Preinstallation Conference: Conduct conference at Project site.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

   2. Protect sills, ledges, and projections from mortar droppings.

   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry

damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 PRODUCTS

2.01 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated on Contract Drawings, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.02 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated on Contract Drawings.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as specified on Contract Drawings.

2. Density Classification:

a. Normal weight below grade unless otherwise indicated on Contract Drawings.
b. Lightweight above grade unless otherwise indicated on Contract Drawings.

3. Size (Width): Manufacturer’s standard units with nominal face dimensions of 16” long x 8” high.

a. Manufactured to dimensions 3/8 inch less than nominal dimensions.

4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

2.03 MASONRY LINTELS

A. General: Provide one of the following:

B. Masonry Lintels: Built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

2.04 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated on Contract Drawings or as selected by Architect from manufacturer's colors.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: Not allowed.

E. Mortar Cement: ASTM C 1329.

1. Products: Type S - Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Lafarge North America Inc.; Lafarge Mortar Cement or Magnolia Superbond Mortar Cement.
    b. Argos – Type S
    c. Amerimix – Type S
    d. Glen Gerry Mortar Cement – Type S
    e. Workrite Mortar Cement – Type S
    f. or Approved Equal

F. Colored Cement Product: Packaged blend made from portland cement and hydrated lime or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
        1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
        2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.

3) Lafarge North America Inc.; Eaglebond Portland & Lime.
4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
5) Or approved equal

G. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

H. Aggregate for Grout: ASTM C 404.

I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Euclid Chemical Company (The); Accelguard 80.
b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

J. Water: Potable.

2.05 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Hot-dip galvanized, carbon steel.

2. Exterior Walls: Hot-dip galvanized, carbon or stainless steel.

3. Wire Size for Side Rods: 0.148-inch diameter.

4. Wire Size for Cross Rods: 0.148-inch diameter.

5. Wire Size for Veneer Ties: 0.148-inch diameter.

6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.06 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed steel bolts complying with F1554, Grade 55 weldable, with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of dimensions indicated.

2.07 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim" and as follows:

1. Fabricate through-wall flashing with Stainless Steel drip edge **where** indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees **and hemmed**.

2. Fabricate through-wall flashing with sealant stop **where** indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

3. Fabricate metal **drip edges and sealant stops** for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.

4. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees **and hemmed**.

5. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

6. Metal Expansion-Joint Strips: Fabricate from **stainless steel** to shapes indicated.

B. Flexible Flashing: Use **one of** the following unless otherwise indicated:

1. Copper-Laminated Flashing: 5-oz./sq. ft. copper sheet bonded min between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1) Advanced Building Products Inc.; **Copper Fabric Flashing** or **Copper Sealtite 2000**].

2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
6) York Manufacturing, Inc.; Multi-Flash 500.

2. Asphalt-Coated Copper Flashing: **7-oz./sq. ft.** copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.

   a. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      1) Advanced Building Products Inc.; Cop-R-Cote.
      2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Coated Thru-Wall Flashing.
      3) Hohmann & Barnard, Inc.; H & B C-Coat Flashing.
      4) Phoenix Building Products; Type ACC-Asphalt Bituminous Coated.
      5) Sandell Manufacturing Co., Inc.; Coated Copper Flashing.

3. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than **0.040 inch**.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Advanced Building Products Inc.; Peel-N-Seal.
      2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
      3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier Thru-Wall Flashing.
      4) Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
      5) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
      6) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
      7) Hohmann & Barnard, Inc.; Textroflash.
      8) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
      9) Polyguard Products, Inc.;**Polyguard 400**.
      10) Sandell Manufacturing Co., Inc.; Sando-Seal.
      11) Williams Products, Inc.; Everlastic MF-40.

   b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

4. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1) DuPont; Thru-Wall Flashing.
   2) Hohmann & Barnard, Inc.; Flex-Flash.
   3) Hyload, Inc.; Hyload Cloaked Flashing System.
   4) Mortar Net USA, Ltd.; Total Flash.

b. Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of adhesive.
d. Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of rubberized-asphalt adhesive. Where flashing extends to face of masonry, rubberized-asphalt coating is held back approximately 1-1/2 inches from edge.
   Color: Submit Standard Color Options for selection by Architect

e. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

5. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall Flashing.
      2) Firestone Specialty Products; FlashGuard.
      3) Heckmann Building Products Inc.; No. 81 EPDM Thru-Wall Flashing.
      4) Hohmann & Barnard, Inc.; Epra-Max EPDM Thru-Wall Flashing.
      5) Sandell Manufacturing Co., Inc.; EPDM Flashing.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.

2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.

3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing **with a drip edge or flexible flashing with a metal drip edge or elastomeric thermoplastic flashing with drip edge**.

4. Where flashing is fully concealed, use flexible **flashing**

D. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

3. Elastomeric Sealant: ASTM C 920, chemically curing sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight as directed by manufacturer.

E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.08 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated on Contract Drawings.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
   b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
   c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
   d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

E. Cleaner

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. National Chemsearch Corporation; Deox Chemical Cleaner
   b. Process Solvent Co., Inc.; Sure Kleen 600

2.09 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated on Contract Drawings.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime or mortar cement mortar unless otherwise indicated on Contract Drawings.

3. For exterior masonry, use portland cement-lime or mortar cement mortar.

4. For reinforced masonry, use portland cement-lime or mortar cement mortar.

5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated on Contract Drawings.

1. For masonry below grade or in contact with earth, use Type S.

2. For reinforced masonry, use Type S.

3. For mortar parge coats, use Type S.

4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.

5. For interior non-load-bearing partitions, Type S.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.

2. Pigments shall not exceed 5 percent of mortar cement by weight.

3. Mix to match Architect's sample.

4. Application: Use pigmented mortar for exposed mortar joints as specified by the Architect:

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.

2. Application: Use colored aggregate mortar for exposed mortar joints as specified by the Architect:

F. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated on Contract Drawings or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.

3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

4. Add Admixtures in accordance with manufacturer’s instructions; mix uniformaly

5. Do not use anti-freeze compounds to lower the freezing point of grout.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.

3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Coordinate and make provisions for installation of anchors, bolts, hangers, frames, insulation, dampproofing, and other items built into masonry work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

1. Provide no less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.03 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.04 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated on contract drawings, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

G. Provide special jamb units where required to execute window and control joint details. Maintain sealant clearances at doors, windows and other openings.

H. Provide lintels at opening of masonry work as necessary to form opening for in-wall equipment, through-wall ducts and piping and as otherwise needed to support openings over 8 inches wide.

I. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated on Contract Drawings.

J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated on Contract Drawings.

1. Support top of wall laterally as indicated on Contract Drawings. Install compressible filler in joint between top of partition and underside of structure above.

2. If not indicated otherwise on Contract Drawings, fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.05 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.

2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on foundations.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.

2. Allow cleaned surfaces to dry before setting.

3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated on Contract Drawings.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.06 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.07 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated on Contract Drawings. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.08 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Locate 3/8 inch wide control joints as indicated on Contract Drawings. Keep vertical joints straight, true and continuous from top to bottom of masonry.

2. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

3. Install preformed control-joint gaskets designed to fit standard sash block.

4. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.

5. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

6. Reinforcing and grout for bond beams at floor, roof or top of wall shall be continuous through the control joints

C. At expansion joints, leave full width of joint free of masonry, mortar and reinforcement. Install joint filler material, recessed from face for sealant.

3.09 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated on Contract Drawings.

3.10 FLASHING

A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated on Contract Drawings.

B. Install flashing as follows unless otherwise indicated on Contract Drawings:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing

on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

5. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602. Place steel reinforcement, grouted spaces and bond beams as work progresses and as follows:

1. Accurately position and secure against displacement from locations shown. Horizontal reinforcement may be placed as work progresses. All vertical reinforcing shall be in place prior to grouting and shall be held in position by means of bar positioners as shown on Contract Drawings.

2. Make splices in bars as shown on Contract Drawings. Lapped splices for reinforcement shall be as specified on the Contract Drawings. Provide lap splices of greater lengths when indicated on Contract Drawings. Welded or mechanical splices shall develop 1.25 times the strength of the reinforcement.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Unless an alternate procedure is approved by the Engineer of Record, the low-lift grouting procedure as noted in the following shall be used in the construction of reinforced unit masonry.

   a. Units may be laid to a height not to exceed eight feet. If the height exceeds five feet, cleanouts must be used.
   b. Place vertical steel in cells with enough steel extending to provide proper lap splice.
   c. Grout cells in five feet high maximum lifts.
   d. Stop grout 2” below top of masonry when grout is to be stopped for 1 hour or more. All horizontal steel shall be fully embedded in grout.
   e. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.
   f. The grouting of any section of wall shall be completed in one day with no interruptions greater than one hour.

3.12 BRACING

A. Provide adequate temporary bracing of masonry walls until it has cured and permanent structural braces (i.e. floor and roof diaphragms, etc.) are in place. Bracing of masonry walls is means and methods of construction and is solely the responsibility of the General Contractor and his masonry sub-contractors. Reference Contract Drawings for additional bracing design requirements.

B. Allow 16 hours to elapse after completion of masonry walls and columns before allowing uniform floor or roof loading construction.

C. Allow an additional 48 hours before allowing construction of concentrated loads on masonry walls and columns.

3.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform tests and inspections as noted below along with inspection schedule items included in the Contract Drawings. Testing agency shall prepare tests and inspection reports and submit to Owner and Owner's Consultants. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: Level B special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.14 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated on Contract Drawings, in 2 uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.15 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.16 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess masonry waste, and legally dispose of off Owner's property.

+ + + END OF SECTION 04200 + + +

SECTION 04255
VENEER MASONRY SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of a veneer masonry system as shown on the Drawings and specified herein.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:

Section 04200, Concrete Masonry Unit
Section 07081, Flashing and Sheet Metal
Section 07100, Waterproofing and Moistureproofing
Section 07210, Building Insulation
Section 07900, Caulking and Sealants

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.

B. Submit 2 samples each of veneer masonry units.

C. Before commencing with the laying of any architectural masonry, construct on the site, where directed by the Architectural/Engineer, a sample 13’-0” x 14’-8” wall at the South side near the west end of the building showing type and tooling or mortar and bond, for the Architect/ Engineer s approval. This sample wall shall remain in place for the duration of the masonry work. Remove sample panel at the completion of the work as directed by the Architect/ Engineer if not part of the permanent structure.

D. Layout Shop Drawings of all masonry must be submitted and approved before work starts.

1.03 QUALITY ASSURANCE

A. Source Control: Obtain exposed masonry units from one manufacturer, with texture and color uniform or of a uniform blend acceptable to the Architect/Engineer as noted on the drawings.

B. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

C. Applicable standards: Standards of the following, as referenced herein:

1. ASTM A 153-82(87) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 1982 (Reapproved 1987).

2. ASTM A 366/A 366M-85 Standard Specification for Steel Sheet, Carbon, Cold-Rolled, Commercial Quality; 1985.

3. ASTM A 635-88 Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Carbon, Hot-Rolled; 1988.

4. ASTM C 67-89a Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile; 1989.

5. ASTM C 144-89 Standard Specification for Aggregate for Masonry Mortar; 1989.

6. ASTM C 150-89 Standard Specification for Portland Cement; 1989.

7. ASTM C 207-79(88) Standard Specification for Hydrated Lime for Masonry Purposes; 1979 (Reapproved 1988).

8. ASTM C 216-89 Standard specification for Facing Brick (Solid Masonry Units Made from Clay or Shale); 1989.

9. ASTM C 270-89 Standard specification for Mortar for Unit Masonry; 1989.

10. ASTM C 404-87 Standard Specification for Aggregates for Masonry Grout; 1987.

11. ASTM C 476-83 Standard Specification for Grout for Masonry; 1983.

12. ASTM D 226-89 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 1989.

13. ASTM D 1056-85 Standard Specification for Flexible Cellular Materials, Sponge or Expanded Rubber; 1985.

14. Cleaning Brick Masonry; Technical Notes on Brick Construction, No. 20

Revised; Brick Institute of America (BIA); 1977.

1.04 DELIVERY, STORAGE, AND HANDLING

A. All perishable materials for the work of this Section shall be delivered, stored and handled so as to preclude damage of any nature. Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers, plainly marked with identification of material and maker. Materials in broken containers, or in packages showing water marks or other evidence of damage, shall not be used and shall be removed from the site.

B. All masonry shall be shipped stacked with hay or straw protection or other suitable protective device, and shall be similarly stacked off the ground on the site. In addition, all masonry stored on the site shall be protected from the weather and staining with the use of tarpaulins or other covering approved by the Architect/ Engineer.

C. Mason's sand shall be protected during shipping, storage and while on job site to prevent contamination.

C. Store aggregates in a manner which will preserve grading characteristics.

D. Store masonry accessories to prevent corrosion, dirt accumulation, and other deterioration.

1.05 PROJECT CONDITIONS

A. Protection of Work: During construction, cover tops of exterior walls with waterproof sheet material at end of each day. Cover partially completed masonry construction when work is not in progress.
   1. Extend cover a minimum of 24 inches down on both sides, securing firmly in place.
   2. Immediately remove mortar, soil, and other such materials from exposed masonry faces to prevent staining.
   3. Protect wall bases from rain-splashed mud and from mortar splatter by means of coverings spread on ground and over wall surfaces.
   4. Protect sills, ledges, and projections from droppings of mortar.

B. Cold-Weather Protection: Do not lay masonry units which have wet surfaces or units which are below freezing. Remove ice or snow from masonry bed by careful application of heat until dry to the touch. Remove masonry damaged by freezing.
   1. General: Comply with the following construction procedures for masonry construction, based on air temperatures at time of installation:
      a. 40 degrees F to 32 degrees F: Heat mixing water or sand to produce mortar temperature between 40 degrees F and 120 degrees F. Protect masonry

from rain or snow for at least 24 hours by covering with weather-resistive membrane.
1. Do not lay masonry units when air temperatures are below 32 degrees F.

2. Grouted construction: On any day when minimum anticipated nighttime temperature is 32 degrees F or less, in addition to complying with general procedures above, heat grout materials to 90 degrees F to produce in-place grout temperature of not less than 70 degrees F at end of work day. Retain protective blankets or enclosures for not less than 48 hours.
   a. Period of protection may be reduced to 24 hours when Type III portland cement is used for grout.
3. Bricks: Comply with the following requirements for clay masonry units which must be wetted before laying because of initial rate of absorption (suction) greater than 30 grams, per ASTM C 67:
   a. Surface temperatures above 32 degrees F: Sprinkle, with water heated to 70 degrees F or above, just before laying.
   b. Surface temperatures below 32 degrees F: Sprinkle, with water heated to 130 degrees F or above, just before laying.
4. Water: Do not heat water for mortar or grout to more than 160 degrees F.

C. Hot-Weather Protection: Cover or shade masonry units and mortar materials and use cool water for mortar whenever ambient air temperature is 90 degrees F or greater. At air temperatures of 85 degrees F or above, if relative humidity is less than 30 percent or wind is in excess of IS miles per hour, provide protection by immediately covering newly constructed walls, by providing windbreaks or by using fog spray to reduce rate of evaporation.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 BRICK MASONRY UNITS

A. Facing Brick: ASTM C 216, and as follows:
1. Grade SW.
2. Type FBS.
3. Size: Actual manufactured dimensions in inches, as follows:
   a. Titan: 3-5/8” x 3-5/8” x 15-5/8”.
   b. Modular: 3-5/8” x 2-1/4” x 7-5/8”.
4. Special Shapes: For sills, caps, and similar applications resulting in exposure of brick surfaces normally concealed from view, provide uncored or unfrogged units with all exposed surfaces finished.
5. Provide brick of color, texture and physical properties similar to those of brick

available for inspection at the Architect/Engineer's office and listed on the drawings.

2.02 MORTAR AND GROUT MATERIALS

A. Portland cement shall conform to ASTM C150 Type I. Type III may be substituted during cold weather construction. Masonry cements shall NOT be used. Provide Type S colored mortar or Portland Cement – lime mix. Color as approved by Architect.

B. Lime for masonry mortar shall be hydrated, conforming to ASTM C207, Type S.

C. The aggregate for mortar shall conform to ASTM C144.

D. The aggregate for grout shall conform to ASTM C 404.

E. Water shall be free from injurious amounts of oils, acids, alkalis or organic matter, and shall be clean and fresh.

F. Accelerating Admixture: Non-chloride admixture for use in mortar mixes during cold weather, proportioned and mixed to comply with directions of manufacturer.

2.03 REINFORCEMENT AND ANCHORAGE

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
   2. Stainless-Steel Wire: ASTM A 580, Type 304.
   3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008, Commercial Steel, with ASTM A 153, Class B coating.
   4. Stainless-Steel Sheet: ASTM A 666, Type 304.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Adjustable Masonry-Veneer Anchors:
   1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
      a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
   2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
      a. Products: Subject to compliance with requirements, provide one of the following:

1) Heckmann Building Products Inc.; Pos-I-Tie.
2) Hohmann & Barnard, Inc.; DW-10-X.
3) Wire-Bond; SureTie.

b. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch wide by 6 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.

c. Anchor Section: Corrosion-resistant, self-drilling, eye-screw designed to receive wire tie. Eye-screw has spacer that seats directly against framing and is same thickness as sheathing and has gasketed, washer head that covers hole in sheathing.

d. Fabricate sheet metal anchor sections and other sheet metal parts from 0.0747-inch (14 gage) thick, steel sheet, galvanized after fabrication.

e. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.25-inch diameter, stainless-steel wire.

2.04 CONCEALED FLASHING MATERIALS

A. Sheet Metal Flashing: Furnish materials and fabricate as specified in Division 7.

B. Flexible Sheet Flashing: Furnish materials as specified in Division 7.

2.05 MISCELLANEOUS MASONRY ACCESSORIES

A. Expansion Joint Strips: premolded flexible cellular neoprene rubber filler strips complying with ASTM D 1056, Grade RE4I, capable of compression up to 35 percent, and of width and thickness indicated.

B. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Weep Holes: Cotton sash cord of length required to produce 2-inch exposure on exterior while leaving 18 inches within exterior wall, or a plastic cell vent weep or plastic tube weep as indicated on the drawings.

D. Sealant and Backer Rod: As specified in Division 7.

2.06 MASONRY CLEANER

A. Detergent Solution: Job-mixed solution of 1/2 cup trisodium phosphate and 1/2 cup laundry detergent per gallon of water.

2.07 MORTAR AND GROUT MIXES

A. General: Do not use admixtures unless indicated as acceptable in the contract documents.
   1. Do not use calcium chloride in mortar or grout mixture.

B. Mixing: Combine and thoroughly mix ingredients in a mechanical batch mixer; comply with referenced ASTM standards for mixing time and water content.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar required, unless otherwise indicated.
   1. Limit cementitious materials in mortar to portland cement and lime.
   2. Use type M or type S mortar for masonry below grade and in contact with earth.
   3. Use Type S mortar for the following applications:
      a. Exterior, above-grade walls.
      b. Locations for which another mortar type has not been specifically indicated.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION PROCEDURES

A. Brick: Wet clay or shale brick which has an initial rate of absorption (suction) per ASTM C 67 of more than 30 grams per 30 square inches per minute. Use wetting methods which will ensure that each masonry unit is nearly saturated but dry to the touch when laid.

B. Ties: Before placing masonry ties, remove loose rust, dirt, and other coatings.

C. Masonry Thickness: Build masonry elements to full thickness shown.

D. Chases and Recesses: Build masonry to accommodate the work of other trades, including chases and recesses as shown or required. Provide not less than 8 inches of masonry between jambs of openings and chases and recesses.

E. Equipment Openings: Leave openings for equipment to be installed in masonry. After installation of equipment, complete masonry work to match work immediately adjacent to opening.

F. Cutting Masonry Units: Use motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work.

3.02 CONSTRUCTION TOLERANCES

A. Variation from Plumb: Do not exceed the following construction tolerances in vertical elements, including surfaces of walls, columns, and arises:

   1. 1/4 inch in 10 feet.
   2. 3/8 inch in one story height, or 20 feet, whichever is less, except 1/4 inch for external corners, expansion joints, and other highly conspicuous vertical elements.
   3. 1/2 inch in 40 feet or more.

4. Plus or minus 1/4 inch in 10 feet, 1/2 inch maximum, for vertical alignment of head joints.

B. Variation from Level: Do not exceed the following construction tolerances for bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal elements:
1. 1/4 inch in one bay or in 20 feet maximum.
2. 1/2 inch in 40 feet or more.

C. Variation from Plan Lines: Do not exceed the following horizontal construction tolerances for related portions of columns, walls, and partitions:
1. 1/2 inch in any bay or in 20 feet maximum.
2. 3/4 inch in 40 feet or more.

D. Variation in Cross Section: Do not exceed the following construction tolerances for thickness of walls and other masonry elements:
1. Minus 1/4 inch.
2. Plus 1/2 inch.

E. Variation in Mortar Joint Thickness: Do not exceed the following construction tolerances for thickness of mortar joints:
1. Bed joints: Plus or minus 1/8 inch.
2. Head joints: Plus or minus 1/8 inch.

3.03 MASONRY CONSTRUCTION - GENERAL

A. Layout: Lay out masonry for accurate pattern bond, for uniform joint widths, and for accurate location of specific features before beginning actual construction. Avoid use of masonry units of less than 1/2 size. Do not use units with less than nominal 4 inch horizontal face dimensions at corners and jambs.

B. Pattern Bond: Lay exposed masonry in running half bond, except where other bonds are indicated at special features.

C. Stopping and Resuming Work: Lay masonry in proper sequence to avoid toothing. Rack walls back in each course at end of each work day. Before resuming, clean exposed surfaces and remove loose masonry units and mortar.
1. Lightly wet previously laid brick masonry units which have rate of absorption (suction) of more than 30 grams, per ASTM C 67, before laying fresh masonry.

D. Built-in Work: As work progresses, build in items indicated for installation in masonry, filling around built-in items solidly with masonry.
1. Fill spaces between metal frames and masonry elements solidly with mortar, unless otherwise indicated.

E. Control and Expansion Joints: Provide vertical and horizontal expansion, control, and isolation joints in masonry where shown or required. Build in items related to such joints as masonry work progresses.

1. Install factory-fabricated elastic expansion joints.

F. Lintels: Install steel lintels at all openings.
1. Bearing: Provide not less than 8 inches of bearing at each jamb unless otherwise indicated.
2. Reinforcement: At masonry openings greater than one foot in width, install horizontal joint reinforcement in 2 horizontal joints approximately 8 inches apart immediately above lintel and immediately below sill. Extend reinforcement which is in addition to required continuous joint reinforcement not less than 24 inches beyond jambs of the opening, except at control joints.

3.04 MORTAR BEDDING AND JOINTING

A. Lay solid masonry units with completely filled bed and head joints. Butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

B. Maintain joint widths indicated, except for minor variations required to maintain bond alignment.
1. Except as otherwise indicated, maintain mortar joint widths of 3/8 inch.

C. Cut joints flush for masonry walls which are concealed or covered by other materials, unless otherwise indicated.

D. Tool exposed joints slightly concave, using a jointer larger than joint thickness unless otherwise indicated.

E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

3.05 ANCHORING MASONRY WORK

A. General: Anchor devices of type indicated.

B. Anchor single-wythe masonry veneer to backup with ties, and to comply with the following requirements:
1. Embed tie section in masonry joints. Fill space to back-up solid with mortar.
2 Locate anchor section relative to course in which tie section is embedded, to allow maximum vertical differential movement between veneer backup.
3. Space anchors at not more than 24 inches on center vertically an 34 inches on center horizontally. At panel openings and panel ends, install additional anchors at spacing of not more than 12 inches on center.

3.06 CONCEALED MASONRY FLASHING

A. General: Provide concealed flashing in masonry work, whether or not specifically indicated, at or above shelf angles, lintels, ledges, and other obstructions to the downward flow of water within the masonry so as to divert such water to the exterior. Extend flashings the full length of such obstructions and a minimum of 4 inches into

masonry at each end or turned up at least 4 inches to form a pan at materials other than masonry. Prepare masonry surfaces smooth and free of projections which could puncture flashings. Place flashings on sloped mortar bed; seal lapped ends of flashing sheets and penetrations through flashing before covering with mortar.

1. Extend metal flashings through exterior face of masonry and turn down to form drip.
2. Extend fabric or laminated flashings to within 1/4 inch of exterior face of masonry.

B. Veneer Flashings: Turn flashings up not less than 4 inches at backup. Seal to prevent moisture penetration between flashing and backup

C. Heads and Sills: Turn up ends of flashing at least 2 inches at heads and sills to form a pan, and seal joints.

D. Sealing: Seal all joints in flashing to assure watertight integrity.

1. Lap end joints on nondeformed metal flashings at least 4 inches; seal laps with elastic sealant or mastic.
2. Lap end joints of flexible flashings at least 4 inches; seal in accordance with manufacturer's instructions.

E. Weep Holes: Provide weep holes in head joints of the first course of masonry immediately above concealed flashings. Space at intervals of 24 inches on center.

F. Reglets and Nailers: Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

3.07 REPAIR AND POINTING

A. Repair: Remove and replace masonry units which are loose, chipped, broken, stained, or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of mortar joints, enlarge any holes or voids except weep holes and completely fill with mortar. Point up all joints, including corners, openings, and adjacent work, to provide a neat and uniform appearance.

3.08 CLEANING AND PROTECTION

A. Clean masonry as follows after mortar is thoroughly set and cured:

1. Remove large mortar particles by hand, using wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel, leaving half of panel uncleaned for comparison.
3. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
4. Use bucket and brush hand-cleaning method described in BIA Technical Notes No. 20 Revised for brick masonry, except use detergent mixture only.

B. Protection: Institute protective measures as required to ensure that unit masonry work will be clean and undamaged at date of substantial completion.

+++ END OF SECTION 04255 +++

SECTION 05120
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Structural steel.
2. Miscellaneous angles and plates.
3. Bolts and anchor rods.
4. Steel assemblies to be embedded in concrete or masonry.
5. Shear stud connectors.
6. Supplementary parts and members necessary to complete and erect structural steel frame.
7. Shop painting.
8. Grout.

B. Related Sections:
1. Section 01330 – Submittal Procedures
2. Section 01400 – Quality Requirements
3. Section 05300 – Steel Decking
4. Section 05500 – Miscellaneous Metal
5. Section 05600 – Metal Stairs
6. Section 09900 – Painting

1.03 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.04 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear, axial and moment connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand LRFD loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC's "Steel Construction Manual, 13th Edition".

B. Detail bolted connections using bolts conforming to ASTM A325N, Bearing Type Connections with threads allowed in shear plane, unless noted otherwise on Contract Drawings.

1. Select and complete connections using schematic details indicated and AISC's "Steel Construction Manual, 13th Edition".

C. Moment Connections: Type FR, fully restrained.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's data in accordance with specifications indicating product compliance to these specifications.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Submit shop drawings and calculation electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.

2. Only complete shop drawing submittals will be reviewed. Shop drawings not in compliance with the Submittal portion of this document will be rejected. Time required by the Structural Engineer to review shop drawing submittals a second or third time will be billed to the General Contractor at the Structural Engineer hourly rates.

3. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

4. Include embedment drawings.

5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.

7. Do not begin fabrication of materials prior to review of shop drawings.

8. Review of shop drawings is for member sizes, spacings, details, and general compliance with the Contract Drawings only.

9. Material quantities, lengths, fit, verification of job conditions and coordination with other trades are responsibility of Contractor.

10. Reproductions of Contract Drawings shall not be used for shop drawings.

11. For structural-steel connections indicated to comply with design loads, include structural analysis data and design calculations prepared by and signed and sealed by the qualified professional engineer responsible for their preparation and licensed in the state where the project is located.

12. Coordination of the structural-steel connection calculations with the structural-steel shop drawings is the responsibility of the structural-steel connections calculations engineer.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).

2. Electrode manufacturer and trade name, for demand critical welds.

D. Qualification Data: For qualified installer and fabricator.

E. Welding certificates.

F. Mill test reports for structural steel, including chemical and physical properties.

G. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.

2. Direct-tension indicators.

3. Tension-control, high-strength bolt-nut-washer assemblies.

4. Shear stud connectors.

5. Shop primers.

6. Nonshrink grout.

1.06 QUALITY ASSURANCE AND QUALITY CONTROL

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD. Not less than 5 years of experience in fabrication of structural steel.

B. Installer Qualifications: A qualified installer with not less than 5 years of experience in installation of structural steel.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

D. Quality Control Welding Inspector Qualifications: Qualified to the satisfaction of the fabricator's or erector's Quality Control Program, as applicable, and in accordance with either of the following:

1. Associate welding inspectors (AWI) or higher as defined in AWS B5.1, Standard for the Qualification of Welding Inspectors.

2. Qualified under the provisions of AWS D1.1 subclause 6.1.4.

E. Quality Control Bolting Inspector Qualifications: Qualified on the basis of documented training and experience in structural bolting inspection.

F. Quality Assurance Welding Inspector Qualifications: Qualified to the satisfaction of the quality assurance agency's written practice, the requirements of the Authority Having Jurisdiction, and either of the following:

1. Welding inspectors (WIs) or senior welding inspectors (SWIs) as defined in AWS B5.1, Standard for the Qualification of Welding Inspectors, except associate welding inspectors (AWIs) are permitted to be used under the direct supervision of WIs, who are on the premises and available when weld inspection is being conducted.

2. Qualified under the provisions of AWS D1.1, subclause 6.1.4.

G. Quality Assurance Bolting Inspector Qualifications: Qualified on the basis of documented training and experience in structural bolting inspections.

H. Nondestructive Testing (NDT) Personnel Qualifications: Qualified in accordance with their employer's written practice, which shall meet or exceed the criteria of AWS D1.1 Structural Welding Code – Steel, subclause 6.14.6 and either of the following:

1. American Society of Nondestructive Testing (ASNT) SNT-TC-1A, Recommended Practice for the Qualification and Certification of Nondestructive Testing Personnel.

2. ASNT CP-189, Standard for the Qualification and Certification of Nondestructive Testing Personnel.

I. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.

2. AISC 360.

3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

J. Preinstallation Conference: Conduct conference at Project site.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.08 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.

B. Channels, Angles, M-Shapes and S-Shapes: ASTM A 36.

C. Plate and Bar: ASTM A 36.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B structural tubing.

E. Steel Pipe: ASTM A 53, Type E or S, Grade B.

1. Finish: Black except where indicated to be galvanized.

F. Steel Castings: ASTM A 216, Grade WCB with supplementary requirement S11.

G. Steel Forgings: ASTM A 668.

H. Welding Electrodes: 70 ksi low-hydrogen.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, ASTM A 563 heavy-hex carbon-steel nuts, and ASTM F 436 hardened carbon-steel washers.

C. Shear Stud Connectors:

1. Provide shear stud connectors with proper ferrules and accessories especially designed to create composite deck action by mating of shear connectors, concrete deck and supporting beam, and capable of providing shear forces shown on Contract Drawings when welded through deck used on the project.

2. Comply with ASTM A 108, Grades C1010-1020, with minimum tensile strength of 60,000 psi.

3. Diameter: Uniform as indicated on Contract Drawings.

4. Head: Concentric with and normal to shaft.

5. Weld Ends: Chamfered and solid flux.

6. Height: At least 1-1/2 inch above top of deck after installation, with at least 3/4 inch clear concrete cover above top of stud, unless noted otherwise on Contract Drawings.

D. Unheaded Anchor Rods: Grade 55, weldable

1. Configuration: Straight.

2. Nuts: ASTM A 563 heavy-hex carbon steel.

3. Plate Washers: ASTM A 36 carbon steel.

4. Washers: ASTM F 436, Type 1, hardened carbon steel.

5. Finish: Plain, except where indicated to be galvanized.

E. Threaded Rods: ASTM A 36.

1. Nuts: ASTM A 563 heavy-hex carbon steel.

2. Washers: ASTM F 436, Type 1, hardened carbon steel.

3. Finish: Plain, except where indicated to be galvanized.

F. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

G. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

H. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

I. Headed Stud Anchors for Embedded Assemblies:

1. Steel shall conform to ASTM A 108 grades C1010-1020, minimum tensile strength of 60,000 psi.

2. Studs shall be of uniform diameter, heads concentric and normal to shaft, and weld end chamfered and solid flux.

2.03 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat, unless noted otherwise in Division 09 painting Sections.

B. Galvanizing Repair Paint: ASTM A 780.

2.04 GROUT

A. Compressive strength in 28 days: 5000 psi minimum but not less than specified strength of base concrete. Non-oxidizing, if grout will be permanently exposed to view.

1. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Sonogrout 10K, manufactured by Sonneborn/ChemRex, Inc.
b. Masterflow 713, manufactured by Master Builders Co.
c. Supreme Grout, manufactured by Gifford Hill Co.

2.05 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.

2. Fabricate beams with rolling camber up.

3. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.

4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Steel Bearing Plates: Fabricate steel bearing plates with headed stud anchors of sizes and thicknesses indicated on Contract Drawings.

C. Headed Stud Anchors:

1. Comply with AWS D1.1, Section 7.

2. Clean surfaces to be welded of rust, oil, grease, paint and dirt. Remove mill scale by scraping or sandblasting.

3. Weld headed studs with appropriate equipment properly adjusted for climatic conditions.

4. Remove ceramic ferrules after welding.

D. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

E. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces. Short-slotted holes shall not be used for primary frame connections (members connecting to columns), trusses and wind bracing unless specifically allowed by the Engineer of Record. Where used, short slotted holes shall be oriented normal to the direction of load.

F. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

G. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

H. Shear Connectors: Do not paint steel surfaces that receive welded shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

I. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

J. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated.

K. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces. Holes for anchor rods in base plates may be oversized in accordance with AISC Specifications. Provide washers as indicated on Contract Drawings.

3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, unless indicated otherwise on Contract Documents.

a. High Strength bolts for bearing connections shall be tightened in accordance with RCSC Specifications to a snug-tight condition. Provide hardened washers as required by the RCSC specification.
b. High strength bolts for pretensioned or slip-critical joints, as noted on the Contract Drawings, shall be tightened in accordance with the RCSC specifications by turn-of-nut with matchmarking, twist-off type tension control bolt assemblies (ASTM F1852) or direct tension indicators (ASTM F959) methods of installation. Provide hardened washers as required by the RCSC specification.
1) High strength bolts for pretensioned or slip-critical joints, as noted on the Contract Drawings, may be tightened in accordance with the RCSC specifications by calibrated wrench method in an AISC-Certified Plant.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.07 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.

2. Surfaces to be field welded.

3. Surfaces to be high-strength bolted with slip-critical connections.

4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).

5. Galvanized surfaces.

6. Top flanges of beams with shear connectors to support metal deck.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Prepare faying surfaces of slip critical connections in accordance with RCSC.

2.08 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize with a minimum G60 coating lintels, shelf angles, plates and welded door frames attached to structural-steel frame and located in exterior walls.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and

loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base, Bearing, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of baseplate as required on Contract Drawings.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Stud Connectors:

1. Prepare steel surfaces as recommended by manufacturer of shear connectors.

2. Use automatic end welding of headed-stud shear connectors according to ASW D1.1 and manufacturer's written instructions.

3. Remove ceramic ferrules after welding.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened unless noted otherwise on Contract Drawings.

a. High strength bolts for bearing connections shall be tightened in accordance with RCSC Specifications to a snug-tight condition. Provide hardened washers as required by the RCSC specifications.
b. High strength bolts for pretensioned or slip-critical joints, as noted on the Contract Drawings, shall be tightened in accordance with the RCSC specifications by turn-of-nut with matchmarking, twist-off type tension control bolt assemblies (ASTM F1852) or direct tension indicators (ASTM F959) methods of installation. Provide hardened washers as required by the RCSC specification.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth if radiographic testing (RT) of the welds is required by the testing agency of the engineer or record.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.05 FIELD QUALITY CONTROL

A. Contractor shall retain a duly designated person who acts for, and in behalf of, the Contractor on all inspection and quality matters within the scope of AISC 360-10, AWS D1.1 and of the Contract Documents.

3.06 FIELD QUALITY ASSURANCE

A. Owner will engage a qualified independent testing and inspecting agency to perform testing and verification inspections as noted below along with inspection schedule items included in the Contract Drawings. Testing Agency shall prepare test and inspection reports and submit in writing to Owner, Authority Having Jurisdiction, Engineer of Record, and Owner's consultants within 48 hours of testing or inspections. Reports shall contain Project identification name and number, date of inspection, name of testing and inspecting agency and location of inspected or tested work. In addition, reports shall include verification of compliance or deviations from the Contract Documents.

B. In addition to the above, the Testing Agency shall submit the following to the fabricator and erector:

1. Inspection reports

2. Nondestructive testing reports

3. Nonconformance reports

4. Reports of repair, replacement or acceptance of nonconforming items

C. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:

   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

2. In addition to visual inspections, field complete penetration groove welds shall be tested by either of the following, at testing agency's option or as specified on the Contract Documents:

   a. Ultrasonic Inspection: ASTM E 164
   b. Radiographic Inspection: ASTM E 94

3. In addition to visual inspections, ultrasonic testing (UT) of welds shall be performed as specified on the Contract Documents. The percentage of required testing may be reduced or shall be increased according to the following:

a. The rate of UT is permitted to be reduced if approved by the Engineer of Record and the Authority Having Jurisdiction. Where the initial rate of UT is 100%, the nondestructive testing (NDT) rate for an individual welder or welding operator is permitted to be reduced to 25%, provided the reject rate, the number of welds containing unacceptable defects divided by the number of welds completed, is demonstrated to be 5% or less of the welds tested for the welder or welding operator. A sampling of at least 40 completed welds for a job shall be made for such reduction evaluation. For evaluating the reject rate of continuous welds over 3 feet in length where the effective throat is 1 inch or less, each 12 inch increment of fraction thereof shall be considered as one weld. For evaluating the reject rate on continuous welds over 3 feet in length where the effective throat is greater than 1 inch, each 6 inches of length or fraction thereof shall be considered one weld.

b. For structures in Risk Category II, where the initial rate for UT is 10%, the NDT rate for an individual welder or welding operator shall be increased to 100% should the reject rate, the number of welds containing unacceptable defects divided by the number of welds completed, exceeds 5% of the welds tested for the welder or welding operator. A sampling of at least 20 completed welds for a job shall be made prior to implementing such an increase. When the reject rate for the welder or welding operator, after a sampling of at least 40 completed welds, has fallen to 5% or less, the rate of UT shall be returned to 10%. For evaluation the reject rate of continuous welds over 3 feet in length where the effective throat is 1 inch or less each 12 inch increment or fraction thereof shall be considered as one weld. For evaluating the reject rate on continuous welds over 3 feet in length where the effective throat is greater than 1 inch, each 6 inches of length or fraction thereof shall be considered one weld.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:

1. Initial testing of shear studs at start of work period: Test weld on at least 2 shear studs at start of each work period to determine proper generator control unit, and stud welder settings. Bend studs 45 degrees from vertical by striking with hammer. Inspect weld. Do not include these studs in required total number of studs required on beam. Contractor shall add replacement studs to supplement studs tested by bending 45 degrees.

2. Visually inspect welds at shear studs: Visually inspect all studs. Test studs that do not appear to have full sound 360 degrees fillet weld at base. Test by bending 15 degrees from vertical toward nearest end of beam by striking with hammer. Contractor shall replace studs that fail this test.
3. Periodic field testing of shear studs: Test one stud on each beam or girder after weld cools. Test by bending 15 degrees from vertical toward nearest end of beam by striking with hammer. If a tested stud fails at weld, all studs on the same beam or girder shall be tested by same procedure. Contractor shall replace studs that fail this test.

F. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents at no additional cost to owner.

3.07 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces, unless noted otherwise in Division 09 painting Section.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

+ + + END OF SECTION 05120 + + +

SECTION 05300
STEEL DECKING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Roof deck.

2. Framing for openings less than 10 inches.

1.03 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Submit shop drawings for review prior to fabrication or installation of materials.

1. Submit shop drawings electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.

2. Only complete shop drawing submittals will be reviewed. Shop drawings not in compliance with the Submittal portion of this document will be rejected. Time required by the Structural Engineer to review shop drawing submittals a second or third time will be billed to the General Contractor at Structural Engineer hourly rates.

3. Indicate erection layouts, details, steel deck dimensions, profile, gage, section properties, coatings and installation instructions. Show supporting framing, lengths, and markings of deck to correspond with sequence and procedure to be followed in installing and fastening deck. Show size and number of holes to be cut in deck.

4. Indicate allowable diaphragm shear capacity corresponding to pattern and type of connections provided on Contract Drawings.

5. Indicate method of installing and connecting accessories.

6. Indicate methods of fastening deck. Show fastener locations, types, sizes and sequence of connections for deck units.

    a. Welds: Use standard ASW welding symbols.
    b. Screws: Use type, size and manufacturer as noted on the Contract Drawings.
    c. Powder Actuated Fasteners: Use type, size and manufacturer as noted on the Contract Drawings.
    d. Button Punches: Use type and manufacturer.

C. Welding certificates.

D. Product Certificates: For each type of steel deck, signed by product manufacturer.

1. Certify that all deck, and deck accessories provided meet or exceed specified requirements.

2. Certify that product and coatings conform to UL, FM, or other agency rated assembly noted on Contract Drawings.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners

F. Evaluation Reports: For steel deck.

G. Field quality-control and inspection reports.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency for rated assembly noted on the Contract Drawings.

2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency for rated assembly noted on the Contract Drawings.

D. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

E. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling. Each unit or bundle shall be labeled and marked in accordance with UL requirements, indicating manufacturer, testing, and inspection.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

C. Do not overload deck during construction by workers or storage of materials.

D. Rusted, crimped or bent deck shall not be installed in the work. Replace damaged deck with new material at no additional cost to Owner.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.02 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.

2. Canam United States; Canam Group Inc.

3. Consolidated Systems, Inc.; Metal Dek Group.

4. Cordeck.

5. DACS, Inc.
6. Epic Metals Corporation.
7. Marlyn Steel Decks, Inc.
8. New Millennium Building Systems, LLC.
9. Nucor Corp.; Vulcraft Group.
10. Roof Deck, Inc.
11. Valley Joist; Subsidiary of EBSCO Industries, Inc.
12. Verco Manufacturing Co.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33, G60 zinc coating.
2. Deck Profile: As indicated on Contract Drawings.
3. Profile Depth: As indicated on Contract Drawings.
4. Design Uncoated-Steel Thickness: As indicated on Contract Drawings.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.

2.03 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth unless noted otherwise on the Contract Drawings.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

I. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

J. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

K. Galvanizing Repair Paint: ASTM A 780.

L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Where deck is indicated to be shored for placement of concrete, install shoring prior to placement of concrete.

C. Clean rust, oil, grease, and debris away from areas to which shear studs are to be welded. Remove mill scale by grinding or by sandblasting.

D. Locate deck bundles to prevent overloading of supporting members.

E. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

F. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

G. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

H. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

I. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.03 ROOF-DECK INSTALLATION

A. Mechanical Fasteners: Deck shall be attached to supporting members as noted on the Contract Drawings.

1. Spacing of fasteners shall not exceed 12 inches along each support, unless noted otherwise on the Contract Drawings.

2. Attachment shall be done immediately after the deck units are aligned.

3. Deck units shall have side laps fastened at 36 inches on center or at midspan (whichever is smaller) for spans greater than 5 feet unless otherwise specified on the Contract Drawings. Fasten deck to perimeter members parallel to deck span at 36 inches on center maximum for spans greater than 5 feet unless otherwise specified on the Contract Drawings.

B. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

C. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 6 inches apart with at least one fastener at each corner.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

1. Install 6 inch minimum wide sheet steel cover plates, of same thickness as deck, where deck changes direction. Mechanically attach at 6 inches on center maximum.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

F. Reinforce steel deck openings less than 10 inches in size with 2x2x1/4 inch steel angles. Place framing angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and mechanically attach to deck at each flute.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform tests and inspections as noted below along with inspection schedule items included in the Contract Drawings. Testing agency shall prepare test and inspection reports and submit to the Owner and the Owner's consultants.

B. Inspect condition of deck units for damage and corrosion. Report deficiencies.

C. Inspect size, spacing, and quality of connections of deck to structure and at side laps for conformance with Contract Drawings. Report deficiencies.

D. Deck: Inspect deck at welded connections. Connections do not conform to specifications where deck is not intact after welding and where blow holes occurred.

E. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

F. Remove and replace work that does not comply with specified requirements.

G. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

D. Repair blow-holes at welds with 18 gage plates welded in place. Replace entire sections of deck where holes cannot be satisfactorily repaired.

3.06 HANGERS FOR MISCELLANEOUS EQUIPMENT

A. Do not attach hangers for ductwork, mechanical piping, or ceilings directly to metal deck.

+ + + END OF SECTION 05300 + + +

SECTION 05400
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Exterior steel stud framing construction.

B. Related Sections:

1. Section 03300: Cast-In-Place Concrete
2. Section 05120: Structural Steel
3. Section 05300: Metal Decking
4. Section 05500: Miscellaneous Metal
5. Section 06100: Rough Carpentry

1.02 REFERENCES

A. Standards of the following as referenced:

1. American Iron and Steel Institute (AISI)
2. American Welding Society (AWS)
3. American Society for Testing and Materials (ASTM)
4. Standard Building Code (SBC)
5. Steel Structures Painting Council (SSPC)

B. Industry Standards:

1. AISI: S100-12: North American Specification for the Design of Cold-Formed Steel Structural Members, 2012 Edition
2. AWS:
   a. AWS D1.1-04: Structural Welding Code - Steel.
   b. AWS D1.3-98: Structural Welding Code - Sheet Steel.
   c. AWS B2.1: Welding Procedure and Performance Qualification.
3. SSPC: Systems and Specifications, September 1989 edition.

1.03 SYSTEM DESCRIPTION

A. Design Criteria:

1. Meet design criteria for wind loading required by local governing code, but in no case less than 25 pounds per square foot.
2. Exterior Horizontal Work: Design system to resist 25 pounds per square foot, minimum, uplift. Follow local code requirements if more stringent.
3. Deflection: Maximum L/360 in any single span or L/600 when supporting brick.

B. Performance Criteria:

1. Provide plumb and true surface for installation of specified surface materials.
2. Install framing within coordinated allowable tolerances.

1.04 SUBMITTALS

A. Product Data: Provide system description and installation data. Mark material to indicate only products proposed for use. For each type of cold-formed steel framing product and accessory indicated on the Contract Drawings, provide the following:

1. Section Properties: Submit section properties, material strengths and ASTM specification compliance verification for each size member, strap or brace of each gage used.
2. Connections: Submit manufacturer's data for each type of manufactured connector, screw or fastener verifying conformance with the Contract Drawings.

B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. Submit shop drawings and calculation electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped

electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.

2. Keyed plans, 1/8"=1'-0" scale minimum, to indicate locations of various cold-formed metal framing sizes and gauges, detail cuts, cold formed metal framing.
2. Framing details; connections and details; sections at half scale, minimum; include member spacing, sizing, boxing, and other specialty requirements necessary to meet design criteria.
3. Modifications to load bearing members are prohibited unless proposed modifications bearing seal and signature of the qualified professional engineer responsible for their preparation and licensed in the state where the project is located and have been submitted and reviewed by Architect.
4. Only complete shop drawing submittals will be reviewed. Shop drawings not in compliance with the Submittal portion of this document will be rejected. Time required by Wallace Engineering Structural Consultants, Inc. to review shop drawing submittals a second or third time will be billed to the General Contractor at Wallace Engineering Structural Consultants, Inc. hourly rates.
5. For cold-formed steel framing indicated to comply with design loads, include complete structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation and licensed in the state where the project is located. Design calculations will be reviewed by the Engineer-of-Record.

C. Quality Control Criteria: Capacity test data for mechanical fasteners certified by independent testing laboratory.

D. Qualification Data: For testing agency.

E. Welding certificates.

F. Product Test Reports: For each listed product, for tests performed by a qualified

testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Powder-actuated anchors.
4. Mechanical fasteners.
5. Adhesive anchors.
6. Vertical deflection clips.
7. Horizontal drift deflection clips.
8. Miscellaneous structural lips and accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Pack framing materials in bundles to protect from bending and damage in shipping. Identify bundles with tags to verify characteristics.
B. Storage and Protection: Store materials to prevent water accumulation in framing.
C. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.
D. During construction, adequately distribute all loads applied to framing members so as not to exceed the carrying capacity of any one member.

1.06 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer licensed in the state where the project is located.
B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed steel framing that are similar to those indicated on this Project in material, design and extent.
C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 for testing indicated.
D. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies

with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

E. Welders' Certifications:

1. Employ welders currently qualified under AWS standard qualification procedures to perform type of work required.

2. Require any welder to retake qualification test when in the Architect's opinion, his work creates reasonable doubt as to his proficiency. Conduct retests at no additional expense. Submit recertification to the Architect after welder has passed retest.

3. Assign each shop and field welder an identifying symbol or mark; identify all welds made by him.

F. Fire-Test-Response Characteristics: Where indicated, provide cold-formed steel framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

G. Comply with current AISI Specifications and Standards.

H. Preinstallation Conference: Conduct conference at Project site.

1.07 SEQUENCING AND SCHEDULING

A. Coordinate requirements of this section with construction activities described in Related Sections Paragraph (Part 1, 1.1, B, 1-8).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Metal Framing:

a. Clark-Cincinnati Inc.

b. Consolidated Systems, Inc.

c. Dale/Incor.

d. Dietrich Industries, Inc.

e. Gold Bond Building Products.

f. Marino Industries Corporation.

g. Superior Steel Studs, Inc.

h. Unimast Inc.

2. Fasteners: Imported fasteners are prohibited:

a. ITW-Buildex.

b. Grabber.

c. Hilti, Inc.

d. ITW Ramset/Redhead.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Contract Drawings.

2. Deflection Limits: Design framing systems to withstand design loads with deflections not exceeding the following limits:

a. Exterior Load-Bearing Wall Framing – Horizontal deflections:

1) Masonry Veneer: l/600 of the wall height.

2) Brittle Finishes: l/360 of the wall height.

3) Flexible Finishes: l/240 of the wall height.

b. Interior Load-Bearing Wall Framing – Horizontal deflections under a minimum horizontal load of 5 lbf/sq. ft.:

1) Masonry Veneer: l/600 of the wall height.

2) Brittle Finishes: l/360 of the wall height.

3) Flexible Finishes: l/240 of the wall height.

c. Exterior Non-Load-Bearing Framing – Horizontal deflections:

1) Masonry Veneer: l/600 of the wall height.

2) Brittle Finishes: l/360 of the wall height.

3) Flexible Finishes: l/240 of the wall height.

d. Floor Joist Framing: Vertical deflection of 1/360 for live loads and l/240 for total loads of the span.

e. Roof Rafter Framing: Vertical deflection of 1/360 for live loads and l/240 for total loads of the span.

f. Ceiling Joist Framing: Vertical deflection of 1/360 of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

a. Roof Framing: Downward movement of 3/4 inch and upward movement of 1/2 inch, unless noted otherwise on Contract Documents.

b. Floor Framing: Downward movement of 3/4 inch, unless noted otherwise on Contract Documents.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Comply with current AISI Specifications and Standards, unless more stringent requirements are indicated.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.02 COMPONENTS

A. General Requirements:

1. Manufacturing Standard: All cold form framing shall be equivalent to SSMA (Steel Stud Manufacturers Association) published standards and

installation recommendations, which will be used as a quality standard reference in the event the Contractor furnishes materials in which the submitted manufacturer does not have a published installation manual.

2. Steel Sheet: ASTM A 1003, Structural Grade, Type H, metallic coated, of grade and coating weights as follows:
   a. Grade: ST33H or ST50H as indicated or as required by structural performance.
   b. Coating: G60
3. Steel Sheet for Vertical Deflection Clips: ASTM A 653, structural steel, zinc coated, of grade and coating as follows:
   a. Grade: 50, Class 1
   b. Coating: G90
4. Welding Electrodes: AWS D1.1-04.

B. Framing Members:
   1. Material: Indicated above; required widths, lengths, and gages selected for span and loads derived from manufacturer=s design tables and reviewed shop drawings.
   2. Gauges: Indicated on reviewed shop drawings, 20-gauge, uncoated thickness, minimum.
   3. Yield Strengths, minimum: 50-ksi.
   4. C-Shaped Studs: 1-5/8-inch flange with 2-inch return, minimum.
   5. C-Shaped Studs or Joists: 1-5/8-inch flange with 2-inch return, minimum.
   6. Runners: 1-5/8-inch deep, minimum, runners by required widths and lengths, same gauge as stud, minimum, unless otherwise noted.

C. Runners, bracing, gussets, rolled angles, web stiffeners, strapping, clips, and members not specifically indicated: Same gauge as framing members, unless otherwise required in reviewed shop drawings.

D. Fasteners:
   1. Fastening Metal Runners to Concrete: Powder-actuated type capable of withstanding 285 pounds single shear, 150 pounds pullout and 240 pounds

bearing force without exceeding allowable stress design of fastener or member fastened.

2. Fastening Members to Each Other: No. 10-16 minimum screws designed for structural connections for shear or bearing and pullout, or as indicated on plans.
3. Fasteners: Required by engineered shop drawings.

E. Framing Accessories:

1. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
   2 Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   a. Supplementary framing.
   b. Bracing, bridging and solid blocking.
   c. Web stiffeners.
   d. Anchor clips.
   e. End clips.
   f. Foundation clips.
   g. Gusset plates.
   h. Stud kickers and knee braces.
   i. Joist hangers and end closures.
   j. Hole reinforcing plates.
   k. Backer plates.

F. ANCHORS, CLIPS, AND FASTENERS

1. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.
2. Unheaded Anchor Rods: ASTM F 1554, Grade 36
   a. Configuration: Straight.
   b. Nuts: ASTM A 563 heavy-hex carbon steel.
   c. Plate Washers: ASTM A 36 carbon steel.

d. Washers: ASTM F 436, Type 1, hardened carbon steel.

e. Finish: Plain, except where indicated to be galvanized.

3. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

4. Powder-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

5. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

a. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

b. Welding Electrodes: Comply with AWS standards.

G. MISCELLANEOUS MATERIALS

1. Galvanizing Repair Paint: ASTM A 780.

2. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

3. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

4. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

5. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

H. FABRICATION

1. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   a. Fabricate framing assemblies using jigs or templates.
   b. Cut framing members by sawing or shearing; do not torch cut.
   c. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      1. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      2. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
   d. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
   e. Do not begin fabrication of work prior to receiving approval of shop drawings and calculations. Fabricate per manufacturer’s current printed instructions.

f. Shop Fabrication: Fabricate items in shop to greatest extent possible so as to minimize field assembly of units at project site. Clearly mark units for assembly and coordinated installation.

2. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

3. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   a. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   b. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

E. Accessories:

1. Wood Blocking: Pressure-treated; specified in Rough Carpentry Section.
2. Gypsum Sheathing: Specified in Gypsum Board Assemblies Section.

2.03 FABRICATION

A. Shop Assembly:

1. Wall Framing: Fabricate to meet criteria indicated in referenced standards and reviewed shop drawings if elected or practical to fabricate wall section panels in shop. Install additional bracing to resist handling and construction loads.
2. Trusses: Fabricate to provide centerline of forces coincidental at joints for eccentricity effects in accordance with reviewed engineered shop

drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.

2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

J. All structural joists and studs shall have a minimum of 10 inches of unpunched steel at bearing or support points.

K. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:

1. Maximum Anchor Spacing: 24 inches, or as shown on Contract Drawings.

B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:

1. Maximum Stud Spacing: 16 inches, or as indicated on Contract Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated on Contract Drawings.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated on Contract Drawings or Shop Drawings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Contract Drawings or Shop Drawings. Fasten jamb members together to uniformly distribute loads.

2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically 48 inches on center or as indicated on Contract Drawings or Shop Drawings. Fasten at each stud intersection. Gypsum wallboard shall not be considered as bridging.

1. Bridging:

a. Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.

b. Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

c. Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated on Contract Drawings or Shop Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.

2. Install double deep-leg deflection tracks and anchor outer track to building structure.

3. Connect vertical deflection clips to bypassing and infill studs and anchor to building structure.

4. Connect drift clips to cold-formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Contract Drawings or Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

a. Install solid blocking at 96-inch centers.

2. Bridging:

a. Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

b. Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

c. Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Contract Drawings or Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.

2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

3. Splices in joists are not permitted.

4. Joist webs shall not be in direct contact with rim track webs.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: As indicated on Contract Drawings or Shop Drawings.

D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Contract Drawings or Shop Drawings.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on the Contract Drawings or Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Bridging:

a. Joist-track solid blocking of width and thickness indicated, secured to joist webs.

b. Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated.

Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 FIELD QUALITY CONTROL

A. Testing: Contractor will retain a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor, owner and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

+++ END OF SECTION 05400 +++

SECTION 05440
COLD-FORMED STEEL TRUSSES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Cold-formed steel trusses for roofs.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.04 SUBMITTALS

B. Product Data: For each type of product.

C. Shop Drawings:

1. Submit shop drawings and calculation electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.

2. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.

3. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

4. Only complete shop drawing submittals will be reviewed. Shop drawings not in compliance with the Submittal portion of this document will be rejected. Time required by Wallace Engineering Structural Consultants, Inc. to review shop drawing

submittals a second or third time will be billed to the General Contractor at Wallace Engineering Structural Consultants, Inc. hourly rates.

5. Include structural analysis data and design calculations prepared by and signed and sealed by the qualified professional engineer responsible for their preparation and licensed in the state where the project is located.

D. Delegated-Design Submittal: For cold-formed steel trusses.

E. Qualification Data: For testing agency.

F. Welding certificates.

G. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.

2. Expansion anchors.

3. Power-actuated anchors.

4. Mechanical fasteners.

5. Miscellaneous structural clips and accessories.

H. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Engineering Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer licensed in the state where the project is Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer licensed in the state where the project is located.

B. Professional Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed steel framing that are similar to those indicated on this Project in material, design and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 for testing indicated.

D. Product Tests: Mill certificates or data from a qualified testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

E. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."

2. AWS D1., "Structural Welding Code - Sheet Steel."

F. Fire-Test Response Characteristics: Where indicated, provide cold-formed steel framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

G. Comply with current AISI Specifications and Standards.

H. Preinstallation Conference: Conduct conference at Project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel trusses from corrosion, deformation, and other damage during delivery, storage, and handling.

B. During construction, adequately distribute all loads applied to framing members so as not to exceed the carrying capacity of any one member.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aegis Metal Framing.

2. Genesis Worldwide Inc.

3. Marino/WARE.

4. Nuconsteel, A Nucor Company.

5. Steel Construction Systems.

6. TrusSteel; an ITW company.

7. USA Frametek.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: For cold-formed steel trusses.

B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on structural drawings.

2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:

a. Roof Trusses: Vertical deflection of l/360 for live loads and 1/240 for total loads of the span or 3/4 inch maximum.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

C. Cold-Formed Steel Framing Design Standards:

1. Roof Trusses: Design according to AISI S214.

2.03 COLD-FORMED STEEL TRUSS MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, structural grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.

2. Coating: G60.

2.04 ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard C-shaped steel sections.

1. Connecting Flange Width: 1-5/8 inches, minimum at top and bottom chords connecting to sheathing or other directly fastened construction.

2.05 ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, structural grade, Type H, metallic coated, of same grade and coating weight used for truss members.

B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

2.06 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.

B. Anchor Bolts: ASTM F 1554, Grade 55, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C.

C. Power-Actuated Fasteners: Fastener system of type suitable for application, fabricated from corrosion-resistant materials, with capability to sustain, without failure, allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.07 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B.

B. Shims: Load bearing, of high-density multimonomer plastic, nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

2.08 FABRICATION

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate trusses using jigs or templates.

2. Cut truss members by sawing or shearing; do not torch cut.

3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

5. Do not begin fabrication of work prior to receiving approval of shop drawings and calculations. Fabricate per manufacturer's current printed instructions.

6. Shop Fabrication: Fabricate items in shop to greatest extent possible so as to minimize field assembly of units at project site. Clearly mark units for assembly and coordinated installation.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates and abutting cold-formed steel trusses for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install, bridge, and brace cold-formed steel trusses according to AISI S200, AISI S214, AISI's "Code of Standard Practice for Cold-Formed Steel Structural Framing," and manufacturer's written instructions unless more stringent requirements are indicated.

B. Install cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened.

1. Fasten cold-formed steel trusses by welding or mechanical fasteners.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install according to Shop Drawings; comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

D. Truss Spacing: 48 inches maximum or as indicated.

E. Do not alter, cut, or remove framing members or connections of trusses.

F. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacings indicated.

G. Erect trusses without damaging framing members or connections.

H. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's TechNote 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses."

I. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.03 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. As indicated.

B. Testing Agency: Contractor will retain a qualified testing agency to perform tests and inspections.

C. Field and shop welds will be subject to testing and inspecting.

D. Prepare test and inspection reports.

3.04 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal trusses are without damage or deterioration at time of Substantial Completion.

+ + + END OF SECTION 05440 + + +

SECTION 05500
MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish all labor, materials, equipment and incidentals required and install all miscellaneous metals as shown on the Drawings and specified herein. The miscellaneous metal items include but are not limited to the following:

1. Anchors or anchor bolts except those specified to be furnished with all equipment.
2. Vault Door.
3. Watertight Doors.
4. Plates and angles for grates.
5. Stainless steel doors and safety gates.

B. Related Work Specified Elsewhere

1. Section 05120: Structural Steel.
2. Anchor bolts for equipment are included in the respective Sections of Divisions 11, 13, 14 and 15.
3. Pipe hangers, supports and concrete inserts are included under Division 15.
4. Cast iron manholes, fences and guard rail are included under Division 2.
5. Section 05600: Stairs
6. Section 05331: Grating
7. Section 05224: Component Aluminum Railing

1.02 SUBMITTALS

A. Manufacturers data on all materials listed in Part 2 of this Section.

B. Detail drawings, as provided for in the General Conditions, showing sizes of members, method of assembly, anchorage, and connection other members shall be submitted to the Engineer for review before fabrication. Drawings shall include vault and watertight door test results.

C. Watertight door test results.

1.03 QUALITY ASSURANCE

A. Reference Standards: Unless otherwise specified, materials shall conform to the following:

Life Safety Code	NFPA 1010
Structural Steel	ASTM A36

Welded and Seamless Steel Pipe	ASTM A53
Gray Iron Castings	ASTM A48, Class 30
Galvanizing, general	ASTM A123
Galvanizing, hardware	ASTM A153
Galvanizing, assemblies	ASTM A386
Aluminum (Extruded Shapes)	6063 T5 (Al urn. alloy)
Aluminum (Extruded Pipe)	6063 T6 (Al urn. alloy)
Aluminum Sheet and Plate	6061 T6 (Alum. alloy)
Bolts and Nuts	ASTM A3O7
Stainless Steel Bolts, Bars & Shapes	ASTM A276
Stainless Steel Plate and sheet	ASTM A167
Welding Rods for Steel	AWS Spec. for Arc Welding

1.04 COORDINATION

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.05 FIELD MEASUREMENTS

A. Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 ANCHORS, BOLTS, AND FASTENING DEVICES

A. Anchors, bolts, etc., shall be furnished as necessary for installation of the work of this Section.

B. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Aluminum and stainless steel shall be attached to concrete by means of stainless steel machine bolts and iron or steel shall be attached with steel machine bolts unless otherwise specifically noted.

C. For structural purposes, unless otherwise noted, expansion bolts shall be Wej-it "Ankr-Tite", Phillips Drill Co. "Wedge Anchors", or HILTI-HIT(C-100). When length of bolt

is not called for on the Drawings, the length of bolt provided shall be sufficient to place the wedge portion of the bolt a minimum of 1-inch behind the reinforcing steel within the concrete.

E. Material shall be as noted on the Drawings. If not listed, stainless steel.

2.02 ALUMINUM ITEMS

A. See Section 08305 Access Hatches.

2.03 STEEL ITEMS

A. All miscellaneous lintels and closures not shown on the Drawings shall be galvanized steel and shall be provided as a part of this Section.

1. Provide galvanized loose steel lintels for openings and recesses in masonry walls as shown. Weld adjoining members together to form a single unit where indicated. Provide not less than 8" bearing at each side of openings unless otherwise indicated.

B. Miscellaneous steel shall be fabricated and installed in accordance with the Drawings and shall include: beams, angles, support brackets, splice plates, anchor bolts (except for equipment furnished in Divisions 11, 13, 14 and 15); lintels and any other miscellaneous steel called for on the Drawings and not otherwise specified.

C. Stainless Steel. Unless otherwise designated or approved, use stainless steel alloy types as follows which conform to ASTM A-167 and ASTM A-276:

1. Stainless steel plates and bars shall be Type 316 or Type 317 unless otherwise noted.
2. Stainless steel anchor bolts shall be Type 316.
3. Stainless steel bolts, nuts and washers shall be Type 316.

PART 3 - EXECUTION

3.01 FABRICATION

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.

B. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.

C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.

D. Welding of parts shall be in accordance with the Standard Code for Arc and Gas Welding in Building Construction of the AWS and shall only be done where shown, specified, or permitted by the Engineer. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting or discoloration.

F. All aluminum finish exposed surfaces, except as specified below, shall have manufacturer's standard mill finish. A coating of methacrylate lacquer shall be applied to all aluminum before shipment from the factory.

G. Castings shall be smooth, free from scale, lumps, blisters, sand holes, and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All finished surfaces shown on the Drawings and/or specified shall be machined to a true plane surface and shall be true and seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified or shown shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. The Contractor shall provide facilities for weighing castings in the presence of the Engineer showing true weights, certified by the supplier.

H. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter before shipment and shall be given one shop coat 0 primer compatible with finish coats specified in Painting Section after fabrication but before shipping. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces, Abrasions in the field shall be touched up with primer immediately after erection. Final painting is specified in Painting Section 09900.

I. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Following all manufacturing operations, all items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 oz. per sq. ft. of surface. The galvanized coating shall be chromate treated

3.02 INSTALLATION

A. Install all items furnished except items to be imbedded in concrete which shall be installed under Division 3. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown and in accordance with manufacturer's instructions and approved shop drawings. All dimensions shall be verified at the site before fabrication is started.

B. All steel surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

C. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to dissimilar metal.

D. Where aluminum contacts concrete, apply a heavy coat of approved alkali resistant paint to the concrete.

+++ END OF SECTION 05500 +++

SECTION 05524
COMPONENT ALUMINUM HANDRAIL

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, equipment, and materials required to furnish and install component aluminum handrail including all fittings, anchors, sleeves, and accessories, as shown on the Drawings and specified herein.

B. Unless specifically designated on the Drawings, all handrails shall be component aluminum handrails meeting the requirements of this section of the Specifications.

C. Handrails shall be furnished and installed where shown on the Drawings.

D. Handrails shall be furnished with a toe board, except on the railings for stairs or where concrete curbs are provided.

1.02 DESIGN REQUIREMENTS

A. Component aluminum handrail system, including railings, posts, and gates, shall be designed and constructed in strict compliance with the requirements of OSHA and the Standard Building Code (SBCCI).

B. Component aluminum handrail system shall also be designed:

1. To withstand the working loads below with a minimum factor of safety of 1.5 based on the ultimate strength of the alloy used.
2. For a minimum safe working load of both of the following loads:
   a. Uniform live load of 50 pounds per linear foot applied horizontally to the top rail or handrail and a vertical load of 100 pounds per foot applied simultaneously.
   b. A 200-pound concentrated live load applied in any direction at any point of the railing.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

C. Splice joints shall be designed and constructed to provide strength equivalent to a straight section of pipe.

1.03 SUBMITTALS

A. Submit complete shop drawings and product data in accordance with the requirements of the General Conditions. Include plans, elevations, sections, details,size and thickness of members, and attachments to other work. Indicate size of fabricated section intended to be delivered.

1. Submit shop drawings and calculation electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed at cost.
2. Reproduction of Contract Drawings shall be used for shop drawings.

B. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, include analysis data and design calculations for the railings prepared by and signed and sealed by the qualified professional engineer responsible for their preparation and licensed in the state where the project is located. Calculations shall clearly define loads, geometry, aluminum strength, concrete strength and connection design for each.

C. Submit, in accordance with the requirements of the General Conditions, manufacturer's recommendations and procedures for maintaining and repairing handrail, including methods, cleaning materials, refinishing materials, and precautions as to the use of materials which may be detrimental to handrail finish.

C. Submit certifications as required in Paragraph QUALITY ASSURANCE below.

1.04 STORAGE AND PROTECTION

A. Keep handling to a minimum and maintain protective covering on handrail until the work is complete. The Contractor shall take care in handling the rails during shipment, unloading, erection, and during construction to prevent damage to the railing.

B. Railing and post components shall be individually wrapped in paper or plastic film sleeves to protect the finish during shipment and installation and shall not be covered with any protective paper or other covering which can adhere to, or damage, the components.

1.05 QUALITY ASSURANCE

A. The Contractor shall provide the Engineer with written certification that the aluminum handrail and accessories are designed and manufactured in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the aluminum handrail supplier may be considered evidence of compliance, provided such tests are performed in accordance with the appropriate ASTM Testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on certified sample of handrail stock. Cost of this testing shall be borne by the Contractor.

B. Furnish a manufacturer's inspection certificate stating that the handrail system as installed meets the requirements of these Specifications and the Manufacturer's written instructions. Contractor shall correct all inadequacies found during the inspection process.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Component aluminum handrail system shall be manufactured by Thompson Fabricating Company of Birmingham, Alabama, Alumagard of Denver, Colorado, or Hollaender Manufacturing of Cincinnati, Ohio.

2.02 MATERIALS AND CONSTRUCTION

A. Railing: Railing shall be an extruded tube manufactured from an aluminum alloy in accordance with ASTM B221, Alloy 6105, Temper T5. Railing shall have a minimum outside diameter of 1.90 inches. Railings shall have a minimum wall thickness of 0.145 inch.

B. Posts:

1. Posts shall be an extruded tube manufactured from an aluminum alloy in accordance with ASTM B221, Alloy 6105, Temper T5. Posts shall have a minimum outside diameter of 1.90 inches. Posts shall have a minimum wall thickness of 0.20 inch.
2. The posts shall have an internal reinforcing dowel to assist in the transfer of the loadings from the post to the base. The dowel length shall extend 12 inches (or longer if required by the manufacturer to meet criteria) above the walking surface and recessed 1/4 inch from bottom of post and shall be tack welded in two locations to secure dowel in the post.

C. Expansion Anchor Bolts: Expansion anchor bolts shall be designed with a safety factor of 4 on ultimate withdrawal and shear in 4,000 psi concrete. Expansion bolts shall be spaced a minimum of 10d apart with 5d minimum edge distance without reduction of withdrawal and shear values used in calculations. Expansion bolts shall be stainless steel of wedge type construction, as specified in Section 05500, MISCELLANEOUS METAL, of these Specifications.

D. Fasteners: Handrail system shall be assembled using components that make rigid joints. Railing joints shall be assembled using stainless steel set screws. Other joints shall be assembled using stainless steel fasteners. No pop riveted, glued systems, or welded railing will be allowed.

E. Anodizing: All railing and posts, and their components, shall be anodized in accordance with Aluminum Association Standard AA-M10-C22-A41 on all exposed surfaces.

F. Brackets and Bases:

1. Side mount brackets shall be nonwelded extrusions attached to posts with stainless steel set screws.
2. Top mounted bases shall be al-mag castings, anodized. Castings shall be permanent mold or die cast. If bases are sand castings or machined, they shall be finished smooth prior to anodizing to approximate the finish of permanent molds or die cast satisfactory to the Engineer. Casings shall be attached to the post with stainless steel set screws and pressure plate. Cast bases shall slip over the outside of the pipe post so that the pipe and integral internal dowel may function together in transferring the load to the base flange. Aluminum bases of welded construction are not acceptable.

G. Handrail system shall provide for draining of entrapped water from the railing systems by minimum 15/64-inch diameter weep holes or other approved means.

H. Toeboards: Toeboards shall be of the same material and finish as the rails and posts. Toeboards shall be extruded design that clamp to the post to allow expansion and contraction. Toeboards shall have a minimum height of 4 inches.

I. Gates: Gates shall be of the same material and finish as the rails and posts. Gates shall be equipped with a spring to assist in closing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. **General**: Handrail system shall be assembled and installed in strict compliance with the manufacturer's instructions. Maximum post spacing shall be 6 feet 0 inch. The handrail manufacturer may use less than 6 feet 0 inch if their system requires closer spacing to meet design criteria.

B. Shop Assembly: Handrail manufacturer shall shop assemble the handrail in shippable modules not to exceed 30 feet in length. Field manufacturing of handrail modules will not be permitted.

C. Set handrail modules plumb within 1/8 inch of vertical and align horizontally to within 1/8 inch in 12 feet. Set stair rail modules plumb within 1/8 inch of vertical and set rake rails aligned horizontally to 1/8 inch in 12 feet.

D. Handrail mounting shall be embedded, top mounting base, or side mounted. Install expansion bolts to proper depth to develop full withdrawal and shear values. Check all fasteners and bolts in base connections and splices for tightness.

E. Handrail components coming into contact with concrete or dissimilar metals shall be coated with bituminous protective coating or installed with a vinyl isolation gasket.

F. Splice joints to facilitate removal of pipe railing shall be provided at all intersections, changes in direction, or at intervals not to exceed 30 feet in straight runs of railing.

G. Adequate provisions for expansion and contraction shall be incorporated in the rails. Expansion joints shall be placed at 60-foot intervals. Handrail shall not be continuous across the concrete expansions joints.

H. Open rail ends shall be closed by terminal end fittings.

I. Gates shall be provided in all handrail openings. Chains will not be permitted at handrail openings.

J. Toeboards shall be shipped loose and field assembled to posts with clamps. The attaching system shall be such that contraction and expansion can occur while maintaining a straight line. Toeboards shall be set so that the bottom of the toeboard is within 1/4 inch above the walking surface.

K. All defective, damaged, or otherwise improperly installed handrail shall be removed and replaced with material that satisfies the requirements of this Section.

3.02 CLEANING

A. Following installation, aluminum handrail shall be cleaned using soap and clean water. Acid solutions, steel wool, or harsh abrasives shall not be used. If stains remain after cleaning, remove finish and restore in accordance with the manufacturer's written instructions to the satisfaction of the Engineer.

+++ END OF SECTION 05524 +++

SECTION 05531
STEEL GRATING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall furnish all labor, materials, equipment and incidentals required to provide steel grating and frames as shown and specified.

2. Grating shall be an open grid of carbon steel bars consisting of plain bearing bars with round or twisted cross bars. Grating shall be electro-pressure welded.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Drawings for the fabrication and erection of all work. include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
   2. Setting drawings and templates for location and installation of anchorage devices.
   3. Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM A 569, Steel, Carbon (0.15 Maximum, percent), Hot-Rolled Sheet and Strip, Commercial Quality.
   2. NAAMM, Metal Bar Grating Manual.

B. Field Measurements:

1. Take field measurements prior to preparation of Shop Drawings and fabrication where required, to ensure proper fitting of the Work.

PART 2 - PRODUCTS

2.01 PERFORMANCE CRITERIA

A. The Contractor shall furnish grating, conforming to the following criteria:

1. Design Loads: Uniform live load, or a concentrated load on any area 24 inches square, whichever gives the greatest stresses.

Live load	Concentrated load
300 psf	2000 lbs.

2. Maximum Clear Span Deflection: 1/180 of span.
3. Maximum Fiber Stress: 18,000 psi.
4. Minimum Size of Members:

    a. Minimum size of bearing bars shall be within standard mill tolerance of that shown on the Load Tables in the NAMMM Manual for applicable loading and deflection requirements. In no case shall their depth be less than 3/4 inch.
    b. Minimum dimensions of cross bars shall be as shown on the tables of Minimum Standard Cross Bars and Connecting Bars in the NAAMM Manual.

5. Banding bar thickness shall be the same as the bearing bar to which it is attached.
6. Maximum bearing bar spacing shall be 1-3/16” unless noted otherwise.

2.02 MATERIALS

A. Bearing bars, banding bars and cross bars: Carbon steel conforming to ASTM A 569.

2.03 FABRICATION

A. Use materials of the minimum size and thickness as specified above, unless otherwise shown. Work to the dimensions shown on approved Shop Drawings.

B. Grating shall be as shown and shall comply with the NAMM Manual, except as specified herein.

1. All tolerances shall be within the limits shown on the details for manufacturing tolerances in the Manual.
2. Banding, nosings and carriers shall be attached by welding, as shown on the details for Welding Standards in the Manual.
3. All welding shall comply with the recommendations of ASTM A 385. Welds shall not be ground, unless otherwise shown or specified.
4. Traffic surface shall be plain.

C. Product and Manufacturer:
1. Irving Gripweld by IKG Industries, Division of Harsco Corp.

2. Blaw-knox Welded Grating supplied by Fontana Metal Sales Corp.
3. Or equal.

D. Type of Finish: Shop applied epoxy paint as specified in Section 09900, Painting, or Galvanized in accordance with ASTM A123.

E. Provide removable grating sections where shown, specified or otherwise required. They shall have end banding bars for each panel. For grating having bearing bars at 1-3/16 inch centers or greater, provide 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts with washers and nuts, unless otherwise shown or specified. For bearing bars spacing less than 1-3/16 inch centers, provide anchors in accordance with manufacturer's recommendations.

F. At concrete openings, support and band grating as shown on detail for Support and Banding of Trench Grating in the NAAMM Manual. Provide steel angle frames having mitered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected to assure flush fit.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Fastening to In-Place Construction:

1. Use anchorage devices and stainless steel fasteners to secure grating to supporting members or prepared openings, as recommended by the manufacturer.

B. Cutting, Fitting and Placement:

1. Perform all cutting, drilling, fitting and welding required for installation. Set the Work accurately in location, alignment and elevation, plumb, level and free of rack. Do not use wedges or shimming devices.

3.02 TOUCH-UP

A. Touch-up shop coating, damaged in the shop or during field erection, by recoating with same material.

3.03 ADJUSTMENT AND CLEANING

A. Grating shall be levelled and fastened securely in place so that no warping, "rocking" panels, or offsets exist, and so that top surface is flush with adjacent floor surfaces.
B. Remove all stains, cement droppings, oils, dirt, grease, or other foreign matter and leave grating in clean, first class condition.

+++ END OF SECTION 05531 +++

SECTION 05510

METAL STAIRS

PART l GENERAL

1.01 RELATED SPECIFICATION SECTIONS:

A. Section 01000 – GENERAL REQUIREMENTS

1.02 SECTION INCLUDES

A. Steel stair frame of structural sections, with open risers.

B. Open grate stair treads and landings.

C. Integral balusters and hand railing.

1.03 REFERENCES

A. ANSI A117.1 - Buildings and Facilities - Providing Accessibility and Usability For Physically Handicapped People.

B. ASTM A36 - Structural Steel.

C. ASTM/ANSI A202.1 - Metal Bar Grating Manual for Steel and Aluminum Gratings and Stair Treads.

D. ASTM A283 - Carbon Steel Plates, Shapes, and Bars.

E. AWS A2.0 - Standard Welding Symbols.

F. AWS Dl.1 - Structural Welding Code.

G. SSPC - Steel Structures Painting Council.

1.04 DESIGN REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Live Load: 100-lb/sq. ft.
2. Concentrated Live Load: 300 lb applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/240 for total loads and L/360 for live loads or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Handrails and Top Rails of Guards:
      a. Uniform live load of 50 lb/ft applied in any direction.
      b. Concentrated live load of 200 lb applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Infill of Guards:
      a. Concentrated live load of 50 lb applied horizontally on an area of 1 sq. ft.
      b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to the International Building Code.
   1. Component Importance Factor is 1.5.

1.05 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include plans, elevations, sections, details, size and thickness of members, and attachments to other work. Indicate size of fabricated section intended to be delivered.

   1. Submit shop drawings and calculation electronically in PDF format via email for review by the Structural Engineer-of-Record. The Structural Engineer-of-Record will review the shop drawings and forward stamped electronic documents to the contractor through the Architect via email. The contractor shall be responsible for transmitting the reviewed set to the fabricator for corrections. The printing of shop drawings as required for review is considered a reimbursable expense and will be billed cost.

   2. Reproduction of Contract Drawings shall not be used for shop drawings.

C. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, include analysis data and design calculations for the stairs and railings prepared by and signed and sealed by the qualified professional engineer responsible for their preparation and licensed in the state where the project is located. Calculations shall clearly define loads, stair geometry, steel strength, concrete strength and connection design for each stair.

E. See note 2 on S-001 for Deferred Submittals

1.06 QUALIFICATIONS

A. Prepare shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Georgia.

B. Welders' Certificates: Submit under provisions of Section 01300, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.
C. See note 2 on S-001 for Deferred Submittals

1.07 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Sections: ASTM A36.

B. Plates: ASTM A283.

C. Pipe: ASTM A53, Grade B or Schedule 40 or 60.

D. Gratings: ANSI A202.1, Type C.

E. Bolts, Nuts, and Washers: ASTM A32S.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, consistent with design of stair structure.

G. Welding Materials: AWS Dl.1; type required for materials being welded.

H. Shop and Touch-Up Primer: SSPC Is, Type 1, red oxide.

2.02 FABRICATION - GENERAL

A. Fit and shop assemble in largest practical sections, for delivery to site.

B. Fabricate components with joints tightly fitted and secured.

C. Continuously seal jointed pieces by continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

G. Accurately form components required for anchorage of stairs and landings and railings to each other and to building structure.

2.03 FABRICATION - OPEN GRATING STAIRS

A. Fabricate treads 1.75-inch-thick in accordance with ANSI A202.1 of welded steel bars, welded, bolted to supports; prime paint finish.

B. Form stringers with rolled steel channels prime paint finish.

C. Form balusters with 1.5-inch diameter steel sections, welded to stringers; prime paint finish.

2.04 FINISHES

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Prime paint items with one coat.

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 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide anchors, plates and angles required for connecting stairs to structure.

C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Field weld components indicated on Drawings. Perform field welding in accordance with AWS D1.1.

E. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible.

F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

G. Obtain Contracting Officer's approval prior to site cutting or making adjustments not scheduled.

H. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

3.04 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/4 inch.

B. Maximum Offset from True Alignment: 1/4 inch.

+++END OF SECTION+++

SECTION 06100
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary and install all items of carpentry work complete as shown on the Drawings and as specified herein including nailers, grounds, and cants.

B. The following list of work items is intended only as a guide to that required, the full scope being determined by the actual job conditions.

1. Rough carpentry and framing, as indicated or required, including grounds, blocking, rough frames, nailing strips and strapping.

2. Rough hardware, anchors and bolts, not specifically included elsewhere.

3. Temporary closures.

4. Installation of doors and frames.

5. Installation of Metal Wall Frames and Louvers

1.02 RELATED WORK

A. Section 03100: Concrete Formwork.
B. Section 08210: Wood Doors.
C. Section 08331: Overhead Rolling Doors.

1.03 JOB CONDITIONS

Deliver, handle and store lumber and plywood to prevent damage. Stack lumber off the ground in a manner to ensure ventilation and protection from the weather.

1.04 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM A 153-98 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 1982 (Reapproved 1987).
2. AWPA C20-02 - Structural Lumber-Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 1988.

3. AWPA C27-93 - Plywood-Fire Retardant Treatment by Pressure Processes; American Wood Preservers' Association;
4. AWPA M4-84 - Standard for the Care of Preservative Treated Wood Products; American Wood-Preservers' Association; 1984.
5. AWPA U7 - American Wood Preservers Bureau Quality Control and Inspection Procedures for Softwood Lumber, Timber and Plywood Pressure Treated with Waterborne Preservatives for Above Ground Use; 1988.
6. National Design Specification for Wood Construction; National Forest Products Association (NFPA); 1986 (1990 Supplement).
7. NBS PS 20-70(86) -- American Softwood Lumber Standard; U.S. Department of Commerce, National Bureau of Standards; 1970 (amended 1986).
8. Grade and Treatment Markings shall appear on lumber with seal and stamp of the inspection agency or bureau having jurisdiction.

1.05 PRODUCT HANDLING

A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All lumber shall be of sound stock, delivered dry, and shall be fully protected at all times from injury and dampness. Split, broken, or otherwise damaged pieces will not be allowed in the work.

B. Lumber for Blocking, Grounds and Nailers shall be 545, either No. 2 Southern Pine, or standard grade Douglas fir, with moisture content of not more than 19%, and will be treated to be fire-resistant.

C. Wood members that will contact masonry or concrete shall be pressure treated with chromated copper arsenate or fluorochrome arsenate phenol. Minimum net retention of solid preservative shall be 0.35 lb per cu ft. All other permanent wood in place shall be pressure treated with any of the following: Celcure, Wolman Salts, Copperized Chromated Zinc Arsenate or Pentachlorophenol dissolved in a volatile mineral spirits solvent and bear an approved A4P1-LP-2 or LP-3 quality mark.

D. All treatment shall be performed in accordance with the requirements of the Standard Specifications of the American Wood Preservers Association for treating wood. Apply a heavy coat of the same preservative used in treating to all surfaces cut after treatment.

E. Nails and spikes, where sizes are not indicated or specified, shall be of suitable size and number to securely fasten and hold members in place.

F. Plywood for project sign shall be A-A EXT-APA grade and 1-inch thick. Posts shall be same as for nailers specified in subparagraph B above.

G. All interior plywood to be fire retardant treated plywood.
All plywood shall be pressure-treated in accordance with American Wood Preservers Association Standard AWPA C27, and each piece shall bear an Underwriters Laboratories, Inc. label. Plywood shall be APA RATED SHEATHING EXP 1 or better, marked PS 1. After treatment, plywood shall be dried to an average moisture content of 15 percent (13).

PART 3 - EXECUTION

3.01 INSTALLATION

A. All carpentry shall be accurately cut, fitted, and installed as detailed on the Drawings.

B. Anchors shall be installed, where indicated or required, to anchor carpentry or other items securely to masonry or concrete.

C. Forms for structural concrete work shall be as specified in Section 03100. Provide all other miscellaneous wood form work as may be required for the completion of the work.

D. Temporary wood doors and cloth or transparent plastic covered frames shall be provided for exterior wall openings during winter construction.

E. Provide wood members in lengths as long as practicable.

F. For bolted work bore holes of same diameter as bolts and drive bolts into place with snug fit with washers between bolt head and wood surface. Make tight at time of installation bolts and lag screws and retighten just before being enclosed by other work or at completion of work. Length of bolts shall be length to suit the condition. Embed bolts in concrete and solid masonry where possible and use expansion shields in drilled holes where not possible.

G. Use number and size of nails to achieve rigid connections and prevent splitting. Bore holes at least one drill size smaller than nails to prevent splitting if necessary.

H. Anchor nailers to adjacent construction with bolts 6 inches from ends and at intervals not more than 48 inches o.c. between.

I. Install project sign where directed by the Engineer. Sign shall remain in position for the duration of construction.

J. Install, maintain and remove all staging for all trades required to reach all work.

K. At completion remove all excess materials and all resultant debris from the operations of work of this section. Leave work in neat, clean condition satisfactory for receipt of other related items of work which are to be installed under other sections.

L. No excess materials or debris shall be burned on site or within the City limits of Atlanta.

M. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.

+++ END OF SECTION 06100 +++

SECTION 06160
CEMENT BOARD SHEATHING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Wall Sheathing.
2. Weather-Resistant Sheathing Barriers.

B. Related Sections include the following:

1. Section 01810 – LEED Specifications.
2. Section 05400 – Cold-Formed Metal Framing.
3. Section 06100 – Rough Carpentry.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI A118.9: Specification for Cementitious Backer Units.

B. American Society for Testing and Materials:

1. ASTM C 954: Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch to 0.110 inch in Thickness.
2. ASTM C 1002: Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
3. ASTM C 1280: Standard Specification for Application of Gypsum Sheathing.
4. ASTM C 1325: Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cement Interior Substrate Sheets.
5. ASTM D 226: Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
6. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
7. ASTM E119: Test Method for Fire Tests of Building Construction and Materials.
8. ASTM E 1677: Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building Walls.

C. Gypsum Association:

1. GA 253: Recommended Specification for the Application of Gypsum Sheathing.

1.03 SUBMITTALS

A. General: Submit in accordance with Section 01330

B. Product Data: Submit manufacturer's current technical literature for product specified.

1.04 QUALITY ASSURANCE

A. Fire Resistance Rated Assembly Characteristics: Provide materials and construction identical to those tested in accordance to ASTM E 119 by an independent testing and inspection agency acceptable to authorities having jurisdiction.

1. Fire Resistance Ratings: Indicated by design designations from UL Fire Resistance Directory.

1.05 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be delivered in their original unopened packages and stored in an enclosed shelter providing protection from damage and exposure to the elements. WARNING: Store all cement board flat. Panels are heavy and can fall over, causing serious injury or death. Do not move unless authorized.

PART 2 - PRODUCTS

2.01 WALL SHEATHING

A. Cementitious Fiber-Mat Reinforced Sheathing: ASTM C 1325, ANSI A118.9, cementitious backer.

1. Product: Subject to compliance with requirements, provide cement board by:
   a. United States Gypsum Company
   b. National Gypsum Company
   c. Or approved equal.
2. Type and Thickness: 1/2 inch thick.
3. Size: 32 by 96 inches or 48 by 96 inches.

2.02 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and application.

B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: DUROCK Brand Steel or USG Sheathing SF steel drill screws 1-1/4 inch with corrosion-resistant coating.

1. For steel framing less than 0.0329 inch thick, attach sheathing to comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C 954.

2.03 WEATHER-RESISTANT SHEATHING BARRIERS

A. Building Paper (if needed): ASTM D 226, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.

B. Building Wrap (if needed): ASTM E 1677, Type I air retarder, with flame-spread and smoke-developed indexes of less that 25 and 450, respectively, when tested according to ASTM E 84, UV stabilized and acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide:
   a. Tyvek StuccoWrap by DuPont (E. I. du Pont de Nemours and Company).
   b. Or approved equal.

C. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.04 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film.

B. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.

C. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

D. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.03 CEMENT BOARD SHEATHING INSTALLATION

A. Comply with ASTM C 1280, GA-253 and manufacturer's written instructions.

1. Fasten sheathing to wood framing with screws.
2. Fasten sheathing to cold-formed metal framing with screws.
3. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
4. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.

C. Horizontal Installation: Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

3.04 WEATHER-RESISTANT SHEATHING BARRIER INSTALLATION

A. General: Cover framing with weather-resistant sheathing paper as follows:

1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap, unless otherwise indicated.

B. Building Paper: Install where indicated. Comply with manufacturer's written instructions. Apply horizontally with a 2-inch overlap and a 6-inch end lap; fasten to framing with galvanized staples or roofing nails.

C. Building Wrap: Comply with manufacturer's written instructions.

1. Seal seams, edges, fasteners, and penetrations with tape.
2. Extend into jambs of openings and seal corners with tape.

3.05 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturers written instructions.

1. Prime substrates as recommended by flashing manufacturer.
2. Lap seams and junctures with other materials at least 4 inches, except that at flashing flanges of other construction, laps need not exceed flange width.
3. Lap flashing over weather-resistant building paper at bottom and sides of openings.
4. Lap weather-resistant building paper over flashing at heads of openings.
5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

3.06 PROTECTION

A. Cementitious Fiber-Mat Reinforced Sheathing: A continuous water barrier must be installed over the studs and lap over the flashing. Weeps must be provided to allow water drainage out of the system at all horizontal terminations on exterior facing walls.

+++ END OF SECTION 06160 +++

SECTION 06200
FINISH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

A. Related sections:
   1. Section 06100: Rough Carpentry.
   2. Section 07900: Sealants and Caulking.
   3. Section 08710: Door Hardware.
   4. Section 09260: Gypsum Board Systems.
   5. Section 09900: Painting.

1.02 REFERENCES

A. Standards of the following as referenced:
   1. Architectural Woodwork Institute (AWI).
   2. American National Standards Institute (ANSI).
   3. National Electrical Manufacturer's Association (NEMA).

B. Industry standards:
   1. AWI: Quality Standards, Guide Specifications and Quality Certification Program, 1985 edition.

C. Grading rules and standards of the following apply to materials, furnished under this section.

   1. American Lumber Standards Committee (ALSC).
   2. American Plywood Association (APA).
   3. National Hardwood Lumber Association (NHLA).
   4. National Bureau of Standards (NBS) Voluntary Product Standards (PS).
   5. Southern Forest Products Association (SFPA).
   6. Southern Pine Inspection Bureau (SPIB).
   7. West Coast Lumber Inspection Bureau (WCLIB).
   8. Western Wood Products Association (WWPA).
   9. Forestry Stewardship Council (FSC)

D. Preservative treated material: meet specified standards of:

   1. American Wood Preservers Association (AWPA).
   2. American Wood Preservers Bureau (AWPB).
   3. American Wood Preservers Institute (AWPI).
   4. No urea-formaldehyde to be used in any material on the job site.

E. Plywood grading rules:

1. Softwood plywood: NBS PS-1-83.
2. Hardwood plywood: NBS PS-51-71.

1.03 SUBMITTALS

A. Shop drawings:

1. Submit for casework, standing and running trim, shelving, and miscellaneous ornamental work.
2. Indicate construction and installation details, species and grades of materials, finishes, plastic laminate selections, and cabinet hardware selections.

B. Product data: Submit for cabinet hardware and similar manufactured items. Submit with shop drawings.

C. Samples, submit as follows:

1. Plastic laminate: Manufacturer's standard color and pattern selection for verification by Engineer.
2. Finish samples: Indicate selected finishes on samples of species and grade material specified.
3. Hardware items: Submit, if requested by Engineer. Samples will be returned to supplier.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of finish carpentry Work to Project site to coincide with installation but not to cause delay in Work.

B. Immediately upon delivery to Project site, place materials indoors, under cover, protected from weather.

C. Store materials minimum 6" above ground on framework or blocking; cover with protective waterproof covering providing for adequate air circulation and ventilation. Store in cool, dry, conditioned space.

1.05 PROJECT CONDITIONS

A. Field measurements: Take field measurements to determine exact millwork sizes. Indicate exact dimensions on shop drawings.

B. Installation of interior finish carpentry or millwork until spaces are enclosed, dry, and capable of being heated is prohibited. Maintain temperature between 55^0 F and 65^0 F for 72 hours before beginning installation and for Project duration.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. Dimensions: Indicated lumber dimensions are nominal. Actual dimensions conform to industry standards established by ALSC and the Rules Writing Agencies. All wood products to be treated to be fire-resistant.
2. Moisture content: 12% maximum
3. Surfacing: Surface four sides, S4S, unless otherwise indicated.
4. Grades for exposed and semi-exposed finish carpentry and millwork and plywood are based on AWI Quality Standards: Custom. Grades for unexposed Work are based on Rules Writing Agencies grading rules.

B. Lumber:

1. Species and grades:
   a. Unexposed millwork framing and blocking:
      1) 2" by 4": Standard Grade West Coast Lumber.
      2) Members larger than 2" by 4": #2 Grade.
   b. Semi-exposed millwork components: Custom Grade Poplar.
   c. Exposed and semi-exposed painted millwork and trim: Custom Grade White Pine, kiln dried (KD).

C. Sheet material:

1. Plywood; thicknesses indicated:
   a. Unexposed and semi-exposed millwork and general carpentry: APA A-C G-1, EXTERIOR.
   b. Exposed painted millwork: APA M.D. OVERLAY, GROUP 1, EXT. exposed sides.
2. Plastic laminate substrate:
   a. Particleboard for wall cabinets: ANSI 208.1-87, three-ply, mat formed, manufactured using long fibered cuttings, bonded with water-resistant adhesive; 42.5 pcf, minimum.
   b. Plywood for base cabinets and countertops: ANSI/HPMA HP 1983; five-ply, rotary cut birch; 1/8" thickness, minimum, Grade 2-2 veneers; sanded face; Technical Type core.
   c. Thickness: 3/4 - inch, minimum.

3. Plastic laminates:
   a. Acceptable manufacturers:
      1) Exxon Chemical Company; Nevamar.
      2) Formica Corp.; Formica.
      3) Lamin-Art Div. of Eagle Picher Inc.; Lamin-Art.
      4) Ralph Wilson Plastics Company; Wilson-Art.

b. Conforming to NEMA Standard LD-3.1-1985, as follows:
   1) Horizontal applications: Grade GP-50
   2) Backing sheet: Grade BK-20.
   3) Horizontal post-forming: Grade PF-42.
c. Colors and patterns: Indicated in Finish Schedule on drawings as PL-#.

4. Solid surfacing counters for cabinets
   a. Acceptable Manufacturers
      1) Corian
      2) Wilsonart
      3) Silestone
      4) or equal.
   b. Colors and patterns: Indicated in Finish Schedule.

D. Hardware:
1. Acceptable manufacturers:
   a. Grant Hardware Company (Grant).
   b. The Engineered Products Company (EPCO).
   c. Knape & Vogt Mfgr. Co. (K&V).
   d. National Lock Cabinet Hardware (National).
   e. Stanley Hardware, Div. of the Stanley Works (Stanley).
2. Closet materials:
   a. Rod, 1-1/16" dia.: K&V, #660 SS; stainless steel clad tubing with K&V, #769 CR flange end cap assembly at exposed ends; K&V #734 and #735 flanges at wall.
   b. Closet shelf and rod bracket: K&V, #1195; wrought steel, cream enamel finish; one for each two feet or portion thereof.
3. Door and drawer pulls: EPCO; 402 Series, 4" centers; satin finished stainless steel wire pulls.
4. Magnetic catches: EPCO; #560.
5. Concealed cabinet hinges:
   a. 100 degrees self-closing 3D type, zinc die cast with cover caps:Grass; #1003, #1004, and #1005.
   b. 165 degrees self-closing 3D type, zinc die cast with cover caps: Grass; #1203 and #1204.
6. Drawer slides: Accuride; Model 3837, full extension, 100 lb. capacity.
7. Cabinet drawer/door lock: National; #8475, nickel plate.
8. Recessed shelf standards and supports: K&V; #255 Standard with #256 Support.

E. Fasteners: Provide bolts, nuts, washers: screws toggle bolts and similar fasteners as indicated or required to attach and secure Work under this section.

2.02 FABRICATION

A. Shop assembly:

1. Comply with applicable requirements of AWI.
2. Quality standards for following types of architectural woodwork; comply with indicated standards as applicable:
   a. Standing trim, running trim, and rails: AWI Section 300, Custom Grade.
   b. Architectural cabinets, laminate clad: AWI Sections 400 for Flush Overlay and 400B; Premium Grade.
   c. Architectural cabinets, tops: AWI Sections 400 for High Pressure Decorative Laminate Tops and 400C for Custom Grade.
   d. Shelving: AWI Section 600: Custom Grade.
   e. Miscellaneous ornamental items: AWI Section 700.
3. Provide joints at logical break points for items which cannot be manufactured in one piece; note joints on shop drawings.

B. Shop finishing:

1. Finish millwork items in accord with finishing requirements of allowable AWI Grade indicated unless otherwise indicated.
2. Provide finish Work smooth, free from abrasion, tool marks, raised grain, and other Grade prohibited defects on exposed surfaces.

C. Tolerances: Fabricate millwork items for Reception Area and Break Area to AWI Custom Grade unless otherwise indicated.

2.03 SOURCE QUALITY CONTROL

A. Inspection:

1. Grade marks:
   a. General: Identify lumber and plywood by official grade mark.
   b. Lumber grade stamp: Contain symbol of grading agency, mill number or name, grade of lumber, species or species grouping or combination designation, rules under which graded, where applicable, and condition of seasoning at time of manufacture.
   c. Plywood: Appropriate grade trademark of APA. Indicate type, grade, class and identification index, and inspection and testing agency mark.
   d. Treated lumber and plywood: Identify each piece with appropriate UL stamp indicating compliance with indicated requirements; verify stamp contains treatment name, manufacturer, and location; third party inspection agency: species; flamespread; AWPA classification; 30 minute test characteristics.
   e. Conceal grade marks on components exposed to view in finished Work.

PART 3 - EXECUTION

3.01 PREPARATION

A. General:

1. Install Work plumb, level, true, and straight without distortions; conceal shims.
2. Provide finish Work smooth, free from abrasion, tool marks, raised grain markings or similar defects on exposed surfaces.
3. Cut Work to fit unless specified to be shop fabricated or shop cut to exact size. Where carpentry and millwork abuts other finished Work, scribe and cut for accurate fit. Drill pilot holes at corners before making cut-outs.
4. Distribute defects allowed in quality grade specified to best overall advantage when installing job assembled Work.
5. Install mill fabricated Work in accord with AWI Section 1700.

3.02 INSTALLATION

A. Interior standing and running trim:

1. Trim and moldings: Install in single, unjointed lengths for openings and for runs less than 10'-0". Use only one piece less than 10' -0" long in longer straight runs Stagger joints in adjacent members. Cope at returns and miter at corners.
2. Attach and secure in place with uniform joints providing for thermal and building movements.
3. Nailing: Blind nail where possible. Use finishing nails where exposed. Set exposed nailheads for filling.
4. Anchoring: Secure Work to anchors or blocking built-in or directly attached to substrate.

B. Millwork:

1. Install in manner consistent with specified quality grade, plumb, level, true, and straight without distortions: shim as required using concealed shims.
2. Secure to grounds, stripping, and blocking with countersunk, concealed fasteners and blind nailing. Scribe and cut for accurate fit to other finished Work.

C. Hardware: Install where indicated in accord with particular hardware specialty manufacturer's installation instructions.

D. Countertops: Install countertops in accord with AWI Custom Grade.

3.03 CLEANING

A. Clean wood, metal, and accessory items using neutral cleaner. Check and correct operating mechanisms for proper operation. Adjust and lubricate hinges, catches, and other operating hardware.

3.04 PROTECTION

A. Protect finished and prefinished surfaces from Work of other trades.

B. Prior to Date of Substantial Completion examine Work for damage. Repair or replace damaged areas to original condition.

+++ END OF SECTION 06200 +++

SECTION 07081
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SCOPE

A. Contractor shall furnish all labor, materials, equipment and incidentals required to provide and install flashing and sheet metal as shown and as specified.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Coordination

1. Review installation procedures under other section and coordinate the installation of items that must be installed with the roof insulation.

D. Related Work Specified Elsewhere:

1.	Section 07082	Elastomeric Sheet Roofing
2.	Section 07400	Preformed Metal Roofing

1.02 SUBMITTALS

A. Product data: Indicate product description, finishes and installation instructions, including interface with adjacent materials and surfaces.

B. Shop drawings:

1. Indicate material types, sizes, shapes, thicknesses, finishes, fabrication details, joint details, anchors, connections, expansion joints, and relations to adjacent work.

2. Draw details and profiles to quarter size scale.

3. Include on detailed shop drawings, locations of sleepers and required fastening strips to secure metal work where sheet metal is applied to other than wood surfaces.

C. Samples, submit as follows:

1. Special finishes: 6" x 6" samples of manufacturer's standard colors for Architect/Engineer's color selection, including a clear coated mill finish sample.

2. Manufactured expansion joint covers, copings, gravel stops, flashing reglets, and other flashing items: 1'-0" length in style and finish specified.

D. Quality control submittals:

1. Certificates: Submit certificates indicating materials supplied or installed are asbestos free.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all federal and state laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. American Iron and Steel Institute (AISI)

2. American Society for Testing and Materials (ASTM)

3. Copper Development Association, Inc. (CDA)

4. Sheet metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

B. Industry Standards:

1. AISI: Stainless Steel Data Manual, 1968 Edition.

2. CDA: Contemporary Copper in Architecture, 1973 Edition.

3. SMACNA: Architectural Sheet Metal Manual, 4th Edition, October 1987.

C. Pre-installation conference:

1. Prior to beginning work, conference will be held to review work to be accomplished.

2. Particular requirements are specified in Loose Single Ply Membrane section.

1.04 DELIVERY, STORAGE AND HANDLING

A. Acceptance at site: Handle materials to prevent damage to surfaces, edges and ends of sheet metal items. Reject and promptly remove damaged materials from site.

B. Storage and protection: Store materials off ground, under cover. Protect from damage and deterioration.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate requirements of this section with work described under Manufactured Roof section. Use flat stock matching respective roofing for shop fabricated flashings, closures and accessories.

1.06 WARRANTY

A. Warrant flashing and sheet metal work to be free of defects in materials and workmanship; combine warranty with roofing warranty.

B. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sheet metal:

1. General: Follow gauge, thickness, or weight requirements in SMACNA Manual for intended use, but not less than indicated below.

2. Sheet Aluminum at .038" min. allow. Standard Color Kynar.

3. Sheet lead: Minimum 4 lbs. PSF hard type.

B. Soldering materials:

1. Solder: Meeting ASTM 032-76, alloy grade 50A, 50% pig lead and 50% block tin.

2. Solder flux for:

a. Stainless steel and copper: Muriatic acid neutralized with zinc.
b. Lead: Non-corrosive rosin.

C. Fasteners: Same material or compatible with sheet metal being fastened.

1. Nails: Flathead, needle point, not less than 12 gauge; sufficient length to penetrate substrate 1" minimum.

2. Expansion shields: Lead sleeves.

3. Screws: Self-tapping type with round heads.

4. Bolts: Furnished complete with nuts and washers.

5. Rivets: Round head, solid shank.

6. Blind clips and cleats: Same gauge as sheet metal.

D. Caulk: Sonneborn NP-l Flexible Lap Sealant. G.E. Silicone as shown.

2.02 FABRICATION

A. Shop Assembly:

1. General:

a. Fabricate sheet metal in accord with reviewed shop drawings and industry standards.

b. Form sheet metal work with clear, sharp and uniform arises. Hem exposed edges.

c. Fabricate corners with minimum 2'-0" returns each side of return; fully seal joints.

2. Stainless steel, aluminum and copper materials:

a. Roughen edges of stainless steel with emery cloth before soldering.

b. Solder sheet metal joints with heavy, well heated coppers. Pre-tie joints not less than 1-1/2" wide. Sweat solder through seam's full width.

c. Provide 1" minimum soldered joints.

d. Neutralize remaining acid with ammonia or baking powder solution; rinse with water.

3. Provide linear sheet metal items in 10'-0" sections minimum, except as otherwise noted. Form flashing using single pieces for full width.

4. Form specified sheet metal items in accord with SMACNA details and existing adjacent work; gauge indicated in SMACNA description of particular

plate, but no less than .038" thickness.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verification of Conditions:

1. Verify locations of all roof openings and penetrations are in accord with reviewed shop drawings.

2. Examine conditions and substrates under which products of this section are to be installed; submit written notification of unacceptable conditions or substrates.

3. Submit copy of installer's report to the Engineer within 72 hours of report receipt.

4. Proceeding with construction activity of this section:

   a. Prior to correction of unacceptable conditions or substrates are prohibited.

   b. Indicates installer's acceptance of conditions and substrates.

3.02 INSTALLATION

A. Sheet Metal:

1. Install work in accord with reviewed shop drawings and industry standards. Provide sheet metal items true to line, without buckling, creasing, warp or wind in finished surfaces.

2. Coordinate flashing at roof surfaces with roofing work to provide weather-tight condition at roof terminations.

3. Perform field joining of lengths specified for shop fabrication, but in lengths no shorter than 10'-0" except at closure pieces.

4. Isolate dissimilar materials to prevent electrolysis. Separate using bituminous paint or roofing felt.

5. Seaming:

   a. Comply with SMACNA Plates #99, #100 and other applicable plates.

   b. Flat-lock seams: Finish not less than 3/4" wide.

c. Soldered lap seams: Finish not less than 1" wide.

d. Other lap seams: Overlap not less than 4" unless otherwise indicated.

e. Seams: Orient properly for direction of water flow.

f. Flatlock seams with cleats soldered.

g. Lap seams occurring in members sloping 45" or more, 4" minimum; bed in with butyl sealant.

h. Perform soldering in same manner indicated in FABRICATION Article.

6. Secure sheet metal items using continuous cleats, clips and blind fasteners as indicated; exposed face fastening is prohibited.

7. Fastening:

a. Nails: Confine to one edge only of flashing 1'-0" or less in width. Space nails at 4" O.C. Maximum. Provide neoprene washers for nails.

b. Cleats: Continuous; form to profile of item being secured.

c. Clips: Minimum 2" wide and continuous; form to profile of item being secured. The clips are continuous and the cap flashing replacement.

8. Form joints in linear sheet metal to allow for 1/2" minimum expansion at 20' -0" OP.C. maximum and 8'-0" from corners. Provide 1'-0" wide back-up plate at intersections. Form plates to profile of sheet metal items. Apply linear sheet metal items in full bed of butyl or urethane caulk over back-up plate.

9. Gutters and downspouts:

a. Construct with riveted and soldered joints, lapped 1" minimum in direction of flow, provide 3/4" minimum expansion joints at 60`-0" O.C. maximum. Form expansion joints in accord with SMACNA Manual, Plate #7 for gutters up to 20 gauge; Plate #11, 20 gauge and heavier.

b. Hang gutters with high points equidistant from downspouts, evenly sloped toward downspouts. Support gutters in accord with SMACNA Manual, Plate #14A.

c. Secure downspouts to exterior walls at 6'-0" O.C. maximum using straps and expansion type fasteners. Lap downspout joints, 1-1/2" minimum and solder.

d. Finish gutters, downspouts and hangers; required, copper material to match existing.

10. Roof Penetration Flashing:

a. Pipe penetrations: Provide flashing extending 2'-6" onto roofing felts each direction for pipes penetrating roof. Flash in accord with slate roofing manufacturer's requirements.

+++ END OF SECTION 07081 +++

SECTION 07100
WATERPROOFING AND MOISTUREPROOFING

PART 1 - GENERAL

1 SCOPE

A. This section specifies waterproofing and moisture proofing of concrete surfaces and below grade masonry surfaces.

PART 2 - PRODUCTS

1 MATERIALS

A. Waterproofing and Moistureproofing Coatings: Waterproofing and moistureproofing coating shall be PVC lining where shown on the Drawings or epoxy resin. Acceptable epoxy resin products are Tnemec Series 69, Ameron Amercoat 351, and Porter 7600 Series Magna Coat. Each of these is a polyamidoamine epoxy.

B. Waterproofing Membrane:

1. Membrane: Waterproofing membrane shall be Bituthene as manufactured by W.R. Grace and Company, Jiffy Seal as manufactured by Protecto Wrap Co., or equal. Volclay Panels or Bentonize bentonite system are acceptable alternates, except where membrane is required between concrete slabs or where there is concrete over waterproofing membrane.

2. Protective Board: Protective board shall be 1/2-inch asphalt impregnated celotex insulation board.

A. Moistureproofing Underlay:

1. Plastic Membrane: Plastic reinforced membrane for moistureproofing underlay shall be a reinforced film with a thickness of 15 mils.

2. Pressure Sensitive Tape: Pressure sensitive tape shall be 2-inch wide polyethylene tape.

PART 3 - EXECUTION

1. CONSTRUCTION

A. Waterproofing Coating:

1. Location: Waterproofing coating shall be applied to the water side of walls and bottoms of channels or tanks which are common with rooms, tunnels or galleries to be occupied by equipment, piping, conduit, or personnel.
2. Surface Preparation: New concrete to be waterproofed shall have aged at least 28 days and allowed to dry to a moisture content recommended by the coating manufacturer. Loose concrete and laitance shall be removed from new concrete surfaces by abrasive blasting. Voids and cracks shall be repaired as specified in Section 03300, CAST-IN-PLACE CONCRETE.
3. Application: Two or more coats at manufacturer's recommended dry film thickness. Total dry film thickness shall be minimum 16 mils, final coat shall be black. Drying time between coats shall be as recommended by the coating manufacturer.

B. Moistureproofing Coating:

1. Location: Moistureproofing coating shall be applied to the earth side of concrete or masonry walls which are below grade and are common with rooms, tunnels, or galleries to be occupied by equipment, piping, or personnel. Moistureproofing coating is not required for walls to be provided with waterproofing membrane or for walls which are poured directly against an excavated surface.
2. Surface Preparation: Preparation of concrete shall conform to Paragraph Surface Preparation. Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with sealer or block filler compatible with the specified primer. Sealer or filler shall dry a minimum of 48 hours prior to application for prime coat.
3. Application: One or more coats shall be applied at the manufacturer's recommended dry film thickness. The number of finish coats shall be sufficient to produce a total dry film thickness of at least 16 mils. Drying time between coats shall be as recommended by the coating manufacturer.

C. Waterproofing Membrane:

1. Location: Waterproofing membrane shall be applied to surfaces as specified.

2. Surface Preparation: Concrete surfaces to receive waterproofing membrane shall be clean, dry, and free of voids, spalled areas, loose aggregate, and sharp protrusions, with no coarse aggregate visible.
3. Application: Waterproofing membrane shall be applied in accordance with the manufacturer's recommendations. Surfaces shall be clean and primed prior to application of the membrane. The manufacturer's representative shall be present during initial application to certify that the Contractor's procedures comply with manufacturer's specifications. Pipes or conduits entering structures shall be watertight. The protective board shall be placed directly against the membrane prior to backfilling. Where the membrane is turned up from the base of the walls, at angles in walls, and at any other place where the membrane may be subjected to unusual strain, strips consisting of two additional plies of membrane shall be applied.

D. Moistureproofing Underlay:

1. Location: Unless otherwise specified, moistureproofing underlay shall be provided under concrete floors or floating slabs-on-grade including those deposited on drain rock.
2. Surface Preparation: Backfilled surfaces to receive moistureproofing underlay shall be leveled off and smoothed over to minimize contact with sharp edges.
3. Application: At joints, moistureproofing membrane shall be lapped 12 inches and sealed with pressure sensitive tape. Where pipes and conduits pass through the membrane, they shall be wrapped tightly with separate sheets of membrane which shall then be sealed with tape to the main membrane. Reinforcing steel or wire mesh shall be supported by chairs with flat bases to protect the membrane.

+++ END OF SECTION 07100 +++

SECTION 07115
SELF-ADHESIVE SHEET WATERPROOFING

PART 1 - GENERAL

1 .01 SCOPE

A. Section Includes:
1. Substrate preparation.
2. Primer.
3. Waterproofing membrane.
4. Edge and penetration detailing material.
5. Protection board.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
1. Manufacturer's technical product data, installation instructions, recommendations for use of each product required.
2. 12-inch square samples of membrane material.
3. 6-inch square samples of protection board.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM C 144-93, Standard Specification for Aggregate for Masonry Mortar; 1993.
2. ASTM C 150-92 -- Standard Specification for Portland Cement; 1992.
3. ASTM D 146-90 -- Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing; 1990.
4. ASTM D 412-92 -- Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension: 1992.
5. ASTM E 154-88 -- Standard Test Methods for Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls, or as Ground Cover; 1988.

1.04 QUALITY STANDARDS

A. The waterproofing system shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements

specified herein and as shown on the Drawings.

B. Manufacturer Qualifications: A company that has produced waterproof membrane and accessories of the type included in this section for at least 5 years.

C. Installer Qualifications: A company approved by the membrane manufacturer and which has completed at least 20 previous installations of membranes similar to the type required.

D. Manufacturer shall provide written certification that the systems provided under this Specification have been designed in accordance with these specifications and are a suitable application for these service conditions.

E. Manufacturer's offering products that comply with these specifications include:
   1. Mirafi Division/The Nicolon Corporation.
   2. Polyguard Products, Inc.
   3. Polyken Technologies Division/The Kendall Company.
   4. Progress Unlimited, Inc.
   5. Protecto Wrap Company.
   6. Royston Laboratories Division/Chase Corporation.
   7. W. R. Grace & Company.
   8. W. R. Meadows, Inc.
   9. Or equal.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in manufacturer's original, unopened containers.

B. Store materials in dry, well ventilated space.

C. Protect membrane materials from prolonged sunlight exposure.

1.06 SITE CONDITIONS

A. Comply with manufacturer's recommendations regarding weather conditions before and during installation, condition of substrate to receive waterproofing, and protection of installed waterproofing system.

   1. Do not install membrane or primer during wet weather or when temperature is below 25 degrees F.

B. Do not leave membrane exposed to sunlight.

1.07 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

B. Special Project Warranty: Submit a written warranty signed by manufacturer and installer, guaranteeing to correct failures in product and workmanship which occur within period indicated, without reducing or otherwise limiting any other rights to correction which the City may have under the Contract Documents. Failure is defined to include faulty workmanship, or product failure which contributes to failure of watertight condition.

1. Warranty period duration: 10 years, starting at date of substantial completion.

PART 2 - PRODUCTS

2.01 SELF-ADHESIVE SHEET WATERPROOFING MEMBRANE

A. Standard Membrane: Self-adhesive, unreinforced, polyester-reinforced, or fiberglass-reinforced rubberized asphalt core bonded to 4-mil-thick polyethylene or polyester film. Packaged in rolls with disposable release paper.

1. Nominal thickness: 0.060 inch (60 mils) minimum.

2. Width: 36 or 48 inches, nominal.

3. Tensile strength (ASTM D 412, modified): 250 psi minimum.

4. Elongation (ASTM D 412, modified): 250 percent minimum.

5. Pliability (ASTM D 146; 1-inch mandrel, 180 degree bend, minus 25 degrees F): No cracks.

6. Puncture resistance (ASTM E 154): 40 pounds, minimum.

7. Peel resistance: 5 pounds per inch, minimum.

B. Provide specially formulated low-temperature membrane if application temperatures below 40 degrees F are likely; otherwise provide manufacturer's standard membrane.

2.02 INSTALLATION ACCESSORIES

A. Primer: Fast-drying, solvent-based rubber material, made by manufacturer of membrane, specifically intended for use with membrane.

1. High solids content, with low volatile organic compound emissions.

2. Provide special primer formulation for application at temperatures below 40

degrees F.

B. Detailing Mastic: Solvent-based rubberized asphalt mastic, made by manufacturer of membrane for sealing of edges and penetrations.

C. Latex-Modified Mortar: Proprietary; premixed and bagged, or site-mixed as follows:

1. Latex (acrylic) admixture: Proprietary non-reemulsifiable acrylic liquid compound, specifically manufactured to improve cohesion, tensile strength, and adhesive properties of portland cement mortars and concrete.

2. Sand: Clean, sharp masonry sand; ASTM C 144.

3. Cement: ASTM C 150, Type I.

4. Mix: 2-1/2 parts sand (by volume), 1 part cement, 50/50 mix of water and latex admixture to provide workability.

2.03 PROTECTION BOARD

A. Asphalt/Mineral Fiberboard: Semi-rigid sheets of fiberglass or mineral-reinforced asphaltic core, pressure-laminated between two asphalt-saturated fibrous liners.

B. Protection Board Adhesive: Rubber-based solvent type recommended by membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are smooth, sound, clean, and dry and that elements which will penetrate waterproofing have been completed and are rigidly installed.

3.02 PREPARATION

A. Remove honeycomb, aggregate pockets, fins, ridges, and projecting rough areas.

B. Fill cracks, holes, depressions, and irregularities with latex patching mortar, sealant, or detailing mastic as recommended by membrane manufacturer.

C. Apply one coat of primer at the rate of 200 to 300 square feet per gallon and allow to dry.

D. Form fillets (cants) at inside corners and around projecting elements using latex patching mortar or detailing mastic and install 10- to 12-inch-wide strip of membrane

material.

E. Outside Corners: Apply 10- to 20-inch-wide strip of membrane material centered on corner.

3.03 MEMBRANE INSTALLATION

A. Place and adhere membrane over entire area to receive waterproofing. Lap seams a minimum of 2-1/2 inches and seal using a hand-held steel roller. Heat-weld end laps if recommended by manufacturer.

B. Slit and flatten fishmouths and blisters. Cover damaged area with patch of membrane material extending a minimum of 6 inches beyond damaged area in all directions.

C. Apply detailing mastic at membrane edges and at penetrations. Detailing mastic may be omitted where membrane terminates in a reglet.

3.04 PROTECTION COURSE

A. Install protection board over membrane as soon as practicable after membrane installation to avoid damage to membrane from sunlight and subsequent operations.

3.05 INSPECTION

A. Do not cover membrane before it has been observed by the Engineer.

3.06 PROTECTION AND CLEANING

A. Protect completed membrane installation from damage until project completion.

B. Do not permit traffic on exposed membrane.

C. Clean spillage and soiling from adjacent surfaces, using cleaning agents and procedures recommended by the manufacturer of the surface.

+++ END OF SECTION 07115 +++

SECTION 07190
VAPOR BARRIER

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish all materials, labor, equipment, and incidentals required to perform all vapor barrier work and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

1.02 RELATED WORK

A. Related Work Specified Elsewhere:

1. Section 03300, CAST-IN-PLACE CONCRETE.

1.03 SUBMITTALS

A. Submit to the Architect/Engineer as provided in the General Conditions for shop drawings, detailed information on materials proposed and installation methods.

PART 2 - PRODUCTS

2.01 MOISTURE BARRIER (UNDER CONCRETE SLABS)

A. Where so indicated on the Drawings, provide a moisture barrier consisting of pre-molded, membrane meeting the standard of ASTM E-96, Method B, 1980 and ASTM D781, 1968, ASTM D1228, 1964.

B. Manufacturers:
1. Stego Wrap Vapor Barrier (15-mil)
2. Or equal.

2.02 OTHER MATERIALS

A. Provide other materials, not specifically described but, required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Install vapor barrier under concrete slabs-on-grade, sealing all lap joints, around all protrusions, and at slab edges.

B. Vapor barrier to extend continually from the top of footing or to be sealed to the foundation wall, or to extend to the outside edge of a monolithic slab or patio.

C. Vapor barrier should be installed with all seams lapped at least 12 inches, taped and sealed with plastic roof cement, or other flexible air tight seal as approved by the Engineer.

D. All punctures in vapor barrier to be repaired with same material, lapped at least 12 inches, taped and sealed.

E. Field fabricate a sealing boot around all utility entries and other penetrations and seal boot airtight to vapor barrier and conduit.

+++ END OF SECTION 07190 +++

SECTION 07210
BUILDING INSULATION

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all building insulation. All insulation shall be installed in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Related Work Specified Elsewhere:

1. Section 03300: Cast-in-Place Concrete
2. Section 07150: Dampproofing
3. Section 07270: Firestopping

1.02 REFERENCES

A. Standards of the following as referenced:

1. American Society for Testing and Materials (ASTM).
2. Federal Specifications (Fed. Spec.).
3. The Society of the Plastics Industry, Inc. (SPI).
4. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. Terms:

1. Rigid Closed Cell Polyisocyanurate

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data and installation instructions for each type insulation and installation.

2. Certificates indicating materials supplied or installed are asbestos free.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling:

1. Store materials under cover, off ground: protect from moisture.

2. Remove wet, damaged, or deteriorated materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Roof Deck and Wall Cavity insulation:

1. Acceptable manufacturers, subject to compliance with specified requirements:

a. Certain Teed Corporation.
b. Knauf Fiber Glass.
c. John Manville Sales Company.
d. Owens Corning Fiberglas Corp.

2. Characteristics:

a. Type: Rigid polyisocyanurate insulation board.
b. Facing:
1) Foil Faced for Wall and Fiberglass reinforce Face for roof insulation.
c. "R" value: R-11.4 min, vertical cavity-wall installations; 2 layers of R-30 min. horizontal roof installations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with manufacturer's product data for each type installation. Cut insulation around obstructions and protrusions. Remove projections interfering with installation.

+++ END OF SECTION 07210 +++

SECTION 07270
FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes materials for complete firestop installation of penetrations consisting of pipe, duct, cable, other electrical devices, or blank opening in fire rated walls, floors, and partitions.

B. Related sections:

1. Section 03300: Cast-in-Place Concrete.
2. Section 04220: Concrete Unit Masonry.
3. Section 05400: Cold Formed Metal Framing.
4. Section 06100: Rough Carpentry.
5. Section 07210: Building Insulation.
6. Section 09260: Gypsum Board Systems.

1.02 REFERENCES

A. Standards of the following as referenced:

1. American Society for Testing and Materials (ASTM).
2. Environmental Protection Agency (EPA).
3. Factory Mutual (FM).
4. Underwriters' Laboratories, Inc. (UL).
5. Warnock Hersey (WH).

B. Industry standards:

1. ASTM E814-83 (1991): *Standard Method of Fire Tests of Through-Penetration Fire Stops*.
2. FM: *Approval Guide*, 1993 edition.
3. UL 1479: *Fire Tests of Through-Penetration Firestops*, 1993 edition.
4. UL Fire Resistance Directory: *Through Penetration Firestop Devices (XHCR) and Through Penetration Firestop Systems (XHEZ)*, 1993 edition.
5. WH: *Certification Listings*, 1993 edition.

1.03 DEFINITIONS

A. Terms

1. Alpha - Alpha - Numeric system for penetration identification: UL 1993 system to universally identify and categorize penetrations.

    a. First alpha grouping: Designate penetration type; "F" for floors, "W" for

walls, "C" for either or both floors and walls.

b. Second alpha grouping: Further designates significant assembly characteristics; "A" for concrete floors with minimum thickness less than or equal to 5", "J" for concrete or masonry walls with minimum thickness less than or equal to 8".

c. Numeric grouping: Designates penetrating item; 1000-1999 for metal pipe, conduit, or tubing, 5000-5999 for insulated pipes.

d. Example; assembly F-A-5001 means Floor penetration - Concrete substrate less than or equal to 5" - Insulated pipes.

2. Fire rated: Having ability to withstand effects of fire for specified time period, as determined by qualified testing.

3. Fire rated assembly: Floor, wall, or other partition also to withstand design fire and hose stream test without failure.

4. Fire resistance rating: Time, in hours, for which rated assembly can withstand effects of fire without burn-through or structural failure.

5. Firestop: Means of sealing openings in fire related assemblies to preserve or restore fire resistance rating.

6. Firestop system: Combination of materials or devices, including penetrating items, required to make up complete firestop.

7. Intumescent: Having the quality to enlarge, swell, or expand with heat.

8. Penetrating item: Pipe duct, conduit, cable tray, cable, or other element passing through opening in fire rated assembly.

9. VOC: Volatile organic compounds.

1.04 SYSTEM DESCRIPTION

A. Design requirements:

1. Designs selected for installation: Provide fire resistance rating at least equal to hourly resistance rating of floor, wall, or partition into which firestop design is installed.

2. Firestop systems and materials:

a. Not require special tools for installation.

b. Do not emit hazardous, combustible, or irritating fumes during installation,

curing, or use.

3. When more than one firestop design is applicable, evaluate individual product characteristics for secondary benefits in performance, e.g., environmental/water sealing or ease of installation or modification.

B. Performance requirements:

1. Fire and hose stream on material: Meet requirements of ASTM E814-83 for F (Flame) Rating or T (Temperature) Rating required by local code.

2. Fire tests: Pass requirements when used in assembly tested in accord with ASTM E119-83.

3. Smoke and fuel contributed tests on firestopping materials: Meet requirements of ASTM E84-87; Flame Spread 25 or less, Smoke Developed 20.

4. Firestop systems do not re-establish the structural integrity of load bearing partitions. Consult Architect prior to drilling or coring operations in any load bearing assembly.

5. Firestop systems are not intended to restrict or accomodate potential traffic. Notify Architect, in writing, if these limitations may be violated.

1.05 SUBMITTALS

A. Product data:

1. Submit complete list of products for use; indicate compliance with VOC limits.

2. Submit data for fire or smoke rated insulation; indicate complete installation instructions for maintaining ratings of wall or floor assemblies to meet code requirements.

3. Submit manufacturer's Safety Data Sheets (MSDS) for materials.

B. Shop drawings: Complete schedule of rated penetrations, location, and proposed rated materials to fill penetrations in accord with UL Alpha - Alpha - Numeric system.

C. Quality control submittals:

1. Certificates:
   a. Indicate materials supplied or installed are asbestos free.

   b. Indicate compliance with applicable VOC limits.

2. Test reports: Submit for products supplied: indicate recognized laboratory test results for same type conditions encountered on Project.

3. Manufacturer's instructions:

    a. Submit exact procedures for installation of rated firestop material to maintain wall, floor, floor/ceiling, or ceiling/roof assemblies ratings; indicate penetration hole/pipe size relationship, if required, for clearances to obtain results same as tested assemblies.

    b. Submit disposal requirements for expended material or partially expended containers.

D. Contract closeout submittals:

1. Project record documents: Completion and inspection reports in FIELD QUALITY CONTROL Article.

1.06 QUALITY ASSURANCE

A. Qualifications, installer: use only one installer for all firestopping work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Provide materials in original unopened containers with manufacturer's labels intact and legible.

B. Acceptance at site:

1. Open, punctured, or opened damaged containers or wet materials will not be accepted.

2. Damaged materials determined by visual inspection will not be accepted.

3. Remove rejected materials from site immediately.

C. Storage and protection:

1. Store materials in dry area in manufacturer's protective packaging; in original containers with labels and installation instructions intact.

2. Store materials under cover, off ground; protect from moisture.

3. Remove wet, damaged, or deteriorated materials.

4. Dispose of expended or partially expended material containers in accord with EPA requirements as required.

1.08 SEQUENCING AND SCHEDULING

A. Additional firestopping requirements may be created by construction activities specified in other sections.

1. Identify locations requiring firestopping.

2. Schedule and coordinate firestopping installation after completion of duct, piping, electrical runs, and prior to covering or concealing openings or eliminating access.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. Products indicated below may be used singly or in combination to meet ratings of adjacent wall, floor, ceiling, or perimeter.

2. Use of product or products singly or in combination requires recognized testing laboratory test results for indicated application; system selection is optional unless testing requires use of one particular type.

3. Intent is to maintain rated integrity of wall, floor or ceiling at penetrations.

4. No ampacity de-rating of cable at penetrations.

5. Reviewed schedule indicates insulation type or types and locations used.

6. Penetrations, smoke and fire, fall into two categories:

a. Not requiring intumescent qualities.

b. Requiring intumescent qualities, such as PVC pipe or other dissolving materials.

B. Acceptable manufacturers:

1. Putty, mortar, re-entry tape, and metal collar/cuff assemblies:

a. Dow Corning Company.
b. FiPro Corp. of America.
c. Flame Stop, Inc.
d. General Electric Company.
e. Hevi-Duty/Nelson.
f. Hilti, Inc.
g. Rectorseal, Inc.
h. Specified Technologies, Inc.
i. 3M Company/Electrical Products Division.

2. Safing insulation:

a. Acceptable products:

1) USG Acoustical Products Company; Thermafiber Safing Insulation.
2) Fibrex; FBX Safing Insulation.
3) Partek Insulation; Paroc Safing Insulation.

b. Characteristics:

1) Composition: Semi-rigid to rigid mineral fiber boards, meeting ASTM C612-83, Class 3.

2) Density: Four PCF, nominal.

3) Thickness: Required for penetration rating.

4) Combustibility: Noncombustible in accord with ASTM E136-82.

5) Flame spread: 15, maximum, in accord with ASTM E84-87.

c. Accessories: Provide manufacturer's standard impaling clips similar to USG Acoustical Products Company 12 gauge Snap-on Clip Type A or Prong Clip Type D.

7. Accessories:

a. Provide damming materials and other materials required for installation.

b. Permanent labels to identify penetration with space for name of installing company, date installed, and UL or WH penetration designation.

PART 3 - EXECUTION

3.01 EXAMINATIONS

A. Verification of conditions: Verify that penetrating elements and supporting devices have installed and temporary lines have been removed.

3.02 PREPARATION

A. Clean surfaces in contact with penetration seal materials of dust, dirt, grease, oil, loose materials, and other substances.

3.03 INSTALLATION

A. General:

1. Install firestopping materials in accord with tested configurations; system selection

is optional unless testing requires use of one particular type.

2. Locations, general:

   a. Cavities of floor-to-floor penetrations; include spaces around conduit, cable, piping, and duct penetrations.

   b. Rated wall and ceiling penetrations; include spaces around conduit, cable, electrical boxes, piping, and duct penetrations.

   c. Vertical service shaft penetrations.

   d. Openings where fire rated walls terminate at metal floor or roof deck.

   e. Other locations indicated.

3. Follow manufacturer's recommendations to obtain a smooth, professional finish.

4. Remove forms or damming materials, if used, after designated cure time unless support materials used are fire resistant or noncombustible nature.

5. Reviewed submittal schedule indicates type or types firestopping used and actual locations.

B. Install permanent labels at each penetration, in conspicuous location on pipe, duct, or other hard surface, indicating assembly configuration installed, date installed, and installing company.

3.04 FIELD QUALITY CONTROL

A. Inspection:

1. Examine penetration seals for correct installation, adhesion, and curing appropriate for respective seal materials.

2. Keep areas of firestopping work accessible; notify code authorities or designated inspectors, in writing, of work released for inspection.

3. Document completion and inspection; file completion and inspection reports with Project closeout documents.

3.05 ADJUSTING

A. Repairs and modifications:

1. Identify damaged or re-entered seals requiring repair or modification.

2. Remove loose or damaged materials.

3. If penetrating elements are to be added, remove enough material to insert new elements being careful not to cause damage to balance of seal.

4. Ensure surfaces to be sealed are clean and dry.

5. Install materials in accord with materials approved by manufacturer as suitable for repair of original seal.

+++ END OF SECTION 07270 +++

SECTION 07400
PREFORMED METAL ROOFING

PART 1 - GENERAL

1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 Specifications Sections, apply to and form a part of this section.

2. DESCRIPTION

A. Furnish all labor, materials, tools, equipment, and services for all preformed metal roofing as indicated, in accord with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, and complete installation.

3. QUALITY ASSURANCE

A. Applicable Standards:

1. SMACNA: "Architectural Sheet Metal Manual" Sheet Metal and Air Conditioning Contractors National Association, Inc.
2. AISC: "Steel Construction Manual" American Institute of Steel Construction.
3. AISI: "Cold Form Steel Design Manual," American Iron and Steel Institute.
4. ASTM A792-83-AZ55: Specification for steel sheet, aluminum-zinc alloy coated (galvanized) by the hot dip process, general requirements (galvalume).

B. Manufacturer's Qualifications: Manufacturer has a minimum of five years' experience in manufacturing panels of this nature.

C. Installer's Qualifications: Installation of panels and accessories by installers with a minimum of five years' experience in panel projects of this nature.

4. SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Submit complete shop drawings and erection details to Engineer for review. Do not proceed with manufacture prior to review of shop drawings. Do not use Drawings prepared by Engineer for shop or erection drawings.
2. Shop drawings show methods of erection, elevations, and plans of roof and wall panels, sections and details, anticipated loads, flashing, roof curbs, vents, sealants, interfaces with all materials not supplied and proposed identification of component parts and their finishes.
3. Samples: Samples and color chips for all proposed finishes:
   a. Submit two 24-inch long samples of panel, including slips (and battens, if applicable).
   b. Submit two 3-inch by 5-inch color chip samples in color selected by Architect/Engineer.

5. WARRANTY

A. Metal panel manufacturer, upon final acceptance for project, shall furnish a warranty covering bare metal against rupture, structural failure, and perforation due to normal atmospheric corrosion exposure for a period of 20 years.

B. Cover panel finish against cracking, checking, blistering, peeling, flaking, chipping, chalking, and fading for a period of 20 years for roof panels (premium fluorocarbon coating produced with Kynar-500 resin).

PART 2 - PRODUCTS

1. .MATERIALS

A. Panel Profile:

1. Face Style: High Seam (HS) Series or Tite-Loc Plus.
2. Panel Width: 18 inches.

B. Panel Style: Concealed fastener.

C. Gauge: 24-gauge (panels and trim).

D. Texture: Smooth.

E. Finish: Premium fluorocarbon coating produced with Kynar 500 resin (20-year warranty).

F. Color: To be selected by the Architect from the manufacturer's full line of colors, including premium colors. Basis of Design: PAC-CLAD Silver Metallic Color, Reflectivity: 0.49, Emissivity: 0.81, SRI: 54.

G. Manufacturer:

1. AEP/Span Metal Corp., Dallas, TX;
2. MM Systems Corp.;
3. Berridge Manufacturing Company, Inc.;
4. PAC-CLAD
5. Or approved equal.

H. Roofing Felt: 30-pound asphalt saturated, with minimum of 6-inch cap horizontally.

I. Down Spouts: See architecture and plumbing drawings.

2. FABRICATION

A. Roll form panels in continuous lengths, full length of detailed runs.

B. Fabricate trim, flashing and accessories to detailed profiles (include wall to roof transitions).

C. Fabricate trim and flashing from same material as panel.

PART 3 - EXECUTION

1. PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver panels to jobsite properly packaged to provide protection against transportation damage.

B. Handling: Exercise extreme care in unloading, storing, and erecting panels to prevent bending, warping, twisting, and surface damage.

C. Storage: Store all material and accessories aboveground on well skidded platforms. Store under waterproof covering. Provide proper ventilation to panels to prevent condensation build-up between each panel.

2. SURFACE CONDITIONS

A. Examination:

1. Inspect installed work of other trades and verify that such work is complete to a point where this work may continue.

2. Verify that installation may be made in accordance with approved shop drawings and manufacturer's instructions.

B. Discrepancies:

1. In event of discrepancy, notify Architect/Engineer.
2. Do not proceed with installation until discrepancies have been resolved.

3. INSTALLATION

A. Install panels so that they are weathertight, without waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction, per manufacturer's instructions and shop drawings.

B. Install panels in accordance with manufacturer's instructions and shop drawings.

C. Provide concealed anchors at all panel attachment locations.

D. Install panels plumb, level, and straight with seams and ribs/battens parallel, conforming to design as indicated.

E. All trim work, flashing, gutters, down spouts, etc., associated with or adjacent to the roofing shall be supplied by the roofing manufacturer to match roofing.

F. Metal roofing manufacturer to be responsible for support structure under roof at Hemphill Tunnel Pump Station Electric and Workshop Buildings. Manufacturer to supply engineered-stamped shop drawings.

4. CLEANING AND PROTECTION

A. Dispose of excess materials and remove debris from site.

B. Clean work in accordance with manufacturer's recommendations.

C. Protect work against damage until final acceptance. Replace or repair to the satisfaction of the Engineer, any work that becomes damaged prior to final acceptance.

D. Touch up minor scratches and abrasions.

+++ END OF SECTION 07400 +++

SECTION 07700
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all roof accessories. All equipment shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Product Data: Submit manufacturer's technical product data, rough-in diagrams, details, installation instructions and general product recommendations.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
2. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. ASTM A526/A526MSpecification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
4. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate

5. ASTM B370, Specification for Copper Sheet and Strip for Building Construction
6. ASTM D2822, Specification for Asphalt Roof Cement
7. ASTM D4586, Specification for Asphalt Roof Cement, Asbestos-Free

1.04 QUALITY STANDARDS

A. The roof accessories shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL PRODUCT REQUIREMENTS

A. Provide manufacturer's standard units, modified as necessary to comply with requirements. Shop fabricate each unit to greatest extent possible.

2.02 MATERIALS, FOR ROOF CURBS

A. None.

2.03 PREFABRICATED ROOF HATCHES

A. None.

2.04 PREFABRICATED PIPE BOOT

A. None.

2.05 COMBINED ROOF DRAIN AND SECONDARY OVERFLOW SYSTEM

A. MIFAB Series R1154-M-13-SPEC-U combined roof drain and secondary overflow system, consisting of a one piece lacquered cast iron roof drain body with integral

sump receiver, no hub outlet, cast iron waterproofing membrane clamp rings with integral gravel stops, one 2-1/2" (64) high integral cast iron overflow standpipe and two self-locking metal dome strainers with a free area of 43 square inches each. Or approved equal.

2.06 ROOF DRAIN FOR INSULATED ROOF DECK

A. MIFAB Series R1104-EU-13 lacquered cast iron roof drain with anchor flange, cast iron waterproofing membrane clamp ring with integral gravel stop, adjustable cast iron extension flange, underdeck clamp, no hub outlet, and standard self-locking galvanized dome strainer with a free area of 43 square inches. Or approved equal.

2.07 SECONDARY OVERFLOW ROOF DRAIN FOR INSULATED ROOF DECK

A. MIFAB Series R1104-EU-13-W lacquered cast iron roof drain with anchor flange, cast iron waterproofing membrane clamp ring with integral gravel stop, adjustable cast iron extension flange, underdeck clamp, no hub outlet, standard self-locking galvanized dome strainer with a free area of 43 square inches, and an adjustable water dam to be set at 2.5" above the primary roof drain level. Or approved equal.

2.08 OVERFLOW DRAIN NOZZLE

A. Jay R. Smith Mfg. Co. Downspout Nozzle 1770T-BS-NB, sized as indicated on the plumbing drawings, used as a parapet overflow where a concealed leader discharges rainwater to the roof and ground. The wall flange covers rough opening and serves as anchor. Provide bird-screen; finish to be nickel bronze. Or approved equal.

2.07 ROOFING UNDERLAYMENT

A. GCP Applied Tech Ice and Water Shield HT, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF ROOF CURBS AND ROOF ACCESS HATCHES

A. General: Comply with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive accessory units, and with vapor barriers, roof insulation, roofing and flashing as required to ensure that each element of the work performs properly, and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures. Except as otherwise indicated install roof accessory items in accordance with construction details of "NRCA Roofing and Water-proofing Manual."

B. Isolation: Where metal surfaces of units are to be installed in contact with noncompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.

C. Flange Seals: Except as otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

D. Cap Flashing: Where cap flashing is required as component of accessory, install to provide adequate waterproofing overlap with roofing or roof flashing (as counter flashing). Seal watertight with thick bead of mastic sealant.

E. Operational Units: Test operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

F. Install pipe boot flashing as shown and as recommended by manufacturer.

3.02 CLEANING AND PROTECTION

A. Clean exposed metal and plastic surfaces in accordance with manufacturer's instructions. Touch up damaged metal coatings.

+++ END OF SECTION 07700 +++

SECTION 07900
CAULKING AND SEALANTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all materials, labor, equipment, and incidentals required to perform all caulking, and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 APPLICATION SCHEDULE

A. Caulk all exterior wall joints between frames in openings and adjacent materials, between masonry and cast in place concrete, expansion and control joints and all other joints shown on the Drawings or required for the completion of the work.

B. Caulk all interior joints between frames and masonry, at tops of masonry walls, between masonry and structural concrete and control joints, exterior window and door frames and all other joints shown on the drawings or required for the completion of the work.

C. Joints of similar nature to those indicated shall be sealed with same sealer, whether indicated on Drawings to be sealed or not.

1.03 SUBMITTALS

A. Submit to the Engineer as provided in the General Conditions for shop drawings, detailed information on materials proposed and installation methods.

B. Product Data: Manufacturer's technical data for each joint sealer product required, including instructions for joint preparation and joint sealer application.

C. Samples for Color Selection: Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available, for each product exposed to view.

D. Samples for Color Verification: Samples of each type and color of joint sealer required. Install joint sealer samples in 1/2 inch wide joints formed between two 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealers in the Work.

1.04 QUALITY ASSURANCE

A. Applicable standards: Standards of the following, as referenced herein:

1. ASTM C 920-98 Standard Specification for Elastomeric Joint Sealants, 1998.

B. Preinstallation Meeting: The contractor shall arrange a meeting with installer, sealer manufacturers' representatives, and other trades whose work affects installation of sealers at project site to review procedures and time schedule proposed for installation of sealers which is coordinated with other related work.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels showing manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of sealers under the following conditions:
1. When ambient and substrate temperature conditions are outside the limits permitted by sealer manufacturer or below 40 degrees F (4.4 degrees C).
2. When substrates are wet due to rain, frost, condensation, or other causes.

B. Joint Dimension Conditions: Do not proceed with installation of sealers when joint dimensions are less than recommended by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.01 CAULKING

A. Caulking Compound: One component, synthetic rubber base sealant, soft curing, nonstaining, conforming to F.S. TT-S-00230 and Thiokol's Building Trade Performance Specifications for Type 1 Class B sealants. Colors shall be selected by the Engineer.

Acceptable Manufacturer

a. Dow Corning Corporation;
b. GE Advanced Materials
c. Pecora Corporation
d. Sika Corporation
e. Tremco Incorporated; Spectrem

B. Primer: As recommended by caulking compound manufacturer.

C. Back-up Material: Closed cell foam polyethylene, or similar non-bituminous material as recommended by manufacturer of caulking compound and completely compatible with selected compound.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION AND INSTALLATION

A. Remove dirt, grease, mortar droppings and other foreign matter from substrate.

B. Require installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

3.02 CAULKING

A. Surface Preparation: Clean metal surfaces free of grease, oil, wax lacquer, and other foreign residue by wiping with a clean cloth moistened with a suitable solvent. Scape or brush masonry surfaces clean. Apply appropriate primer to contact surfaces.

B. Joint Preparation: Joints to be caulked having a depth in excess of 3/8-inch shall be packed with back-up material. Round back-up material shall be sized to require 20 percent to 50 percent compression upon insertion. In joints not of sufficient depth to allow packing, install polyethylene bond-breaking tape at back of joint. Avoid lengthwise stretching of back-up material. Cut all corners, avoid wrapping around corners.

C. Application: Apply compound with pressure flow gun with nozzle of proper size and shape to suit width of joint, promptly after mixing and with sufficient pressure to fill joint. Apply as a continuous operation horizontally in one direction, and vertically from bottom to top, except joints having excessive widths where compound might sag, the joints shall be built up with successive beads. Finish joints smooth and slightly coved.

3.03 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

+++ END OF SECTION 07900 +++

SECTION 08110
STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all steel doors and frames. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Section includes:

1. Fire rated steel doors and frames.
2. Insulated doors.

D. Related work specified elsewhere:

1. Section 08710 Finish Hardware.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical data substantiating that products comply with requirements.

B. Shop Drawings: Submit shop drawings for fabrication and installation of specified items, coordinated with opening schedule shown on the Drawings; include the following information:

1. Details of construction, joints, and connections.
2. Details of each frame type, including anchorage.
3. Elevations of each opening type.
4. Conditions at openings, including coordination with glass and glazing requirements.
5. Location and installation requirements of door hardware and reinforcements.

6. Schedule of openings coordinated with numbering system used in contract documents.

C. Hardware templates shall be furnished to the door manufacturer by the Contractor for correct hardware alignment and reinforcing.

D. Samples: Submit as follows for composite metal doors and frames:

1. Door: 1'-0" by l'-0" corner section showing door construction.
2. Welded frame: 1'-0" by 1'-0" head and jamb corner section showing welded corner construction.
3. Anchors: One of each type.

E. Product data: Indicate that hollow metal work complies with specified requirements, including performance criteria.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Doors and panels shall be individually wrapped in corrugated cardboard with wood strips on vertical edges and banded with metal straps. Store materials in unopened packages in a manner to prevent damage from the environment and construction operations. Handle in accordance with manufacturer's instructions.

1.04 QUALITY CRITERIA

A. Applicable standards: Standards of the following, as referenced herein:

1. American National Standards Institute, Inc. (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Steel Door Institute (SDI).
4. National Fire Protection Association (NFPA), National Fire codes.
5. Underwriters' laboratories, inc. (UL)

B. Furnish fire rated components bearing factory applied labels of Underwriter's Laboratories, Inc. (UL) giving component rating.

C. Allowable erection tolerances:

1. Variation from specified clearances: 1/32".
2. Variation in face alignment, pairs of doors: 1/16".
3. Variation in face alignment between door and frame: 1/8" maximum.

D. Performance criteria:

1. Physical endurance: Comply with performance level for specified grade classification in accord with SDI-100-85 and ANSI A151.1-1980 for doors and hardware reinforcing, ANSI/SDI-119 1983 for frames and anchors.
2. Finish: Comply with standard performance criteria of ANSI A224.1-1980 for primed steel surfaces.
3. Thermal performance: U=0.24 or better, apparent thermal performance in accord with SDI 113-79.
4. Air infiltration:
   Maximum 1.25 cfm/1.5. at 1.567 psi (24 mph) in accord with SDI-116-79.

E. Field Verification: Field verify existing frame opening dimensions. Before ordering frames, notify Engineer of discrepancies between field dimensions and frame sizes indicated on drawings.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 METAL DOORS

A. Type and design:

1. Provide full-flush design, in dimensions and types shown on the Door Schedule in the Drawings, 16 gauge properly reinforced for the finish hardware.

B. Finish: Hot-dipped galvanized steel with zinc coating conforming to ASTM A525. Prime paint at the factory.

C. Manufacturers: Products of the following manufacturers, or equal, meeting these specifications, may be used on this project:

1. Amweld
2. The Steelcraft Mfg. Co.
3. The Ceco Corporation
4. Republic Steel Corporation
5. Or equal.

D. Door Classification:

1. Label fire-rated composite metal doors: (Class B, 1.5 hour doors and Class C, 3 hour doors) with mineral fiberboard core, 18 ga., 1-3/4" thickness.

E. Door Construction:

1. Edge bevel: Vertical edges beveled 1/8" in 2".
2. All door edges to be continuously fully welded and ground smooth, not voids.

2.02 METAL FRAMES

A. Construction: 16 gage interior, 14 gage exterior welded cold-rolled steel construction, with joints full welded, dressed and ground smooth. Provided welded frames with temporary spreaders during shipping and erection.

B. Finish: Hot-dipped galvanized steel with zinc coating conforming to ASTM A525. Prime paint at the factory with Rust-inhibitive enamel or paint either air drying or baking, suitable as a base for specified finish paints.

C. Frame anchors:

1. Wall anchors for frame attachment to masonry walls: Manufacturer's standard adjustable type for attachment to masonry. Fabricate of not less than 18 gage galvanized steel. Provide one anchor per jamb for each 2'-0" of height or fraction thereof.

2. Floor anchors: Clip type to receive two fasteners per jamb, welded to bottom of jambs and mullions.

3. In-place masonry or concrete: 3/8" countersunk, flat head, stove bolts fabricated from A151, Type 316 stainless steel of expansion shields, spaced 6" maximum from top and bottom of frame 2'0-" o.c. maximum.

D. Applied stops: Formed, 20 ga. steel with mitered corners. Attach using countersunk oval head machine screws at 1'-0" o.c., maximum.

E. Preparation for hardware:

1. Reinforcement: Reinforce components for hardware installation in accord with SDI-100-85.

2. Punch single leaf frame to receive three silencers: double leaf frames to receive two silencers per leaf, at head.
3. Factory prepared hardware locations shall be in accord with "Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames", as adopted by the Steel Door Institute.

F. Wide Openings: Reinforce frame wider than 48" with roll formal steel channels fitted tightly into frame head, or provide frames of minimum 14 gage steel.

G. Coordinate electrical feeds to doors with frames.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All frames and fittings shall be installed and adjusted in strict accordance with the recommendations of the manufacturer and the approved shop drawings.

B. After erection of doors and frames, precautionary methods shall be employed to adequately protect exposed surfaces of installed items from damage due to installation of other work from lime, acid, cement, or other harmful compounds.

3.02 DOOR INSTALLATION

A. Install hollow metal doors in frames, using hardware specified in Finish Hardware section.

B. Edge clearances at doors:

1. Between door and frame, at head and jambs: 1/8".
2. At meeting edges of pairs of doors: 1/8".
3. At sills without thresholds: 3/8" maximum above finished floor.
4. At sills with thresholds: 3/8" maximum above top of threshold.

C. Fire-rated doors: Install in accord with requirements of NFPA 80.

3.03 SETTING FRAMES

A. Install hollow metal frames in accord with SDI-105 "Recommended Erection Instructions for Steel Frames", approved shop drawings and product data.

B. Welded frames:

1. Set welded frames in position prior to beginning partition work. Brace frames until permanent anchors are set. Fully grout frames.

2. Set anchors for frames as work progresses. Install anchors at hinge and strike levels.

3. Remove temporary braces and spreaders after wall construction is complete.

4. Install welded frames in prepared openings in concrete, masonry and clay tile walls using countersunk bolts and expansion shields.

C. Fire-rated frames: Install in accord with requirements of NFPA *80.

3.04 ADJUST AND CLEAN

A. Prime coat touch-up: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touch-up coat of compatible air-drying primer.

B. Final Adjustments: Check and readjust operating door hardware items, leaving work of this section undamaged and in complete and proper condition.

+++ END OF SECTION 08110 +++

SECTION 08305
ACCESS HATCHES

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install all access hatches as shown on the Drawings and specified herein.

B. (Not Used)

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be submitted:

1. Manufacturer's data on all materials listed in Part 2 of this Section.

2. Detail drawings showing sizes of members, method of assembly, anchorage, and connection to other members shall be submitted to the Engineer for review before fabrication.

3. Certification that submitted hatches meet specified load ratings.

4. Executed copy of manufacturer's standard warranty.

B. (Not Used)

1.03 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.

1. ASTM A36 – Standard Specification for Carbon Structural Steel

2. ASTM A48 – Standard Specification for Grey Iron Castings

3. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless

4. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

5. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

6. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip

7. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes

8. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

9. AWS Specifications for Arc Welding

B. (Not Used)

1.04 COORDINATION

A. The work of this Section shall be completely coordinated with the work of other Sections.

B. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

C. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.05 FIELD MEASUREMENTS

A. Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.

B. (Not Used)

1.06 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this section, before during and after installation and to protect the work and materials of all other trades.

B. Delivery and storage: Deliver materials to the jobsite, and store in a safe dry place with all labels intact and legible at the time of installation.

C. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.07 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

B. (Not Used)

PART 2 PRODUCTS

2.01 HATCH SCHEDULE

Location	Quantity	Size	Description	Load Rating	Model
Tunnel Drop Structure	2	2’-6”’x4’	Single Leaf Aluminum Access Hatch	300 psf	Bilco J-6AL or equal
Meter Vault	1	8’x2’6”	Service Stair Aluminum Access Hatch	300 psf	Bilco L-50 or equal
Meter Vault	1	8’x2’6”	Service Stair Aluminum Access Hatch	300 psf	Bilco L-50 or equal

2.02 SINGLE LEAF ALUMINUM ACCESS HATCHES

A. Size: 30"W x 48"L.

B. Material: Cover and frame are 1/4" (6 mm) aluminum

C. Cover: Diamond-pattern tread plate reinforced for 300 psf (1464 kg/m2) live load.

D. Frame: Extruded aluminum channel frame with bend down anchor tabs around the perimeter. A 1-1/2" (38mm) drain coupling is welded under the frame for a pipe connection to a dry well or disposal system

E. Hinges: Heavy forged Type 316 stainless steel hinges with 1/4" (6 mm) type 316 stainless steel hinge pins.

F. Latch: Type 316 stainless steel slam lock with fixed interior handle and removable exterior turn/lift handle. Latch release is protected by a flush, gasketed, removable screw plug

G. Lift Assistance: Compression spring operators enclosed in telescopic tubes. Automatic hold-open arm with release handle automatically locks cover(s) in the open position.

H. Finish: Mill Finish aluminum with a bituminous coating applied to the exterior of the frame.

I. Hardware: Type 316 stainless steel throughout

2.03 SERVICE STAIR ALUMINUM ACCESS HATCHES

A. Furnish and install where indicated on plans service stair aluminum access hatches, size width: 30" x length: 96". Length denotes hinge side. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.

B. Performance characteristics:
   1. Cover shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150th of the span or 20 psf wind uplift.
   2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
   3. Operation of the cover shall not be affected by temperature.
   4. Entire hatch shall be weathertight with fully welded corner joints on cover and curb.

C. Cover: Shall be 11 gauge aluminum with a 3” (76mm) beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.

D. Cover insulation: Shall be fiberglass of 1” thickness, fully covered and protected by a 18 gauge aluminum liner.

E. Curb: Shall be 12” in height and shall be 11 gauge aluminum. The curb shall be formed with a 3-1/2” flange with 7/16” holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6” on center, to be bent inward to hold single ply roofing membrane securely in place.

F. Curb insulation: Shall be rigid, high-density fiberboard of 1” (25mm) thickness on outside of curb.

G. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer

tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.

H. Hardware
   1. Heavy pintle hinges shall be provided.
   2. Cover shall be equipped with an enclosed two point spring latch with interior and exterior turn handles.
   3. Roof hatch shall be equipped with interior and exterior padlock hasps.
   4. The latch strike shall be a stamped component bolted to the curb assembly.
   5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing.
   6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. Use Type 316 Stainless Steel Hardware.
   7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
   8. Finishes: Factory finish shall be mill finish aluminum.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all items furnished except items to be imbedded in concrete which shall be installed under Division 3. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown and in accordance with manufacturer's instructions and approved shop drawings. All dimensions shall be verified at the site before fabrication is started.

B. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc- chromate primer followed by two coats of aluminum metal and masonry paint to dissimilar metal.

C. Where aluminum contacts concrete, apply a heavy coat of approved alkali resistant paint to the concrete.

+ + + END OF SECTION 08305 + + +

SECTION 08330
OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, and incidentals required and install the overhead doors as shown on the drawings and specified herein.

B. All power and control wiring from the load side of the disconnect switch shall be furnished and installed under this Section in accordance with Division 16.

C. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 RELATED WORK

A. Section 05500: Steel Channel Frames (Miscellaneous Metals).
B. Section 04400: Masonry.
C. Section 09900: Painting
D. Section 08734: Overhead Coiling Door Operators

1.03 SUBMITTALS

A. Submit to the Engineer for approval, as provided in the General Conditions shop drawings showing plans, rough-in diagrams, dimensions, sections, finishes and elevations; fabricating, arranging, and fastening details; materials of fabrication, including hardware and reinforcement; methods of fabrication; and manufacturer's printed installation and maintenance instructions.

B. Color samples: Manufacturers current color samples(s) for factory finish coating.

1.04. QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

B. Applicable standards: Standards of the following, as referenced herein:

1. American National Standards Institute, Inc. (ANSI).

2. American Society for Testing and Materials (ASTM).

3. Steel Door Institute (SDI).

4. National Fire Protection Association (NFPA), National Fire codes.

5. Underwriters' laboratories, inc. (UL)

C. Furnish fire rated components bearing factory applied labels of Underwriter's Laboratories, Inc. (UL) giving component rating.

D. Allowable erection tolerances:

1. Variation from specified clearances: 1/32".

2. Variation in face alignment, pairs of doors: 1/16".

3. Variation in face alignment between door and frame: 1/8" maximum.

E. Performance criteria:

1. Physical endurance: Comply with performance level for specified grade classification in accord with SDI-100-85 and ANSI A151.1-1980 for doors and hardware reinforcing, ANSI/SDI-119 1983 for frames and anchors.

2. Finish: Comply with standard performance criteria of ANSI A224.1-1980 for primed steel surfaces.

3. Thermal performance: U=0.09 (R=10.9) or better, apparent thermal performance in accord with SDI 113-79.

4. Air infiltration:
Maximum 1.25 cfm/1.5. at 1.567 psi (24 mph) in accord with SDI-116-79.

F. Field Verification: Field verify existing frame opening dimensions. Before ordering frames, notify Engineer of discrepancies between field dimensions and frame sizes indicated on drawings.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Overhead Coiling Doors shall be face of wall mounted, of the size indicated, and push button electrically operated with chain and chain wheel manual override:

1. Curtain shall be flat, insulated, type FIT-265, 24 ga. galvanized steel front and back designed to resist a wind pressure of 20 pounds per square foot; deflection shall not exceed 1/240 of the opening width. Curtain shall roll up on a bracket-supported drum, and shall be balanced with a helical spring.
2. Insulated vision lites will be provided within five rows of slats as indicated on the door schedule.
3. Endlocks shall be of the wind lock design.
4. Bottom rail angles to be aluminum of equal weight, and shall be securely fastened to each side of the bottom of the curtain.
5. All exterior facing doors shall be high wind load doors to meet maximum wind load per the building code.

B. Hardware shall be heavy duty type. Door to be A151, type 316 stainless steel and guides shall be not thinner than 3/16 inch, and shall form a channel picket of a depth which will retain the curtain in place when the curtain is subjected to the wind pressure stipulated above.

C. Weatherstripping shall consist of a rubber loop type astragal affixed to the bottom rail and extending into each channel picket guide, and a rubber strip affixed to the exterior of each guide, thus closing the space between the guide and the curtain, and with seals as necessary to comply with IECC requirements for air infiltration.

D. Hood shall be of .04" thick aluminum with air baffle formed to fit the contour of end brackets, and shall be reinforced with either steel rods or rolled beads at the top and bottom edges. A rubber neoprene or vinyl water seal at the hood shall be provided to prevent airflow around the coil on all exterior doors.

E. Bottom Draft Seal: Provide flexible seal assembly across full width of door on the bottom panel edge. Bottom panel shall be designed to compensate for sloped floors up to an edge-to-edge difference of 2 inches.

F. Door to be chain operated, flat slat coiling overhead door, model 627 as manufactured by Overhead Doors or equal..

G. All coiling doors shall be thermally insulated for a value of R-10.9 minimum.

H. See 08734 - Overhead Coiling Door Operators.

2.03 FINISH

A. Finish: Aluminum curtain slats, aluminum hood and all other miscellaneous aluminum parts shall be 5052-H32 alloy conforming to ASTM 8 (209) 1983, and shall have a factory finish Kynar 500 powder coat paint finish as selected by the Architect/Engineer.

2.04 AUTOMATIC REVERSING CONTROL

A. Furnish curtain with automatic safety switch of type indicated, and complying with UL 325. Extend switch full width of curtain bottom, and locate within neoprene or rubber astragal mounted to bottom curtain rail.

B. Contact with switch before fully closing will immediately stop downward travel of overhead coiling curtains and reverse direction to fully opened position.

C. Connect to control circuit through retracting safety cord and reel, or through self-coiling cable.

D. Provide electrically actuated automatic bottom bar.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Overhead Coiling Door shall be installed where indicated, and in accordance with the manufacturer's printed installation instructions. Horizontal lines shall be level, and vertical lines shall be plumb. Anchors for guides, brackets, and other fasteners shall be located where indicated.

3.02 ADJUSTING AND CLEANING

A. Adjusting and Cleaning shall consist of ensuring smooth operation, lubricating and testing the overhead door, and of preparing the overhead door for field painting. Overhead doors shall operate smoothly, quietly, and without squeaking and binding.

+++ END OF SECTION 08331 +++

SECTION 08710
FINISH HARDWARE

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all finish hardware including door butts, hinges and closures. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:

Section 08110, Steel Doors and Frames
Section 08331, Overhead Rolling Doors
Section 08210, Wood Doors

1.02 QUALITY ASSURANCE

A. Provide hardware in compliance with the local building code requirements. Also comply with NFPA101 Life Safety Code and ANSI A117.1 where applicable.

B. Provide hardware for fire rated openings in accordance with NFPA80, Fire Doors and Windows and NFPA105 Smoke and Draft Control Door Assemblies.

C. Provide the services of a finish hardware supplier who has been furnishing hardware in the project's vicinity for a period of not less than two (2) years and is an experienced hardware consultant (AHC). The consultant shall be available during the course of the work to the Engineer and Contractor.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Complete schedule of hardware. Using the format of this specification, indicate type, number location, and finish of each item. Include manufacturers name and model description, fastening devices, and complete keying schedule. Reference architect's door designation. Submit five (5) copies.

2. Cross-reference between door number and hardware headings.

3. When requested submit physical samples of each item of hardware showing manufacturers name, model, and finish.

4. Furnish templates and approved schedule to each related manufacturer of equipment which require same for the fabrication of their material.

1.04 DELIVERY STORAGE AND HANDLING

A. Deliver finish hardware to project site in manufacturers protective packaging. All items are to be marked to indicate door opening number, hardware schedule number, or other identifying marks.

B. Store hardware in secure lock-up area that is dry and lighted.

1.05 WARRANTY

A. Warrant door closers against failure due to defective materials and workmanship for a period of five (5) years beginning at date of substantial completion. Closers judged defective during this period shall be replaced or repaired at no cost to the owner.

B. All other warranties and bonds are to be in accordance with the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 FINISH

A. Finish, unless otherwise indicated, shall be US26D, satin chrome.

B. Door closers shall be spray-painted for finish to match adjacent hardware.

2.02 KEYING

A. All new cylinders shall be keyed to a new Master Key System.

B. Provide the following number of keys:

1. Three Change Keys per lock.
2. Six Master Keys.

2.03 HINGES

A. Acceptable manufacturers:

1. H. Soss
2. Stanley
3. Hager

B. Hinges shall be the types, materials, sizes, and finishes indicated in Finish Hardware Schedule.

1. Provide 4-1/2 inch x 4-1/2 inch size on doors up to 3'0" wide. Provide 5-inch x 4-1/2 inch on doors over 3'0" wide. Provide 1-1/2 pair on doors up to 7'6" and one additional hinge for each 2'6" of door thereafter. All exterior outswing doors shall have N.R.P. feature. Provide hinge types as listed in hardware sets.

2.04 LOCKSETS AND LATCHES

A. Acceptable Manufacturers:

1. Schlage Lock Company
2. Sargent & Company
3. Corbin Div. of Emhart
4. Russwin Div. of Emhart
5. Best Lock Company
6. Or equal.

B. Acceptable lockset series and design:

1. L9000 Series - 06B Design
2. 18-8100 Series - LNL Design
3. 9500 Series - 977L4 Design
4. 5000 Series - L4 Newport Design
5. 35H Series - 14G Design
6. Or equal.

C. Cylinders shall be mortise, six pin type complete with cam and tail piece for exit devices.

2.05 SURFACE MOUNTED DOOR CLOSERS

A. Acceptable manufacturers and product:

1. Rixson-Firemark, Inc.; 2020 Series x SNB
2. LCN
3. Or equal.

B. All surface closers shall be of one manufacturer. The closers shall be nonhanded and nonsized. They will be hydraulically controlled and full rack and pinion operation. They shall have cast iron bodies and will have adjustments for backcheck, general speed, and latch speed.

C. Provide mounting plates as required, hex nuts and bolts for application to hollow metal doors, and thru bolts for application to wood doors.

2.06 STOPS AND MISCELLANEOUS

A. Acceptable manufacturers:

1. Quality Hardware
2. H. B. Ives Co.
3. Baldwin Hardware Corp.

4. Or equal.

B. Types as indicated in Hardware Schedule.

2.07 BOLTS

A. Acceptable manufacturers:

1. Quality Hardware
2. H. B. Ives Co.
3. Baldwin Hardware Corp.
4. Or equal.

B. Flush bolts shall be 1" x 6-3/4" brass, rectangular front, per lengths indicated, with 3/4" throw. Furnish bottom strike and top strike plate.

C. Bolts and accessories for use on fire-rated doors shall be Underwriters' Laboratories listed.

2.08 FLAT GOODS

A. Acceptable manufacturers:

1. Quality Hardware Company
2. Baldwin Hardware Corp.
3. H. B. Ives Co.
4. Accurate
5. Or equal.

2.09 THRESHOLDS AND WEATHERSTRIP

A. Acceptable manufacturer:

1. Reese
2. Pemko
3. National Guard
4. Or equal.

2.10 WEATHERSTRIPPING: HEAD, JAMBS AND SILL

A. Acceptable manufacturers shall include National Guard Products, Inc., Pemko Mfg. Company, Zero Weatherstripping Company, Inc., Hager or equal.

B. The types are as indicated on the hardware Schedule.

2.11 SILENCERS

A. Silencers shall be rubber, self-lipping, cream color. Provide three silencers for single doors and 2 silencers for pairs of doors.

PART 3 - EXECUTION

3.01 PRELIMINARY

A. Receive, store in temporary bins, and be responsible for all finish hardware. Tag, index, and file all keys temporarily during construction.

B. Check all hardware upon arrival on job site against approved Finish Hardware Schedule. Function of hardware shall be examined against the job site conditions and interferences. If exceptions in these regards are found, notify Architect at once and retain subject hardware in its original packing carton. Adjustment and/or substitutions shall be made only as authorized by the Engineer.

3.02 INSTALLATION

A. Install hardware to doors as listed in the door schedule. Comply with "Recommended Locations for Builders Hardware for Custom Steel Doors and Frames", as published by The Door and Hardware Institute, except for height locations below. Application shall be by skilled workmen, who work with proper equipment, shall be in accord with manufacturer's instructions, fit to work of others accurately, applied securely, and adjusted properly. Hardware let into work of others shall be neatly done from template and shall fit perfectly. Exercise care not to injure work of others.

Locksets and latchsets: Centered 40" A.F.F.
Deadlocks: Centered 60" A.F.F.
Push Plates: Centered 48" A.F.F.
Pulls: Centered 48" A.F.F.

B. Install finish hardware to template. Cut and fit substrate to avoid substrate damage or weakening. Cover cut-outs with hardware item. Mortise work to correct location and size without gouging, splintering, or causing irregularities in exposed finished work.

C. Where cutting and fitting is required on substrates to be painted or similarly finished, install, fit, and adjust hardware prior to finishing, and then remove and place in original packaging. Reinstall hardware after finishing operation is completed.

D. Attach thresholds with flathead screws in expansion shields spaced at 24" o.c. maximum and symmetrical with the center of door opening.

E. Attach door closers to door, whether wood or metal, with hex nut and bolt assemblies. Where closers have stop function, install closer to stop the door before striking obstructions.

F. All locksets, specialty locks and cylinders shall be installed so as to be made operable via insertion of their keys held with cut edges up, smooth edges down.

G. Install push/pull sets so as to conceal all back mounted "pull" handle attachments from view on the "push" side of doors.

3.03 CLEANING AND ADJUSTING

A. At time of hardware installation, adjust each hardware item to perform function intended. Lubricate moving parts with lubricant acceptable to hardware manufacturer.

B. Prior to "Date of Substantial Completion", readjust and relubricate hardware. Repair or replace defective materials. Clean hardware as recommended by manufacturer to remove dust and stains.

3.04 FASTENINGS

A. All exposed screws shall be Phillips head, finished to match item and sized to suit job requirements.

B. Surface applied items such as closers and overhead holders shall be applied with hex nut and bolt assemblies.

3.05 OPERATION AND ADJUSTMENT

A. After installation, all templates, instruction sheets, installation details, and special tools shall be turned over to the Engineer at Final Acceptance of the building.

B. After Final Acceptance, the hardware supplier shall be available to instruct Owner's designated personnel in the proper adjustment and maintenance of hardware and finishes.

3.06 COORDINATION

A. Fully coordinate finish hardware installation with other specified systems which relate to installation and ultimate coordinated function intended for a complete operating system.

3.07 HARDWARE SCHEDULE

1. Electrical Building - Hardware Schedule. See – Architectural drawings – A 6 – 101
Door 101-B
Door 101-C
Door 102
Door 103

	Set NO. 1	Doors		
3 PR	Butts	4-1/2 x 4-1/2	626	Hager
1	Latchset	37HON3G626		Best
1	Closer	404QH	Al	LCN
1	Dome Stop	331Es	ALUM	Quality
3	Silencers			
	Set NO. 2	Door		
3 PR	Butts	4-1/2 x 4-1/2	626	Hager
1	Electronic Lockset	Fail Safe		Adam Rite
1	Closure	404QH	Al	LCN

Hardware Sets: - Each Door

Set 3	Doors	Front Entrance	
3 PR	Butts	BB850 x 5" 612	Hager
1	Lockset	35H7FWW14G612SH	Best
1	Closer	4041 CUSH 13 DEL PARALLEL ARM	LCN
1	Threshold	896 BR	Nat Guard
1	Stop	431 ES 612	Quality
1 Set	Weatherstrip	S 182	Accurate
3	Silencers	1337-B	Quality
Set 4	Doors		
	Butts	BB850 x 4/12" 612	
3 PR	Lockset	35H7G14G12SH	
1	Closer	4040 13	
1	Threshold	890 DKB	
1	Stop	431 ES 612 332 Riser	
1	Weatherstrip	S 812	
1 set			
Set 5	Doors	Gazebo	
3 PR	Butts	BB850 x 41/2" 612	
1	Lockset	35H7G14G612SH	
1	Closer	4040 13	
1	Threshold	890 DKB	
1	Stop	431 ES 612	
1 Set	Weatherstrip	S182	

+++ END OF SECTION 08710 +++

SECTION 08734
OVERHEAD ROLLING DOOR OPERATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Overhead Rolling Door Operators.

1.2 RELATED SECTIONS

A. Section 05500 - Metal Fabrications: Support framing and framed opening.

B. Section 06200 - Finish Carpentry: Wood jamb and head trim.

C. Section 08330 – Overhead Coiling Doors.

D. Section 08331 – Overhead Coiling Fire Doors.

E. Section 08710 - Door Hardware: Product Requirements for cylinder core and keys.

F. Section 09900 - Painting: Field applied finish.

G. Section 16130 - Raceway and Boxes: Conduit from electric circuit to door operator and from door operator to control station.

H. Section 16150 - Wiring Connections: Power to disconnect.

1.3 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

C. NEMA MG 1 - Motors and Generators.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

B. Electric Motors shall be alternating-current squirrel-cage motors conforming with NEMA MG 1.

C. Wiring Connections: Requirements for electrical characteristics.

1. 480V, 3 Phase, 60 Hz.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Details of construction and fabrication.
4. Installation methods.

C. Shop Drawings: Include detailed plans, elevations, details of framing members, required clearances and accessories. Include relationship with adjacent construction.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified with minimum of five years documented experience.

B. Installer Qualifications: Authorized representative of the manufacturer with minimum five years documented experience.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Install in areas designated by Architect.
2. Do not proceed with remaining work until workmanship and installation is approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. Provide operators with a 3 year or 30,000 cycle limited warranty on motor and parts.

B. Provide operators with a 3 year limited warranty on motor and parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Overhead Door Corp., 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067. ASD. Tel. Toll Free: (800) 275-3290. Phone: (469) 549-7100. Fax: (972) 906-1499. Web Site: www.overheaddoor.com. E-mail: sales@overheaddoor.com.

B. Or equal.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 OVERHEAD ROLLING DOOR OPERATORS

D. Heavy Duty Rolling Door Operator: Model RHX True Gear Head Type Door Operator:

1. Application:
   a. Rolling Steel Doors.
   b. Rolling Steel Fire Doors.
2. Electric Motor: UL listed.
   a. Rating:
      1) 3 horsepower, 460V, three phase with automatic thermal reset overload.
   b. Motor frame comply with:
      1) NEMA 56 for 3 hp three phase.
   c. Construction:
      1) Washdown – NEMA 4 / NEMA 4X construction
   d. The operator shall be suited for:
      1) NEMA ICS 6 Type 4X water tight dust tight environment with corrosion resistance.
   e. Reduction: Primary reduction is worm gear in oil bath.
   f. Duty cycle: Accommodate heavy usage, up to 60 cycles per hour under a large constant load.
      1) Brake: DC Disc type with selectable Progressive Braking for smooth stopping.
      2) Clutch: Adjustable torque-limiter type.
      3) Limit System: LimitLock limit system, magnetic type providing absolute positioning with push to set and remote setting capabilities. Limit system shall remain synchronized with the door during manual operation and supply power interruptions.
3. Control System: Microprocessor based with relay motor controls on a single board. System incorporates a 16 character Liquid Crystal Display (LCD) to display the system status. System shall include the following:

a. Capable of monitoring and reporting on a variety of operating conditions, including: Current operating status, Current command status, Motor movement status, Current error status (if applicable), Hoist Interlock status (if applicable), External Interlock status, and 24VDC status.
b. A delay-on-reverse operating protocol.
c. Maximum run timers in both directions of travel that limit motor run time in the event a clutch slips or some other problem occurs.
d. Provisions for the connection of a 2-wire monitored photo-eye or a 2-wire monitored edge sensor, as well as non-monitored 2-wire sensing edges, photo-eyes or other entrapment protection devices.
e. Control action will be constant contact close until a monitored entrapment device is installed, allowing for selection of momentary contact.
f. Provisions for connection of single and/or 3-button control stations.
g. Provisions for connection of an external 3-wire radio controls and related control devices.
h. On board open, close and stop control keys for local operation.
i. CodeDodger radio receiver that is dual frequency cycling at 315 Mhz and 390 Mhz capable of storing 250 single button and/or 250 Open-Close-Stop transmitters with the ability to add and/or delete transmitters individually, identify and store activating transmitter IDs.

4. Mounting:
   a. Rolling Steel doors:
      1) Front of hood and chain/sprocket coupling to door.
      2) Top of hood and chain/sprocket coupling to door.
      3) Wall-mount and chain/sprocket coupling to door.
5. Release:
   a. Release shall be a pull and hold type mechanism with single cable operation and an integrated interlock switch on hoist units.
6. Hoist: Chain hoist consists of chain pocket wheel, chain guard and smooth hand chain on hoist units.
7. Entrapment Protection:
   a. Control system shall have provisions to connect monitored entrapment protection devices such as monitored electric sensing edge, or monitored photo-eye and to provide constant contact close control operation in lieu of such devices.
8. Control accessories:
   a. Operator Controls:
      1) Push-button operated control stations with open, close, and stop buttons.
      2) Controls for interior location.
      3) Controls surface mounted.
      4) Motor starter with overload.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify door sizes, configuration, tolerances and conditions are acceptable.

B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly without distortion or stress.

C. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

D. Coordinate installation of electrical service with Section 16150. Complete wiring from disconnect to unit components.

3.4 ADJUSTING

A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.

B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

A. Clean components using non-abrasive materials and methods recommended by manufacturer.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

+++ END OF SECTION 08734 +++

SECTION 09260
GYPSUM BOARD SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY:

A. Related sections:
1. Section 06100: Rough Carpentry.
2. Section 06200: Finish Carpentry.
3. Section 07210: Building Insulation.
4. Section 09510: Acoustical Ceilings.
5. Section 09900: Painting.

1.02 SUBMITTALS:

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
1. Product data: Indicate product description, including compliance with specified requirements and installation requirements. Mark manufacturer's brochures to include only those products proposed for use Include complete details of shaft-wall system.

1.03 REFERENCES:

A. Standards of the following as referenced:

1. American Society for Testing and Materials (ASTM).
2. Federal Specification (Fed. Spec.).
3. Gypsum Association (GA).
4. Underwriters' Laboratories, Inc. (UL).

1.04 SYSTEM DESCRIPTION:

A. Design requirements:

1. Fire resistance ratings: Construct designated walls and ceilings in accord with indicated UL design numbers.

2. Sound rating: Construct designated partitions in accord with manufacturer's submitted product data for obtaining indicated Sound Transmission Class (STC) ratings.

3. Moisture Resistance: Construct all partitions to be moisture resistant.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Storage:

1. Stack gypsum board off floor, on pallets providing continuous support for gypsum board to prevent sagging. Stack gypsum board in manner to prevent long lengths over short lengths

2. Store adhesives in dry area; provide protection against freezing at all times.

3. Do not overload floor system.

4. Deliver materials in original and unopened packages, containers, or bundles, with brand names and manufacturer's labels intact and legible.

5. Store materials in dry location, fully protected from weather and direct exposure to sunlight.

6. Store corner bead and other metal and plastic accessories to prevent bending, sagging, distortion, or other mechanical damage.

1.06 PROJECT CONDITIONS:

A. Install interior gypsum board only after building is enclosed.

B. Ventilation:

1. Provide ventilation during and following adhesive and joint treatment application.

2. Use temporary air circulators in enclosed areas lacking natural ventilation.

3. Allow additional drying time between coats of joint treatment, under slow drying conditions.

4. Protect installed materials from drafts during hot, dry weather.

5. Temperature: Maintain temperature in areas of installation between 50 and 70 degrees F for at least 24 hours before installation begins and for not less than 48 hours after joint finishing has been completed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Acceptable manufacturers:

1. Products specified as standard of quality are indicated in COMPONENTS Article.

2. Products of manufacturers listed below meeting indicated standards and specified manufacturer's product data characteristics, except as modified below, are

acceptable for use, subject to approval of product list and samples.

3. Certain manufacturer's products may be required for use in particular tested and rated assemblies. Use ONLY those products indicated as acceptable by testing agency in rated construction.

4. Framing members and accessories:

   a. Dale/Incor.
   b. Dietrich Industries, Inc.
   c. Domtar Gypsum.
   d. Gold Bond Building Products/National Gypsum Co.
   e. Unimast, Inc.
   f. Or equal.

5. Gypsum products and shaft wall systems:

   a. Domtar Gypsum.
   b. Georgia-Pacific Corp.
   c. Gold Bond Building Products/National Gypsum Co.
   d. U.S. Gypsum.
   e. Or equal.

2.02 COMPONENTS

A. Framing members:

1. Standard metal studs and floor and ceiling runners:

   a. Material and type: ASTM A568-85, 33 ksi minimum yield strength, electro-galvanized steel, form to shape in accord with ASTM C645-88.
   b. Studs: 1-1/4" minimum face width by depths and lengths indicated.
   c. Runners: 1" deep minimum; widths required to receive studs, same gauge uncoated thickness as studs.
   d. Gauges:

      1) Typical wall construction: 25 gauge uncoated thickness minimum.
      2) Walls with ceramic tile as final finish: 20 gauge uncoated thickness minimum with respective gauge increase for below.
      3) Actual gauge required by partition height in accord with stud manufacturer's product data for height/gauge limitations.

2. Structural studs and floor and ceiling runners: Specified in Cold Formed Metal Framing Section.

B. Gypsum board:

1. Water-resistant gypsum board: Meeting ASTM C630-85 and Fed. Spec. SS-L-30D,

Type VII, Grade W or X Class 2: 5/8”thickness, Regular, tapered edges.

2. Gypsum sheathing: Specified in Rough Carpentry section.

D. Fire-rated insulation for rated assemblies: Specified in Building Insulation section.

E. Fasteners:

1. Metal runners and furring channels to following substrates; develop full loading characteristics without exceeding allowable stress design of member being fastened:

a. Concrete: Hilti Fastening Systems; SDF 22, powder actuated fasteners; developing loading of 85 lbs. tension, minimum, 110 lbs. shear, minimum.
b. Steel: Hilti Fastening Systems; ESD16, powder actuated fasteners providing full point penetration of steel member.
c. Masonry: Powder actuated type capable of withstanding 193 lbs. single shear and 200 lbs. bearing force.
d. Metal decking: ASTM C1002-88, Type S or S-12, pan head, size for application.

2. Framing members fastened together: ASTM C1002-88, Type S or S-12, pan head, size for application.

3. Screws for gypsum board application:

a. Single or base layer gypsum board to metal framing: ASTM C1002-88, Type S or S-12 and ASTM C954-86, bugle head; size for applications.
b. Face layer gypsum board to metal framing in double layer construction not exceeding 1-1/4" gypsum board total thickness: ASTM C1002-88, Type S or S-12 and ASTM C954-86, bugle head; size for applications.
c. Gypsum board to gypsum board: ASTM C1002-88, Type G, 1-1/2" bugle head.
d. Applications not listed: Conform to referenced standards and gypsum board manufacturer's product literature for conditions encountered.

F. Joint materials and adhesives:

1. Joint tape: Meeting ASTM C475-81 and Fed. Spec. SS-J-570B, Type II; perforated.

2. Joint compound: Meeting ASTM C475-81 and Fed Spec. SS-J-570B Type I: vinyl base, ready-mixed tape embedment and topping compounds.

G. Accessories:

1. Corner reinforcement: Unimast, Inc., SHEETROCK$_{TM}$ No. 800; galvanized steel with 1-1/4" wide expanded metal flanges.

2. Metal jamb, ceiling, and casing "U" and "J" shaped trim providing edge protection and neat finished edges: Unimast, Inc., SHEETROCK$_{TM}$ Trim No. 801 Series; 1-1/4" wide expanded metal flanges.

3. Control joints: Unimast, Inc., SHEETROCK$_{TM}$ Zinc Control Joint No. 093; roll-formed zinc alloy.

4. Resilient channel: Unimast, Inc., RC-1$_R$ Resilient Channel; ASTM A568-85, 25 gauge galvanized steel, minimum.

5. Furring channels: Unimast, Inc., DWC-25 ASTM C645-88, 25 gauge uncoated thickness minimum, electro-galvanized steel, 7/8" deep by 1-1/4" face width.

6. Cold-rolled channels: ASTM C645-88, 16 gauge, minimum, black asphaltum painted steel 3/4" deep 1/2" wide flange and 1-1/2" deep with 17/32" flange.

7. Furring channel clips: Manufacturer's standard type for attachment of furring channels to cold-rolled runner channels.

8. Adjustable wall furring brackets: ASTM A568-85, 20 gauge, minimum, galvanized steel, for attaching 3/4" furring channels and furring channels to masonry walls.

9. Lateral bracing, use either system:

    a. Channels and clip angles: ASTM C645-88, 16 gauge, minimum, galvanized steel 3/4" deep with 1/2" wide flange cold-rolled channel and 2" by 2" by 16 gauge by 1/4" less than stud width length clip angle.
    b. Solid bridging: CR runners specified in Framing members Paragraph above and 1-1/2" by 20 gauge electro-galvanized plate.
    c. Fasteners: Specified in Fasteners Paragraph.

10. Ceiling hanger wire: Minimum 8 gauge annealed steel wire galvanized in accord with ASTM A641-82, Class I coating.

11. Tie wire: Minimum 18 gauge annealed steel wire galvanized in accord with ASTM A641-82, Class I coating.

12. Special trim shapes: Fry Reglet Corp., aluminum drywall moldings; natural aluminum finish; indicated shapes.
13. Air and Vapor Barrier Tape: Apply at interior face of exterior envelope components: wall penetrations, roof penetrations, flanges, corners, joints and seams to provide an air-tight building. Use and apply per the manufacturer’s instructions:
    a. TYPAR Construction Tape
    b. STOGuard Tape
    c. 3M Air and Vapor Barrier 3015
    d. Or equal approved by the Architect prior to bid date.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Framing and furring:

1. Install steel framing members in accord with ASTM C754-88, tolerances indicated in Article 3.02, and as follows:

2. Runners:

a. Accurately align runners at floor and ceiling or structure; anchor securely with specified fasteners approximately 2" from runner ends and not exceeding 2'-0" O.C.

b. Attach at floor and underside of structural deck for full height partitions with specified fasteners: space at 2'-0" O.C., maximum.

c. Attach to ceiling suspension system for partitions indicated to terminate at ceiling; use 1/8" toggle bolts or sheet metal screws into 'Tee", spline, or other members: space at 2'-0" O.C., maximum.

d. Install runners indicated to receive rated insulation in two continuous beads of acoustical sealant.

3. Studs:

a. Position full length studs vertically:

b. Engage floor and ceiling runners. Attach with specified fasteners at floor and ceiling runners.

c. Space as indicated, or, if not indicated, at 2'-0" O.C. maximum except as indicated below.

d. Walls receiving tile specified in Tile Section: Space 20 gauge, minimum, studs 1'-4" O.C.

e. Install double studs at interior and exterior corners, expansion joints, partition termination, and within 2" of door and borrowed lite openings in partitions. Locate next stud not more than 6" from double studs.

f. Secure abutting and intersecting walls with fasteners through stud flanges.

g. Install acoustical tape on metal studs in walls to receive rated insulation abutting other studs or dissimilar surfaces.

4. Lateral wall bracing:

    a. Channels and clip angles:

        1) Insert continuous cold rolled channel through stud web holes; 6" overlap at channel splice.
        2) Screw attach clip angle to each wall stud web and cold rolled channel. Use four screws at each stud; two screws each stud web; two screws at cold rolled channel.

    b. Solid bridging system:

        1) CR runner: Install cut-to-length sections with web-flange bent 90 degrees at each end horizontally; fasten to adjacent vertical studs.
        2) Metal plate, one plate each side wall: Fasten continuous metal plate at each stud flange with one screw and four screws at each CR runner.

    c. Locations:

        1) Horizontally: Each door and borrowed lite frame head at jamb; 8'-0" O.C. maximum along wall face.
        2) Vertically; follow manufacturer's requirements if more stringent.

            a. Less than 6'-0": None required.
            b. Over 6'-0" and less than 10"-0": One row at 4'-0" AFF.
            c. Over 10'-0": One row at 4'-0" AFF and one additional row for each 6'-0" of wall height or portion thereof.

5. Furring:

    a. Attach to masonry substrate with appropriate fasteners; space at 2'-0" O.C. on alternating furring channel flange.

    b. Position channels vertically, space at 2 '-0" O.C. maximum.

    c. Provide minimum 20 gauge steel plate at locations of handrails attached to metal framed gypsum board partitions, set at handrail height and rise for handrail bracket attachment. Attach to metal framing full handrail length.

B. Ceiling and soffit suspension systems:

1. Provide complete suspension system including hangers, main runner channels, furring channels, and attachments. Conform to gypsum board manufacturer's product data for sizes, locations, and spacings.

2. Secure to concrete by wire-tying to cast-in-place hanger wires or hanger inserts, installed prior to placing of concrete, or by powder actuated fasteners developing full strength of hanger. Coordinate placement of wire hangers or inserts with

concrete Work.

3. Hangers:

   a. Space hangers at 4'-0" O.C., maximum, each direction.

   b. Wrap wire minimum three times horizontally, turning ends upwards.

4. Provide extra hangers within 6" of ends of main runners and to support light fixtures, ceiling diffusers and grilles, access panels, and other items in or on ceilings. Provide extra hangers at control joints to support discontinuous runners.

5. Locate hangers plumb in relation to main runners; avoid contact with insulation covering ducts and pipes. Do not pass hangers through ducts. Alter spacing of hangers or splay hangers to avoid ducts and other obstructions; do not exceed maximum allowable ceiling areas to be supported by each hanger. Offset horizontal forces of splayed hangers by counter-splaying or bracing.

6. Install cold-rolled channels at 4'-0" O.C., maximum. Install furring channels to cold rolled channels at 1'-4" O.C. , maximum for 1/2" thickness gypsum board; 2'-0" O.C. , maximum for 5/8" thickness gypsum board.

7. Locate main runners within 6" of parallel walls to support ends of cross furring.

8. Locate furring channels perpendicular to main runners and not more than 2" from parallel walls. Attach to main runners at end intersection with double strand of 16 gauge wire.

9. Do not abut runners or furring into masonry or concrete construction; allow not less than 1" clearance between such construction and ends of runners or furring.

10. Splice main runners and furring channels by overlapping with flanges of channels interlocked; wire tie each end of splice with not less than double strand of 16 gauge wire. Overlap not less than 1'-0" for main runner splices; not less than 8" for furring channels.

11. Provide required additional ceiling framing to frame openings. Coordinate support framing with Work of other trades.

12. Provide discontinuous lap at control joints, in main runners, and accessories occurring over joints. no not bridge joints with cross furring where joints run perpendicular to furring. Provide furring to support each side of joint where joints run parallel to furring.

C. Gypsum board, general:

1. Install gypsum board in accord with manufacturer's product data, GA-216-85, and ASTM C840-87, except where more stringent requirements are specified.

2. Use gypsum board of maximum lengths to minimize end joints. Stagger end joints.
3. Abut gypsum boards without forcing. Fit ends and edges of gypsum board. Do not place butt ends against tapered edges.

4. Support ends and edges of gypsum board panels on framing or furring members except for face layer of double layer Work.

5. Install gypsum board accessories in accord with gypsum board manufacturer's product data or as follows:

    a. Control joints: Install in walls and ceilings at locations indicated, not exceeding 30'-0" O.C.

    b. Corner beads: Install at all external corners.

    c. Metal trim shapes: Provide at exposed edge of gypsum board at door and window openings, intersections with other materials, and intersection of walls with ceilings.

6. Install sound attenuation blankets at indicated locations.

7. Shaft wall system: Install in accord with submitted and reviewed manufacturer's product data.

8. Coordinate installation of special fire rated insulation specified in Building Insulation section.

9. Isolation Joints: Where gypsum board construction intersects structural compponents, provide isolation by stopping board a minimum of ¼-inch from structure, for finishing by means of exposed or semiexposed trim.

D. Gypsum board, single layer installation:

1. Ceilings: Apply gypsum board with long dimension at right angle to framing. Terminate ends and edges of gypsum board on furring members.

2. Walls:

    a. Apply gypsum board vertically or horizontally at Contractor's option.

    b. Stagger end joints in opposite sides of partitions.

    c. Terminate long edges or ends of gypsum board on framing or furring members.

3. Fastening: Screw attach gypsum board to metal studs at 12" O.C. , maximum at intermediate studs, 8" O.C. at ends; use specified fasteners.

E. Gypsum board, double layer installation:

1. Base layer:

a. Ceilings: Apply gypsum board base layer with long dimension at right angle to framing. Terminate ends and edges of board on furring members.

b. Walls: Apply gypsum board base layer vertically. Terminate ends and edges of boards on framing or furring members. Stagger vertical joints on opposite sides of partition.

c. Fastening: Screw attach gypsum board to metal studs at 2' -0" O.C. , maximum; use specified fasteners.

2. Face layer:

a. Apply face layer horizontally to base layer with minimum 10" offset in parallel base and face layer joints.

b. Fastening: Screw attach gypsum board to metal studs at 12" O.C., maximum at intermediate studs, 8" O.C. at ends; use specified fasteners.

F. Gypsum board joint treatment:

1. Apply joint compound to joints and angles in gypsum board add embed joint tape. Apply two additional coats of compound over tape, allow drying between coats, featheredge and sand or damp sponge smooth each coat.

2. Walls and ceilings: Apply three coats, minimum, compound over fastener depressions; sand or damp sponge smooth each coat; bring to level plane of gypsum board surface.

3. Fastener pop:

a. Repair fastener pop by installing second fastener approximately 1-1/2" from fastener pop and reseat fastener.

b. Where face paper is punctured, drive new fastener approximately 1-1/2" from defective fastener and remove defective fastener.

c. Fill damaged surface with compound and sand or damp sponge smooth to level of plane of gypsum board.

4. Fill cracks with compound; sand or damp sponge smooth and flush.

5. Dust surfaces; leave ready for decoration.

3.02 APPLICATION:

A. Allowable tolerances for framing, unless indicated otherwise:

1. Variation from plumb: 3/8" in 10'-0" height, non-cumulative.

2. Variation in room horizontal squaring diagonals: 1/4".

3. Variation in walls from tangent line (straightness): 1/4" in 10 '-0" non-cumulative.

4. Variation in location of walls from dimension: +1/4".

5. Location of dimensioned openings: +3/8".

6. Variation in rough opening size: +1/4",-1/8"

B. Allowable tolerances in finished suspended ceilings:

1. Maximum deflection of suspension system components, hangers, and fastening devices supporting lighting fixtures, ceiling grilles, and acoustical units: L/360 of span.
2. Variation from level in finished ceiling: +1/8" in 12 '-0".

3. Variation in plane of adjacent gypsum board panels prior to joint treatment: 1/16".

3.03 SCHEDULES:

A. Finish levels are taken from, *Recommended Specifications on Gypsum Board*, unless indicated otherwise:

1. Level 1:

a. Joints and interior angles: Tape embedded in joint compound; surfaces free of excess compound; tool marks and ridges acceptable
b. Locations: Plenum areas above ceilings, areas where assembly is concealed by final construction, smoke barriers, and separation walls in attics.

2. Level 3:

a. Joints and interior angles: Tape embedded in joint compound.
b. Two separate coats joint compound applied over joints, interior angles, fastener heads, and accessories; surfaces free of excess compound ; joint

compound surfaces smooth and free of tool marks and ridges.

c. Locations: Appearance areas receiving heavy or medium texture finishes or heavy grade wallcoverings are to be applied as final finish.

3. Level 4:

   a. Joints and interior angles: Tape embedded in joint compound.
   b. Three separate coats joint compound applied over joints, interior angles, fastener heads, and accessories; surfaces free of excess compound; joint compound surfaces smooth and free of tool marks and ridges.
   c. Locations: Appearance areas receiving flat paints, light texture finishes, or light or medium weight wallcovering.

4. Level 5:

   a. Joints and interior angles: Tape embedded in joint compound.
   b. Apply three separate coats joint compound over joints, interior angles, fastener heads, and accessories; surfaces free of excess compound; joint compound surfaces smooth and free of tool marks and ridges.
   c. Utilize either method for final procedure prior to final finish application:

      1) Roll apply batter consistency mixture of gypsum board joint compound and water to surfaces; remove immediately with wide broadknife, without leaving ridges or gouges in finished surface. Allow to dry prior to prime coat application, OR;
      2) Apply Level 5 surfacing material at 300-500 SF per gallon in accord with manufacturer's installation instructions; allow to dry.

   d. Locations: Appearance areas receiving low luster, semi-gloss, gloss, or enamel finish paints or coatings, light texture finishes, light or medium weight wallcovering, unbacked vinyl wallcovering, or severe light conditions.

+++ END OF SECTION 09260 +++

SECTION 09900
PAINTING

PART 1 - GENERAL

1.01 SCOPE

A. This Section of the Specifications includes, but is not necessarily limited to, standards for cleaning and painting structures and equipment described in the Drawings and Specifications. Furnish all materials, equipment, and labor necessary to complete the Work.

B. Section includes:

1. Surface preparation to receive finishes.
2. Priming and backpriming interior and exterior finish carpentry.
3. Painting, staining, or otherwise finishing of all surfaces.
4. Finishing millwork.

C. Related Work Specified Elsewhere

1. Section 04400, Masonry.
2. Section 05120, Structural Steel.
3. Section 05500, Miscellaneous Metal.
4. Section 05530, Steel Grating.
5. Section 15050, Basic Mechanical Materials and Methods.

1.02 SUBSTITUTIONS

A. To the maximum extent possible, similar coatings shall be the products of one manufacturer. Guidelines for determination of acceptability of product substitutions are given in Instructions to Bidders. Contractors intending to furnish substitute materials or equipment are cautioned to read and comply strictly with these guidelines.

1.03 SUBMITTALS

A. All submittals and storage and protection provisions shall be in accordance with the requirements of the General Conditions, and the following.

1. Product data:

a. Submit complete list of products for use; indicate compliance with:
   1) Mercury-free composition limits.
   2) VOC limits, when mixed and thinned.
   3) Indicate lead content.

b. Indicate manufacturer, brand name, quality, and type paint for each surface to be finished; correlate to specified item if from other manufacturer than specified item. Refer to the attached sample Paint Submittal Schedule for required

submittal format.

c. Include specified manufacturer's data sheets for reference to submitted manufacturer's data sheets.

d. Manufacturer's Safety Data Sheets (MSDS) for materials.

e. Intent of Contractor to use products specified does not relieve him from responsibility of submitting product line.

2. Samples:

a. Color samples: Submit two sets of color samples from paint manufacturers proposed for use for color selections by Engineer.

b. Brush-outs:

1) Prepare actual brush-outs for each color paint, stain, or finish following final color schedule issuance.

2) Submit brush-outs in duplicate: minimum size, 120 sq. in.

3) Apply products in number of coats specified for actual Work.

4) Provide following substrates for brush-outs:

a) Concrete unit masonry: Paint one face to simulate concrete and masonry.

b) Hardboard to simulate drywall, lumber, board products, and metals for paint finish.

c) Actual species and grade of wood specified for transparent finish.

3. Quality control submittals:

a. Certificates:

1) Indicate interior paints and stains are mercury-free.
2) Indicate lead content. Lead content in excess of 0.06% by weight of nonvolatile content calculated as lead metal is prohibited.
3) Indicate compliance with applicable VOC limits when mixed and thinned.

1.04 PROJECT MEETING

A. Prior to ordering any of the materials covered under this Section, the Contractor, Engineer, painting subcontractor, and paint manufacturer's representative shall attend a progress meeting in accordance with the General Conditions and review the Work to be performed under this Section.

1.05 PAINTING REQUIREMENTS

A. Finish paint all exposed surfaces except anodized or lacquered aluminum, fiberglass reinforced plastic, stainless steel and copper surfaces. Items to be left unfinished or to receive other types of finishes are specifically shown on the Drawings or specified.

1. Unpainted Products: Full field cleaning and priming will be performed in accordance with specification requirements for unpainted products. Maintain adequate equipment on the site to assure proper cleaning.

2. Shop Primed Products:

a. Manufactured products may be shop cleaned and primed. Shop cleaning must equal or exceed cleaning specified in the Painting Schedule. Clean as specified and reprime all abrasions, weld splatter, excessive weathering, and other defects in the shop prime coating.

b. Manufacturers furnishing shop primed products shall certify that cleaning was performed in accordance with specification requirements and that the specified primer was used.

c. Fully field clean and prime any shop primed products which the Engineer determines that were not cleaned in accordance with the Specifications prior to priming, that the wrong primer was applied, that the primer was applied improperly, or has excessively weathered, or the product is otherwise unacceptable.

3. Finish Painted Products:
Certain products such as electrical control panels and similar items may, with the approval of the Engineer, be furnished finish painted. Properly protect these products throughout the project to maintain a bright and new appearance. If the finish surfaces are defaced, weathered, or not of the selected color, repaint as necessary in accordance with the paint system manufacturer's written recommendations.

4. Hardware:
Remove all electrical plates, surface hardware, fittings and fastenings prior to painting operations. These items are to be carefully stored, cleaned and replaced upon completion of Work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.06 SEQUENCING AND SCHEDULING

A. Schedule and coordinate this Work with other trades; proceeding until other Work and job conditions are proper to achieve satisfactory results is prohibited.

B. Examine specification sections for various other trades; be thoroughly familiar with Work required in other sections regarding painting.

PART 2 - PRODUCTS

2.01 MATERIAL SCHEDULE

A. Material schedules list pretreatment coats, wash coats, seal coats, prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

2.02 APPLICATION DATA

A. All applicable data currently published by the paint manufacturer relating to surface preparation, coverages, film thickness, application technique, drying and overcoating times is included by reference as a part of this Section. It will be the responsibility of the Contractor to obtain and fully understand the appropriate data sheets for the coatings specified.

2.03 MATERIALS

A. Paints shall be factory mixed and delivered to the job in unbroken original packages bearing the manufacturer's name and brand designation and shall be applied in strict accordance with the manufacturer's printed specifications. Two-component coatings shall be mixed in accordance with manufacturer’s instructions. All two-component coatings, once mixed, shall be applied within the pot-life recommended by the manufacturer.

B. Unless otherwise specified, paints shall be of the best grade. All thinners, driers, varnish, etc., shall be of the best grade and shall be furnished by the coating manufacturer for use with the specified paints.

C. Paint thinners and tints: Products of same manufacturer as paints or approved by paint manufacturer for use with paint.

D. Shellac, turpentine, patching compounds, and similar materials required for execution of Work: Pure, best quality products.

E. All paints, finishes, stains, primers, shellacs, sealants and coatings shall comply with the

requirement of LEED 2009 IEQ Credit 4.2: Low-Emitting Materials - Paintings and Coatings.

2.04 COLORS

A. The Architect/Engineer will select the colors to be used on the various portions of the Work. Provide color cards for the coatings proposed. Where more than one coat of paint is required, job tint the paint for each undercoat off-shade to show complete coverage.

B. Paint inside of ductwork flat black for entire area visible through ceiling openings. Paint underside of ductwork and other above ceiling items flat black for entire area visible through ceiling openings.

C. Paint exposed pipes and ductwork same as adjacent ceiling surfaces, unless noted otherwise.

D. Review Finish Schedule for color selections that may have already been made by the Architect/Engineer.

PART 3 - EXECUTION

3.01 GENERAL

A. Adequately protect other surfaces from paint and damage. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Repair damage as a result of inadequate or unsuitable protection.

B. Protection: Cover finished Work of other trades, surfaces not being painted concurrently, and prefinished items.

C. Application of materials in spaces where dust is being generated is prohibited.

3.02 PRODUCT HANDLING

A. Delivery

1. Deliver materials in original, sealed containers of the manufacturer with labels legible and intact.

2. Each container shall be clearly marked or labeled to show paint identification, paint type and color, date of manufacture, batch number, analysis or contents, identification of all toxic substances, and special instructions.

B. Storage

1. Store only acceptable project materials on the project site.

2. Store material in a suitable location and in such a manner as to comply with all safety requirements including any applicable federal, state and local rules and requirements. Storage shall also be in accordance with the instructions of the paint manufacturer and the requirements of the insurance underwriters.

3. Restrict storage area to paint materials and related equipment.

4. Place any materials which may constitute a fire hazard in closed metal containers and remove daily from the project site.

5. Maintain neat, clean conditions in storage area; remove used rags from work areas at end of each day's work; store rags in closed containers.

6. Close containers at end of each day's Work. Leave no materials open.

7. Safety precautions:

   a. Provide temporary fire protection equipment in materials storage area. Mark fire protection equipment location for quick access.

   b. Prohibit smoking in storage area; post signs in visible location adjacent to and within storage area.

3.03 CLEANING AREA

A. Construct a temporary shed no smaller than 40 feet wide and 60 feet long for field cleaning, including blasting and priming operations. Maintain this area for all non-fixed painting operations until all such work has been completed and approved. Provide all fixtures and appurtenances required to perform the work including fixtures to support the work off the ground and proper storage facilities.

3.04 ENVIRONMENTAL CONDITIONS

A. Environmental conditions which affect coating application include, but are not necessarily limited to, ambient air temperature, surface temperature, humidity, dew point and environmental cleanliness. Comply with the manufacturer's recommendations regarding environmental conditions under which coatings may be applied.

3.05 SURFACE PREPARATION

A. General: All surfaces shall be thoroughly clean, dry, and free from oil, grease or dust. All fabricated metal products shall have all weld flux and weld spatter removed and sharp peaks in weld ground smooth. The Engineer will inspect the surface preparation prior to the application of coatings. If the preparation is found to be satisfactory, a written order will be given to proceed with coatings.

B. Lumber, plywood, and veneered surfaces:

1. Apply shellac, maximum four lb. cut to knots, pitch, and resinous sapwood prior to application of first paint coat.

2. Surfaces to be painted: Fill nail holes, cracks, joints, and defects with spackling compound. Apply after first coat of paint.

3. Sand surfaces smooth, except where rough-sawn surfaces are indicated. Dust to remove debris.

4. Treat mildewed surfaces with solution of one quart hypochlorite bleach, one tablespoon laundry detergent, and three quarts water. Rinse and allow to dry prior to painting.

5. Previously painted surfaces: Remove dirt, debris, and chalking by washing with detergent and water or low pressure cold water spray. Dull glossy surfaces by light sanding. Remove loose paint and blisters by scraping and sanding.

C. Gypsum board:

1. Fill narrow, shallow cracks and small holes with patching plaster or non-shrinking spackling compound. Allow to dry; sand smooth without raising gypsum board paper nap.

2. Wall surfaces designated to receive semi-gloss or gloss finish: Roll apply batter consistency mixture of gypsum board joint compound and water to surfaces; remove immediately with wide broadknife, without leaving ridges or gouges in finished surface. Allow to dry prior to prime coat application, Or;
Apply U.S. Gypsum Company, Sheetrock First Coat at 300-500 SF per gallon in accord with manufacturer's installation instructions. Allow to dry prior to prime coat application.

D. Ferrous Metals: Standards for the surface preparation of ferrous metals required in the Material Schedules are the standards of the Steel Structures Painting Council (SSPC, SP-1 through SP-10). Inspection of these surfaces will be evaluated by field comparison with visual comparator panels. These panels shall be securely wrapped in clear plastic and sealed to protect them from deterioration and marring.

E. Galvanized metal: Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

F. Aluminum: Sand to remove oxides. Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

G. Cast-In-Place Concrete Surfaces :

1. No Coatings Required.

3.06 APPLICATION

A. Conditions: No paint shall be applied upon damp or frosty surfaces, or in wet or foggy weather. No paint shall be applied in temperatures below 40^0 F. or when freezing (32^0 F.) is predicted within 24 hours of application, or under temperature or humidity conditions not recommended by the manufacturer.

B. Surface Preparation: After specified surface preparation, all surfaces shall be brushed free of dust or foreign matter. Surfaces shall be completely dry before any paint is applied.

1. Apply materials only when moisture content of surfaces is within manufacturer's recommended range.

C. Application: Paint shall be evenly spread in the proper thickness so that there shall be no drops, runs or sagging of the coating. Where runs and drops do occur, they shall be removed and the surface re-coated to the satisfaction of the Engineer. Sufficient time, as directed by the manufacturer, shall be allowed for the paint to dry before the application of succeeding coats.

1. Apply materials in accord with manufacturer's approved product data to achieve specified DFT.

2. Apply materials using clean brushes, rollers, or spray equipment. Limit paint spraying only to those materials recommended by manufacturer to be sprayed with no loss of performance, durability, or color.

3. Apply materials at rate not exceeding manufacturer's recommendations for surface being coated, less ten percent for losses.

4. Sand and dust between coats to remove defects visible from 5' - 0" distance. Tint primer and intermediate coats slightly to provide slight contrast.

5. Finish coats: Smooth, free of brush marks, streaks, laps or pile-up of paint, skips, or missed areas.

6. Make coating edges adjoining other materials or colors sharp and clean without overlapping.

7. Primer coats may be omitted for surfaces specified to receive factory applied primer if finish coats are compatible with primer. Substitute bond coat recommended by paint manufacturer for specified primer coat if finish coats are not compatible.

8. Refinish entire partition surface where portion of finish on gypsum board partition is damaged or unacceptable.

9. Back prime exterior and interior finish carpentry and millwork with material specified for prime coat without runs on face; finish cut edges just prior to installation.

10. Seal interior doors' tops and bottoms of with prime coat only; side edges same as faces.

11. Finish exterior door edges same as exterior faces.

D. Protection of Work Area: Use drop cloths or other suitable means to protect other surfaces of the structure or equipment in place. Upon completion of the Work, remove all paint spots from surfaces as directed by the Engineer.

E. Inspection: The Engineer will inspect each coat prior to the application of subsequent coats. If the work is found to be satisfactory, a written order will be given to proceed. Application of additional coats until completed coat has been inspected is prohibited. Only inspected coats of paint will be counted in determining the number of coats applied.

F. Defective Work: Remove and replace, at the direction of the Engineer, any painting work found to be defective or applied under adverse conditions.

3.07 PAINTING SCHEDULE

A. Paint construction on roof top; include mechanical and electrical equipment except as indicated below.

1. None.

A. Surfaces not requiring painting or coating:

1. Face brick.
2. Cast-in-place concrete and Precast concrete.
3. EIFS.
4. Prefinished surfaces and items.
5. Concealed ductwork, conduit, and piping.
6. Fume hood exhaust fan enclosures on roof.
7. Solvent Room exhaust fan on roof.
8. HPLC room exhaust fans on roof.

C. The Painting Schedule summarizes the painting systems to be applied to the various surfaces.

SAMPLE PAINT SUBMITTAL SCHEDULE

System	Specification	Item	Surface Prep	Primer	Finish & Touch Up	Color
A	SS 3300-2.05	Epoxy Floor Sealer	Blastrac or Muriatic Etch	76 Series, 4-6.0 mils	2 Coats of 76 Series, 4-6.0 mils	Gray
B	SS 3300-2.06	Tnemec 61 Submitted	SSPC-7	Self Priming	2 Coats of Tnemec 61,4-6.0 mils per coat	Gray
C	SS 4400	Masonry Paint	SSPC 2 or 3 Pressure Washing to Remove Loose Concrete & Dirt	Block Fil 46-W-8,1 Coat	2 Coats of Valspar 76 Series at 4-6.0 mils per coat	Gray
D	SS 5500	Misc. Metals	SSPC 6 for Non-Immersion	Tnemec 90-97	2 Coats of 89 Series for Non-Immersion at 4-6.0 mils	Warm Gray M3759
E	SS 5500	Misc. Metals	SSPC 10 of Immersion	Not Required	2 Coats of 78 Series for Immersion at 4-6.0 mils	Gray
F	SS 5500	Roof Hatch	Mill Finish Aluminum	Not Required	Not Required	Not Required
F	SS 8331	Door Slats	Mill Finish Aluminum	Not Required	Not Required	Not Required
System	Specification	Item	Surface Prep	Primer	Finish & Touch Up	Color
D	SS 15000	Dip Pipe	SSPC 6 for Non-Immersion	Tnemec 90-97	2 Coats of 89 Series for Non-	Buff D4608

					Immersion at 4-6.0 mils	
E	SS 15000	Dip Pipe	SSPC 10 for Immersion	Not Required	2 Coats of 78 Series for Immersion at 4-6.0 mils	Gray
I	SS 15060	Plastic Pipe	Lightly Sand	Not Required	2 Coats of 89 Series, 4-6.0 mils per coat	Warm Gray M3759
I	SS 15060	Valves & Operator	Lightly Sand	Not Required	2 Coats of 89 Series, 4-6.0 mils per coat	OSHA Orange
I	SS 15060	Pumps & Drives	Lightly Sand	Not Required	2 Coats of 89 Series, 4-6.0 mils per coat	Vale Green P2402
I	SS 15060	Unit Heaters & Ventilator Operators	Lightly Sand	Not Required	2 Coats of 89 Series, 4-6.0 mils per coat	Light Gray F42 ANSI 70

PAINTING SCHEDULE

Surfaces	Substrate Materials	Paint Material/Schedule
Millwork Interiors	Wood	110
All Wood Surfaces, Except Millwork Interiors	Wood	Transparent Finish -112
Ceilings	Gypsum Board	122

Walls	Gypsum Board	Latex Low Luster Enamel - 121
	M.R. Gypsum Board	Latex Low Luster Epoxy - 122
	CMU Block	131
Interior Structural Steel	Galvanized Metal	140*
	Ferrous Metal	140
All Other Listed Metal Surfaces, Except Dumpsters	Galvanized Metal	141
	Ferrous Metal	141
Dumpsters, Exterior Surface	Ferrous Metal	240
Dumpsters, Interior Surface	Ferrous Metal	241
PVC Roof Drain Piping	Polyvinylchloride	150

* Galvanized metal shall not be painted unless called for on the Finish Schedule.

MATERIAL SCHEDULE 110

TYPE: POLYURETHANE

USE: MILLWORK INTERIORS

SURFACE PREPARATION: PER SECTION 3.05.B

GLIDDEN

FIRST COAT: ULTRA-HIDE QUICK-DRYING SANDING SEALER NO. 5035 -1.1 MILS*

SECOND COAT: WOODMASTER CLEAR POLYURETHANE SATIN SHEEN NO. 82 - 1.3 MILS*

*MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 2.4 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. Benjamin Moore Company
   b. Devoe and Reynolds Company, Inc.
   c. Pratt and Lambert, Inc.
   d. PPG Industries, Inc.
   e. Sherwin-Williams Company

MATERIAL SCHEDULE 112

TYPE: POLYURETHANE

USE: TRANSPARENT FINISH ON WOOD

SURFACE PREPARATION: PER SECTION 3.05.B

GLIDDEN

FIRST COAT: WOODMASTER OIL WOOD STAIN, NO. 1600 SERIES

SECOND COAT: ULTRA-HIDE QUICK-DRYING SANDING SEALER NO. 5035 - 1.1 MILS*

THIRD COAT: WOODMASTER CLEAR POLYURETHANE GLOSS NO. 81 - 1.3 MILS*

FOURTH COAT: WOODMASTER CLEAR POLYURETHANE SATIN SHEEN NO. 82 -1.3 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 3.7 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. Benjamin Moore Company

b. Devoe and Reynolds Company, Inc.
c. Pratt and Lambert, Inc.
d. PPG Industries, Inc.
e. Sherwin-Williams Company

MATERIAL SCHEDULE 121

TYPE: LOW LUSTER LATEX ENAMEL

USE: GYPSUM BOARD, AS SPECIFIED OR INDICATED ON DRAWINGS.

SURFACE PREPARATION: PER SECTION 3.05.C.

GLIDDEN

FIRST COAT: SPRED ULTRA EGGSHELL LATEX WALL & TRIM PAINT NO. 4100 SERIES - 1.6 MILS*

SECOND COAT: SPRED ULTRA EGGSHELL LATEX WALL & TRIM PAINT NO. 4100 SERIES - 1.6 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 3.2 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LISTS AND SAMPLES:

   a. Benjamin Moore Company.
   b. Devoe and Reynolds Company, Inc.
   c. Pratt and Lambert Inc.
   d. PPG Industries Inc.
   e. Sherwin-Williams Company.

MATERIAL SCHEDULE 122

TYPE: EPOXY

USE: WATERPROOF OR M.R. GYPSUM BOARD, AS SPECIFIED ON DRAWINGS

SURFACE PREPARATION: PER SECTION 3.05.C

SHERWIN-WILLIAMS

FIRST COAT: PROMAR 200 ZERO LATEX - 1.5 MILS*
SECOND COAT: PRE-CATALYZED WATERBASED EPOXY EGGSHELL SHEEN – 2 MILS*
THIRD COAT: PRE-CATALYZED WATERBASED EPOXY EGGSHELL SHEEN – 2 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 5.5 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LISTS AND SAMPLES:

    a. Benjamin Moore Company.
    b. Devoe and Reynolds Company, Inc.
    c. Pratt and Lambert Inc.
    d. PPG Industries Inc.
    e. Glidden.

MATERIAL SCHEDULE 131

TYPE: EPOXY

USE: INTERIOR CMU MASONRY

SURFACE PREPARATION: CC-I

SHERWIN WILLIAMS

FIRST COAT: HEAVY DUTY BLOCK FILLER – 10.0 MILS DRY*

SECOND COAT: MACROPOXY 646-100 FC - 4.0 MILS DRY *

THIRD COAT: MACROPOXY 646-100 FC- 4.0 MILS DRY *

* MINIMUM DRY FILM THICKNESS

KOPPERS

FIRST COAT: AND MASONRY FILLER

SECOND COAT: HI-GARD EPOXY - 4.0 MILS DRY

THIRD COAT: HI-GARD EPOXY - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY FOR SECOND AND THIRD COAT

NOTES:

1. IF MINIMUM 18.0 MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. Tnemec.

MATERIAL SCHEDULE 140

TYPE: EPOXY

USE: FERROUS METAL SURFACES AND STRUCTURAL STEEL LOCATED INSIDE A BUILDING WHICH ARE NOT SUBMERGED OR LOCATED ABOVE A LIQUID. NOT FOR USE WITH PROCESS EQUIPMENT.

SURFACE PREPARATION: SSPC SP-6

SHERWIN-WILLIAMS

PRIMER: KEM-KROMIK UNIVERSAL METAL PRIMER- 3.3 MILS*

FIRST COAT: MACROPOXY 646-100 FC - 4.0 MILS*

SECOND COAT: ACROLON 100 URETHANE - 3.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 10.3 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Koppers.
    b. Tnemec.

MATERIAL SCHEDULE 141

TYPE: HIGH BUILD EPOXY

USE: PROVIDE THE FOLLOWING COATING SYSTEM FOR FERROUS METAL SURFACES ON ALL MECHANICAL EQUIPMENT AND ACCESSORIES INCLUDING BUT NOT LIMITED TO: PUMPS, VALVING AND OTHER PROCESS EQUIPMENT AND EXTERIOR STRUCTURAL STEEL AND EXPOSED STEEL PIPE.

SURFACE PREPARATION: SSPC-SP10 NEAR WHITE BLAST-IMMERSION SERVICE

SHERWIN-WILLIAMS

PRIMER: ZINC CLAD III - 3.0 MILS*

FIRST COAT: MACROPOXY 646-100 FC - 4.0 MILS*

SECOND COAT: ACROLON 100 URETHANE - 3.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 10.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Koppers.
b. Tnemec.

MATERIAL SCHEDULE 150

TYPE: ACRYLIC LATEX

USE: ALL PVC SURFACES TO BE PAINTED, AS SPECIFIED OR SHOWN ON DRAWINGS.

SURFACE PREPARATION: CLEAN AND DRY.

GLIDDEN

FIRST COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

SECOND COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 4.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. Benjamin Moore Company.
   b. Devoe and Reynolds Company, Inc.
   c. Pratt and Lambert Inc.
   d. PPG Industries Inc.
   e. Sherwin-Williams.

MATERIAL SCHEDULE 240

TYPE: ALIPHATIC POLYURETHANE

USE: EXTERIOR OF SLUDGE HOPPER AND DUMPSTER

SURFACE PREPARATION: SP-6

SHERWIN-WILLIAMS

PRIMER: ZINC CLAD III - 3.0 MILS*

FIRST COAT: MACROPOXY 646-100 FC - 4.0 MILS*

SECOND COAT: ACROLON 100 URETHANE - 3.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 10.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Koppers.
    b. Tnemec
    c. Valspar.

MATERIAL SCHEDULE 241

TYPE: HIGH BUILD EPOXY

USE: PROVIDE THE FOLLOWING COATING SYSTEM FOR FERROUS METAL SURFACES ON ALL MECHANICAL EQUIPMENT AND ACCESSORIES INCLUDING BUT NOT LIMITED TO: PUMPS, VALVING AND OTHER PROCESS EQUIPMENT AND EXTERIOR STRUCTURAL STEEL AND EXPOSED STEEL PIPE.

SURFACE PREPARATION: SSPC-SP10 NEAR WHITE BLAST-IMMERSION SERVICE

SHERWIN-WILLIAMS

PRIMER: ZINC CLAD III - 3.0 MILS*

FIRST COAT: MACROPOXY 646-100 FC - 4.0 MILS*

SECOND COAT: ACROLON 100 URETHANE - 3.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 10.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Koppers.
    b. Tnemec.

PIPE AND EQUIPMENT COLORS

STENCIL WORDING	SYMBOL	COLOR	LETTERS & ARROW
Raw Water		SW6366-BLUEBLOOD	YES AND DIRECTION OF FLOW
Potable Water		SW6366-BLUEBLOOD	YES AND DIRECTION OF FLOW
Non-Potable Water	W3	SW6366-BLUEBLOOD	YES AND DIRECTION OF FLOW
Compressed Air		SW4084-SAFETY YELLOW	YES
Air Vacuum	ARV		YES
Vent	V		YES

+ + + END OF SECTION 09900 + + +

SECTION 10200
LOUVERS

PART 1 - GENERAL

1. SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all louvers complete. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Work specified in this section is subject to the provisions of Section 15050, BASIC MECHANICAL MATERIALS AND METHODS.

C. Related Work Specified Elsewhere:

Section 15050, BASIC MECHANICAL MATERIALS AND METHODS.
Section 15890, DUCTWORK AND ACCESSORIES.
Section 15990, TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

2. SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data: Indicate material types, finishes, sizes, fabrication, and installation details.

B. All louver performance data submitted for approval shall bear the AMCA Certified Ratings Seal for Air Performance and Water Penetration.

3. PROJECT CONDITIONS

A. Protection: Protect prefinished surfaces from damage and staining. Provide protective covering for louvers during subsequent construction.

B. Coordinate installation of louvers to be built into building structure. Secure templates and lay out to rough dimensions furnished by manufacturer.

PART 2 - PRODUCTS

1. LOUVERS

A. Acceptable Manufacturers:

1. Ruskin ELF211D, 16”x16” with insect screen Basis of Design.
2. American Warming and Ventilating;
3. Greenheck;
4. Or equal.

B. Characteristics:
1. Louver components (heads, jambs, sills, blades, etc.) shall be factory assembled by the manufacturer into a complete unit. Connect to fan sleeve, provide an extension as needed with all components for an air-tight connection.
2. Material: 6063-T5 extruded aluminum alloy, meeting ASTM B221-79a, blades a minimum of 0.10-inch thick and frames a minimum of 0.120-inch thick. Frame depth shall be 2 inches. Provide extended sill on frame.
3. Finish: KYNAR 500 with 20-year warranty for corrosion protection. Color to match adjacent brick or as selected by Architect.
4. Construction: Welded.
5. Blade Design: Stormproof with drainable blades.
6. Fasteners: Stainless steel.
7. Building Paper: 15-pound asphalt saturated organic felts meeting ASTM D266-77.
8. Insect Screen
9. Louver frame shall be sleevable as required to accommodate barometric relief damper installation. Refer to Section 15890, DUCTWORK AND ACCESSORIES.
10. Louvers shall conform with the following performance requirements:

    a. Free Area: Not less than 38 percent.
    b. Static Pressure Loss: Not more than 0.20-inch of water gauge at any airflow of 1000 fpm free area velocity in intake direction.
    c. Water Penetration: Not more than 0.01 ounces per square feet of free area at an airflow of 1,197 fpm free area velocity.

C. Louver design shall incorporate structural supports as required to withstand a wind load of 20 pounds per square foot.

D. Furnish combination louvers with totally enclosed electric motor actuators suitable for a corrosive environment.

E. Sizes: As noted on the Architectural drawings.

PART 3 - EXECUTION

1. EXAMINATION

A. Check openings to ensure that dimensions conform to Drawings.

B. Assure that openings are free of irregularities that would interfere with installation.

2. INSTALLATION

A. Install louvers in accordance with manufacturer's product data in prepared openings, plumb and level.

B. Attach louvers using stainless steel fasteners spaced at 1 foot 0-inch OC at head, sill, and jambs. Separate aluminum from dissimilar metals using one layer of building paper or as specified in Section 09900, PAINTING.

C. Louvers shall be caulked and sealed at the frame and flanges to make the installation watertight.

3. ADJUSTING AND CLEANING

A. Repair damage to louvers to match original or replace.

+++ END OF SECTION 10200 +++

SECTION 10295
INTEGRATED PEST MANAGEMENT (IPM)

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Integrated Pest Management (IPM) to address the following pests:

1. Indoor populations of rodents, insects (including termites), arachnids, and other arthropods.
2. Outdoor populations of potentially indoor-infesting species that are within the property boundaries.
3. Nests of stinging insects within 20 (twenty) feet of the building and within the property boundaries.
4. Individuals of all excluded pest populations that are incidental invaders inside the building.
    a. Excluded Pest Populations:
        1) Birds, bats, snakes, and all other vertebrates other than commensal rodents.
        2) Pests that primarily feed on outdoor vegetation.

B. Integrated Pest Management (IPM) shall include the following:

1. Initial building and site inspection.
2. Developing an IPM Plan appropriate to the building, site, and local ecosystems.
3. Implementing the approved IPM Plan.
4. Documenting IPM services.

C. Related Sections:

1. Section 01500 - Temporary Facilities
2. Section 01352 – Indoor Air Quality (IAQ) Management
3. Section 01740 – Progress Cleaning
4. Section 01830 – Operation and Maintenance Data
5. Section 01780 – Sustainable Design Closeout Documentation
6. Section 01821 – Environmental Demonstration & Training
7. Section 02900 – Trees, Plants and Ground Covers

1.02 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114.

B. Action Threshold: The level at which action is initiated as determined by how many pests can be tolerated.

1. The action threshold reflects the pest management objective for the site. The presence of some pests does not, in itself, necessarily require action. When pest populations exceed established action thresholds, action must be taken.

C. Biological Control: The use of living organisms—parasites, predators, or pathogens—to maintain pest populations.

D. Cultural Control: The manipulations of the site ecosystem that make it less friendly to the establishment and proliferation of pest populations.

E. Exclusion: The practice of structural and procedural modifications to reduce access used by pests.

F. Integrated Pest Management (IPM): An approach to pest management that uses current, comprehensive information on the life cycles of pests and their interactions with the environment to identify and implement effective methods of pest control with the least possible hazard to people, property, and the environment.

G. Mechanical Control: The use of one or more physical components of the environment, such as temperature, humidity, or light, to the detriment of the pest.

H. Phenology: The annual cycles of plants and animals and how they respond to seasonal changes in their environment.

1.03 QUALITY ASSURANCE

A. Contractor Qualifications:

1. Experience: Minimum of 5 years experience in performing the types of services specified herein.
2. Certification:
   a. Contractor personnel providing on-site pest control service must maintain certification as Commercial Pesticide Applicators in the category of Industrial, Institutional, Structural, and Health Related Pest Control. Uncertified individuals working under the supervision of a Certified Applicator will not be permitted to provide service under this contract.

B. Pesticides:

1. Contractor shall be responsible for application of pesticides according to the label.
2. Regulatory compliance:
   a. All pesticides used by the Contractor must be registered with the U.S. Environmental Protection Agency (EPA) and applicable jurisdictions.

b. Transport, handling, and use of all pesticides shall be in strict accordance with the manufacturer's label instructions and all applicable laws and regulations.

3. Contractor shall not store any pesticide product in the project building(s) and site.
4. Prohibited Pesticides:
   a. Contractor shall not apply any pesticide product that has not been included in the approved IPM Plan or approved in writing by the Owner.
5. Minimization of Risk:
   a. When pesticide use is necessary, Contractor shall employ the least risk pesticide, most precise application technique, and minimum quantity of pesticide necessary to achieve control.
   b. Application of pesticides in any inside or outside area shall not occur unless visual inspection or monitoring devices indicate the presence of pests in that specific area.
   c. Recommendations for preventive pesticide treatments in areas where inspection indicates a potential insect or rodent infestation will be evaluated by the Owner on a case-by-case basis. Written approval must be granted by the Owner prior to any preventive pesticide application.
   d. Notification: Contractor shall notify Owner at least 48 hours in advance of the application of any pesticide. Exceptions may be made for applications made for emergencies, where an imminent threat to health exists (e.g., stinging insects). For emergency applications, notification must be made as soon as practical.

C. Key Pests and Action Thresholds:

key pest	**action threshold**	
	interior	**exterior**
birds	1 bird	1 nest on building
rats	any evidence	any evidence
flies	1 complaint (when one or more become a nuisance)	1 complaint (when one or more become a nuisance); also, **30/day** based on monitoring count
ants	1 complaint	1 fire ant mound within 100 feet of building/ pavement
cockroaches	1 cockroach in public areas or fresh food areas	n/a
pantry pests (meal moth)	1 complaint	n/a
crickets	1 complaint	n/a
weeds	n/a	tbd

D. Coordination with construction operations:

1. Review Contractor's Indoor Air Quality (IAQ) Management Plan to verify moisture controls are appropriate to anticipated IPM Plan.
2. Review Contractor's Waste Management Plan to verify sanitation levels are appropriate to anticipated IPM Plan.
3. Review Contractor's progress cleaning methods to verify sanitation levels are appropriate to anticipated IPM Plan.

E. Coordination with Owner's operations:

1. Coordinate with Section 01830 – Operation and Maintenance Data: Sanitation information consistent with approved IPM plan.
2. Coordinate with Section 02900 – Trees, Plants, and Ground Covers.

1.04 PRECONSTRUCTION MEETING

A. After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner and Architect to discuss the proposed IPM Plan and to develop mutual understanding relative to details of environmental protection.

1.05 SUBMITTALS

A. Integrated Pest Management (IPM) Plan: Not less than 10 days before the Pre-construction meeting, prepare and submit an IPM Plan including, but not limited to, the following:
1. Verify key pests and action thresholds for each key pest are appropriate to project, local ecosystem, and climate.
2. Proposed IPM Strategies: Provide for each key pest, appropriate to the building, site, and local ecosystems.
    a. Indicate strategies for inspection, prevention and for response to identified pest problems.
        1) Inspection: Describe methods and procedures to be used for identifying sites of pest harborage and access, and for making objective assessments of pest population levels throughout the term of the contract.
        2) Prevention: Describe methods and procedures recommended for prevention of pest harborage and access.
        3) Response: Indicate prioritization of strategies such that non-chemical controls are utilized before chemical controls; and lesser risk options are used before resorting to actions with greater risk factors.
3. Proposed Materials and Equipment:
    a. Provide brand names of pesticide application equipment, rodent bait boxes, insect and rodent trapping devices, pest monitoring devices, pest detection equipment, and other pest control devices or equipment that may be used to provide service.

b. Commercial Pesticide Applicator Certificates or Licenses: The Contractor shall provide photocopies of State-issued Commercial Pesticide Applicator Certificates or Licenses for every Contractor employee who will be performing on-site service under this contract.

c. Pesticides: For all pesticides to be used, submit:

1) Product data indicating conformance to U.S. National Organics Program (NOP) Final Rule list.

2) Current EPA-registered label.

3) Material Safety Data Sheet. MSDSs shall be prepared/updated within the previous five years and shall include responses to Sections 1 – 16 in accordance with ANSI Z400.1 and as follows:

a) Section 11: Toxicological Information. Include data used to determine the hazards cited in Section 3. Identify acute data, carcinogenicity, reproductive effects, and target organ effects.

b) Section 12: Ecological Information. Include data regarding environmental impacts in the event of an accidental release.

c) Section 13: Disposal Considerations. Include data regarding the proper disposal of the chemical. Indicate whether or not the product is considered to be "hazardous waste" according the US EPA Hazardous Waste Regulations 40 CFR 261.

d) Section 14: Transportation Information. Identify hazard class for shipping.

e) Section 15: Regulatory Information. Identify federal, state, and local regulations applicable to the material.

4. Service Schedule: Provide a complete service schedule that includes weekly or monthly frequency of Contractor visits, specific day(s) of the week of Contractor visits, and approximate duration of each visit.

a. Start of Service Schedule: Start of construction.

5. Revise and resubmit Plan as required by Owner.

a. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

B. Baseline IPM Reports: Prior to beginning implementation of approved IPM Plan, submit the following:

1. Initial Building Inspection Report. Conduct a site visit to verify the pest control needs of all locations and identify problem areas and any equipment, structural features, or management practices that may contribute to pest infestations.

a. Submit Report summarizing observations. Indicate proposed revisions, if any, to approved IPM Plan that may be necessary based upon results of Initial Building Inspection.

2. Summary of Conventional Pest Management Controls for Key Pests: Submit summary of conventional pest management materials and methods that would be applicable to the building and site for key pests. Include the types of pesticide, application rates, estimated annual quantity required, and environmental issues of concern for each.

C. Operations and Maintenance Information: Submit instructions for Owner's personnel regarding Owner operations and maintenance procedures associated with Contractor provided IPM services.
1. Include overview of potential pest problems, conventional practices and environmental impacts, and IPM practices and environmental impacts.
2. Coordinate with landscaping maintenance program.
3. Coordinate with building cleaning and routine maintenance programs.

D. Field Quality Control Documentation.
1. IPM Inspection Reports
2. IPM Deficiency Reports
3. IPM Log Book.

PART 2 - PRODUCTS

2.01 CHEMICAL CONTROLS

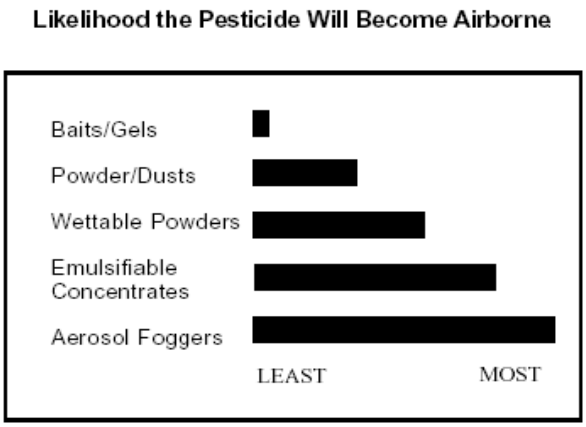
A. Prohibited Pesticides:

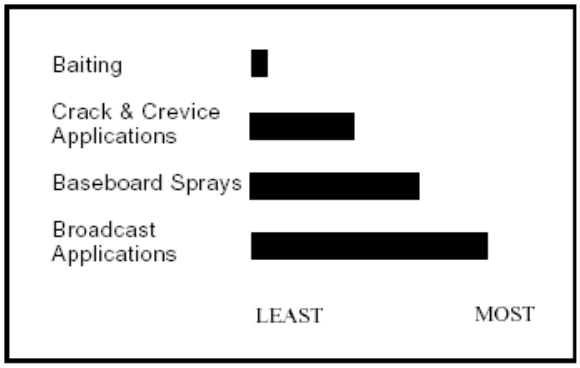
1. Pesticides containing active ingredients classified as known, likely or probable carcinogens or reproductive toxins according to any of the following lists: State of California EPA List of Chemicals Known to Cause Cancer or Reproductive Toxicity, State of Illinois EPA List of Known Endocrine Disrupters, US EPA List of Chemicals Evaluated for Carcinogenic Potential.
2. Pesticides containing inert ingredients included on US EPA's List 1: Inerts of Toxicological Concern.
3. Pesticide formulations and uses presenting a potential physical hazard or dust/powder inhalation hazard to building occupants.
4. Pesticides with label precautionary statements including "toxic" or "extremely toxic" to bees, birds, fish or wildlife. *Does not apply to pesticides used as per label directions to control bird, fish, wildlife or stinging insect pests.*
5. Pesticides with label precautionary statements including specific warnings regarding ground or surface water contamination.

B. Lesser Risk Pesticides: Materials listed on the U.S. National Organic Program's Final Rule, US Code of Federal Regulations 7CFR 205, list of acceptable materials and as follows:

1. Crawling insects: Boric acid based or plant based pesticides.
   a. Botanical pesticides: Pyrethrum, neem formulations, rotenone, and others as approved by Owner.
2. Rodents: Vitamin D3 (Cholecalciferol) or Quintox.
3. Weeds: Plant based pesticides and herbicides. Coordinate with Section 02900 – Trees, Plants and Ground Covers.
   a. Botanical pesticides: Pyrethrum, neem formulations, rotenone, and others as approved by Owner.
4. Plant diseases: Plant based fertilizers. Coordinate with Section 02900 – Trees, Plants and Ground Covers.
   a. Compost Teas: Verify that compost tea does not include invasive species, including seeds. Verify that compost tea does not include animal pathogens.

C. Lesser Risk Pesticide Application Methodologies:





PART 3 - EXECUTION

3.01 NON-CHEMICAL PEST MANAGEMENT

A. Provide IPM in accordance with approved IPM Plan and as follows:

1. Cultural Controls:

a. Sanitation and exclusion: Recommend structural and procedural modifications as appropriate to reduce food, water, harborage, and access used by pests.
b. Soils: Maintain healthy, biologically active soils. Coordinate with Section 02900 – Trees, Plants and Ground Covers.
c. Habitat for beneficial organisms: Recommend modifications as appropriate to promote healthy habitat for beneficial organisms. Habitat enhancement may include flowering annual or perennial plants that provide pollen and nectar needed during certain parts of the insect life cycle, overwintering sites, and wind protection. Coordinate with Section 02900 – Trees, Plants and Ground Covers.
d. Phenology: Determine correlation with insect emergence and pest control. Develop recommendations as appropriate.

2. Mechanical Controls
   a. Traps:
      1) Rodents: Trapping devices shall be the standard method for indoor rodent control. All such devices shall be concealed out of the general view and in protected areas so as not to be affected by routine cleaning and other operations.
      2) Insects: Trapping devices shall be the standard method for indoor fly control.
   b. Vacuums:
      1) Insects: Portable vacuums shall be the standard method for initial cleanouts of cockroach infestations, ants, termites, and for control of spiders in webs.
   c. Flame weeding: Unless otherwise approved by Owner, flame weeding shall not be permitted.
   d. Mulches, living or non-living:
      1) Weeds: Mulch shall be used for suppression of weeds, insect pests, and plant diseases as appropriate. Coordinate with Section 02900 – Trees, Plants and Ground Covers.
   e. Boiling Water:
      1) Fire Ants (exterior): Boiling water shall be the standard method for control of exterior fire ants. Use boiling water at a rate of approximately 3 gallons per mound.
3. Biological Controls:
   a. Lady bugs, nematodes, and other biological controls: Permitted only for control of exterior ants, aphids, and/or other insects as appropriate. Coordinate with Section 02900 – Trees, Plants and Ground Covers.

3.02 CHEMICAL PEST MANAGEMENT

A. Chemical Controls: Unless otherwise approved by Owner, Contractor shall use non-chemical methods of control. When pesticide use is necessary, the Contractor shall employ the least risk, NOP-listed pesticide; most precise

application technique; and minimum quantity of pesticide necessary to achieve control.

B. Baits Boxes: Bait boxes shall be maintained with an emphasis on the safety of non-target organisms.

1. Bait boxes shall be placed out of the general view, in locations where they will not be disturbed by routine operations.
2. Lids shall be securely locked or fastened shut.
3. Bait boxes shall be securely attached or anchored to floor, ground, wall, or other immovable surface, so that the box cannot be picked up or moved.
4. Bait shall be secured in the feeding chamber of the box and never placed in the runway or entryways of the box.
5. Bait boxes shall be labeled on the inside with the Contractor's business name and address, and dated by the Contractor's technician at the time of installation and each servicing.

3.03 PEST REMOVAL

A. Pest Removal: Remove traps, bait boxes, and their contents according to the approved IPM Plan and as requested by Owner.

3.04 SPECIAL REQUESTS AND EMERGENCY SERVICE

A. On occasion, the Owner may request that the Contractor perform corrective, special, or emergency service(s) that are beyond routine service requests. The Contractor shall respond to these exceptional circumstances and complete the necessary work within three (3) hours after receipt of the request.

3.05 FIELD QUALITY CONTROL

A. Inspection: Inspect building and site for pests and beneficials to gather information about the health of the landscaping and local ecosystem, pests, and natural enemies.

1. Methods: Use methods indicated in approved IPM Plan and as follows:
   a. Sweep nets, sticky traps, and pheromone traps may be used to collect insects for both identification and population density information.
   b. Leaf counts may be used for recording plant growth stages.
   c. Square-foot or larger grids laid out in a field may provide a basis for comparative weed counts.
   d. Records of rainfall and temperature may be used to help predict the likelihood of disease infections.
2. Schedule: Inspect at regular intervals and at critical times in accordance with approved IPM Plan.
3. Reports: Document results of inspections. Submit using form approved by Owner.

B. Recommendations: Throughout the term of this contract, the Contractor shall be responsible for advising the Owner about any structural, sanitary, or procedural modifications that would reduce pest food, water, harborage, or access.

1. The Contractor shall be responsible for adequately suppressing all pests included in this contract regardless of whether or not the suggested modifications are implemented.
2. The Contractor will not be held responsible for carrying out structural modifications as part of the pest control effort. However, minor applications of caulk and other sealing materials by the Contractor to eliminate pest harborage or access may be approved by the Owner on a case by case basis. The Contractor shall obtain the approval of the Owner prior to application of sealing material and other structural modification.

C. Log Book: The Contractor shall maintain a pest control logbook or file. These records shall be kept on-site and maintained on each visit by the Contractor. Each logbook or file shall include:

1. IPM Plan: A copy of the approved IPM Plan.
2. IPM Contact List: Include contact information for Contractor and Owner contact. Indicate emergency contact information for Contractor.
3. Schedule: Contractor's service schedule for the property. Identify IPM activity that has been performed.
4. Product Data: A list of all pesticides used on property and product data for each as follows:
   a. Product data indicating conformance to U.S. National Organics Program (NOP) Final Rule list.
   b. Current EPA-registered label.
   c. Material Safety Data Sheet.
5. IPM Inspection Reports and Deficiency Reports.
6. Pest Diagrams: Plans and site drawings noting the location of pest activity, including the location of all traps, trapping devices, and bait stations in or around the site.

+++ END OF SECTION 10295 +++

SECTION 10430
EXTERIOR SIGNS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes providing all non-illuminated wall mounted and post mounted signs complete with all components by single manufacturer at locations indicated on the Drawings. Provide all exterior signs from same manufacturer.

B. Related Work Specified Elsewhere:

1. Section 03300, Cast-In-Place Concrete.
2. Section 07900, Caulking and Sealants.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Shop drawings.

a. Submit complete shop drawings; indicate all materials, sizes, configurations, applicable substrate mountings, and required location of connections provided in other sections. Specifically indicate tolerances required from other sections for base mounted modules.

b. Submit typography sample for copy. Use Century Gothic Bold.

c. Submit art work for special graphics.

d. Templates - Furnish templates required for locations of anchors installed by others.

2. Product data.

a. Submit manufacturer's signed statement regarding compliance with Article 1.04, Paragraph A.

b. Submit manufacturer's product literature indicating units and designs selected.

c. Submit maintenance data and cleaning requirements for all exterior surfaces.

1.03 QUALITY ASSURANCE:

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including

the partial listing below:

1. AA, Aluminum Association.
2. ANSI, American National Standards Institute.
3. ASTM, American Society for Testing and Materials.

B. Manufacturer Qualifications: Provide Work required under this section from manufacturers regularly engaged in Work of this magnitude and scope for minimum of five years.

C. Pre-installation Conference: Closely coordinate tolerances required in this section for installation to bases supplied in other sections.

1.04 QUALITY STANDARDS

A. Acceptable Product:

1. Other manufacturer's products are acceptable if submitted in accord with Product Options and Substitutions section and are in strict compliance with these specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Coordinate delivery of Work to Project site under this section for immediate installation.

B. Handling materials and equipment: Handle signage in careful manner in order not to damage or mar surfaces of signs or adjacent finish surfaces as applicable.

1.06 SEQUENCING AND SCHEDULING

A. Coordinate installation with adjacent finish materials in manner not to destroy adjacent surfaces.

B. Coordinate with other sections for cast-in or built-in anchors and mounting hardware required in Work accomplished in other sections.

1.07 WARRANTY

A. Provide manufacturer's standard five-year limited warranty covering coating degradation, chalking, fading, and fiberglass delaminating.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Types:

1. Post and panel.

B. Sizes:

1. 48” tall x 24” wide. Bottom of sign 24” above grade.

C. Design units with selected components specified in Article 2.02.

2.02 COMPONENTS

A. Graphics Panel Module:

B. Posts:

1. Material. - Aluminum

2. Post profile. - square

3. Finish and color: Double faced painted aluminum panels.

4. Design post for panel size: individual lengths required by manufacturer for in ground mount.

C. Graphics:

1. Special note. Use of clear overcoat on completed graphics regardless of colors or types selected is strictly prohibited.

2. Pressure sensitive graphics (PSG) colors. Selected by Architect/Engineer.

3. Type.

a. Size – 2” minimum
b. Style - Selected by Architect/Engineer.
c. Type code – Century Gothic Bold

2.03 ACCESSORIES

A. Provide miscellaneous hardware and items required for installation of in-ground and base mounted sign modules.

2.04 FABRICATION

A. Fabricate units to configurations indicated on reviewed shop drawings. Internally

reinforce units in accord with reviewed shop drawings.

B. Provide copy required on reviewed shop drawings in accord with manufacturer's standard procedures.

C. Fabricate posts to lengths required for in-ground mounting.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive sign modules; verify for proper location of cast-in anchors installed under other sections.

B. Notify Engineer in writing of unacceptable substrate or improper location of anchors. Beginning Work indicates acceptance of substrate. Subsequent modifications to substrate or modules becomes this section's complete responsibility.

3.02 INSTALLATION

A. Install sign modules in locations indicated on drawings in accord with reviewed shop drawings. Square, plumb, and level units.

B. Bore required holes for post mounted sign modules; set and align posts; fill and compact space around post with concrete.

3.03 CLEANING

A. Clean all exposed surfaces just prior to Date of Substantial Completion in accord with manufacturer's written cleaning instructions.

3.04 SCHEDULES

A. Coordinate schedules with Engineer.

EXTERIOR SIGN TYPES

E.1: Parking Space Identity
Polysign Series 4160.2. Size: Panel-1/4" x 12" x 12". Post-2" x 2" x 4'. Posts and panel to have painted finish. Pressure-sensitive graphics and field color to be chosen from standards. "Visitor" to be 2" high; "Symbol" to be 8" high. Format: center/center.
Handicapped
Electrical Charging Sign

E.2: Directional Sign
Polysign Series 4120.1. size: 2" X 48" high x 24" wide. Posts and panel to have painted finish. Pressure-sensitive graphics and field color to be chosen from standards. Arrows to be

3"; lettering not to exceed 2" high. Units to have 6' posts furnished. Format: Flush left.

E.3: Building ID
Similar to directional sign

E.4: NOT USED

+ + + END OF SECTION 10430 + + +

SECTION 10440
IDENTIFYING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all the materials for and shall properly erect and install all identifying devices at the locations shown and as indicated on the Drawings, and as specified herein.

B. This shall include all identification signs and warning signs, including supports, fastening devices, and accessories, and all labor, materials, tools, and appurtenances required to complete the Work.

C. It is the intent of this Specification that the installation shall be complete in all respects and ready for use. The Contractor shall be responsible for all incidental details and for any special construction necessary to complete the work in an acceptable manner.

D. Related Work Specified Elsewhere:

1. Section 10520, Fire Extinguishers.
2. Section 15440, Emergency Shower and Eyewash Fixtures.
3. Section 15060, Piping and Appurtenances.

1.02 SUBMITTALS:

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

B. Samples: Submit samples of each sign form and materials showing finished, colors, surface textures and qualities of manufacturer and design of each sign component including graphics.

1.03 QUALITY ASSURANCE:

A. Uniformity of manufacturer: For each sign form and graphic image process indicated furnish products of single manufacturer.

B. Quality of signage shall be not less than ASI-SPE construction.

PART 2 - PRODUCTS

2.02 MATERIALS

A. General: Identifying devices shall be of the type and materials specified for each

category. Unless otherwise indicated, signs shall be the manufacturer's stock items.

B. Life Safety Signs: Signs shall be butyrate with red lettering on white background, and conforming to OSHA regulations. Sign denoting fire extinguisher location shall be vinyl with pressure-sensitive adhesive backing.

1. NO SMOKING WITHIN 25 FEET OF THE BUILDING: Located at all entrance doors.
2. FIRE EXTINGUISHER: Located above all extinguishers.

C. Interior and Directional Signs: Signs shall be ASI/2 type A, constructed of 0.015-inch vinyl laminated to 1/4-inch acrylic backing. Letters shall ASI/2 pressure-sensitive vinyl letters. Signs shall have 1-inch border around perimeter. All signs to be compliant with ADA and COA standards. Colors to be as selected by Architect from standard manufacturer colors.

D. Exterior Signs: sign shall be 12" x 18" embossed steel with cast iron base and 1-inch diameter pipe standard, 36-inches high, with black enamel finish.

1. NO PARKING: Located as shown on the plans. (White background, red letters).
2. HANDICAPPED PARKING ONLY: Located as shown on the plans. (Blue background, white letters).
3. LOW EMISSIONS VEHICLE PARKING ONLY: Located as shown on the plans. (White background, green letters)

PART 3- EXECUTION

3.01 INSTALLATION:

A. General: Locate sign units and accessories where shown or directed, using mounting methods of the type described and in compliance with the manufacturer's instructions.

1. Install signs level, plumb and at the height indicated, with sign surfaces free from distortion or other defects in appearance.3.02 CLEANING AND PROTECTION:

A. At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Engineer.

+++ END OF SECTION 10440 +++

SECTION 10520
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all wall mounted fire extinguishers. All equipment shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:

1. Section 10440, Identifying Devices.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
1. Manufacturer's certification.
2. Manufacturer's data and installation instructions.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.
4. NFPA, National Fire Protection Association.

1.04 QUALITY STANDARDS

A. The fire extinguishers shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life

with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been designed in accordance with these specifications, in accordance with NFPA10, and is a suitable application for these service conditions.

C. Manufacturer's offering products that comply with these specifications include:

1. Larsen's Manufacturing Co.
2. J. L. Industries
3. Modern Metal Products by Muckle
4. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 FIRE EXTINGUISHERS

A. Provide fire extinguishers in accordance with the following:

Product	Hand held, dry chemical fire extinguisher
Capacity	10 Pounds
Class	ABC
Mounting	Wall Brackets

B. Unit shall be UL labelled. Unit shall have pressure indicating gauge rated for Class A, B and C fires.

C. Service, charge and tag each fire extinguisher not more than ninety-five (95) calendar days prior to the Date of Substantial Completion of the Work as that Date is established by the Engineer.

D. A universal emergency sign shall be attached to building structure above each fire extinguisher.

PART 3 - EXECUTION:

3.01 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 Installation

A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

B. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Engineer.

+++ END OF SECTION 10520 +++

SECTION 11246
SUBMERSIBLE SUMP PUMP

PART 1 GENERAL

1.01 Scope

Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation for the sump pump. All equipment shall be installed, tested and placed in operation in accordance with these Specifications and the manufacturer's recommendations.

1.02 **(NOT USED)**

1.03 Submittals

A. Submit shop drawings and engineering data in accordance with the requirements of Section 01340 of these Specifications. Indicate the following:

1. Manufacturer's name, pump size and model number and description bulletin of the pump furnished.

2. Outline dimension of the pump.

3. Pump characteristic curves showing head, capacity, horsepower, minimum head, rated and shut off conditions.

4. Motor manufacturer's name, motor horsepower, rpm, frame size and motor descriptive information. Include motor features and data sheet.

B. Operation and maintenance manuals shall be furnished in accordance with the requirements of Section 01730 of these Specifications.

1.04 Storage and Protection

Pumps shall be stored and protected in accordance with the requirements of Section 01640 of these Specifications. The Contractor shall not have the sump pumps delivered to the site more than 30 calendar days before installation.

1.05 Quality Assurance

The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

A. Sump pumps to be model Little Giant 16s-Cim, 1 hp, 3-phase, 460-volt by Franklin Electric Co., Inc., or approved equal.

B. Sump pump control system to be model Little Giant 3221w201h17a by Franklin Electric Co., Inc. Or approved equal.

2.02 Operating Requirements

A. Pumps shall produce 50 gpm at 26-ft TDH.

B. The operating range of the pump shall include minimum head, rated and shut off conditions. The pump shall be non-overloading throughout this operating range.

2.03 Sump Pump

A. General: The sump pump shall be a totally submersible, electric motor driven pump. Pump discharge connection shall be screwed and of the size shown on the Drawings. Pump shall be furnished with feet or with stands.

B. Pump Casing: The pump casing, volute and discharge connection to be PVC, stainless steel, or cast iron.

C. Impeller: The impeller shall be constructed of stainless steel or engineered thermoplastic and shall be taper fit and keyed to the shaft. The impeller shall have a minimum Brinell hardness of 200. Impeller fasteners shall be stainless steel.

D. Shaft: The common pump and motor shaft shall be 303 stainless steel, rigidly supported by two sets of anti-friction bearings. The shaft shall be designed with minimum overhang and adequate section to prevent deflection.

E. Shaft Seal: The shaft seal shall be a double mechanical seal in a separate oil filled chamber.

2.04 Motor

A. The pump motor shall have the following characteristics: 1.15 service factor; continuous duty; submersible pump motor. Motors shall be 480 volt, 60 Hz, 3 phase unless otherwise specified or shown on the Drawings.

B. The pump motor shall be housed in a watertight housing and shall be suitable for continuous duty.

C. Cable: The power cable shall be of the type of construction suitable for submersion in wastewater. Strain reliefs shall be provided at each cable entry into the pump. Cable length shall provide for installation as shown on the Drawings.

D. Overload Protection: Provide built in, automatic protection that prevents damage caused

by clogging, overloading, dry running and voltage drop.

2.05 Controls

A. Control panel(s) shall be furnished by the pump manufacturer. Designation is CP-11-SP and CP-10-SP.

B. Power Supply: 480 volts, three phase. All controls shall operate on 120 volts maximum. Provide a control panel main flange mounted circuit breaker disconnect switch with an AIC of 42,000.

C. Enclosure: NEMA 4X stainless steel.

D. Components

1. Relays: Heavy duty industrial control type, 10 amp, 600 volt reversible contacts, equal to Square D, Class 8501, Type X.

2. Motor Starters: Combination NEMA rated with circuit breakers with on AIC of 42,000 Allen-Bradley Bulletin 500.

3. Selectors and Indicating Lights: Heavy duty, oil tight with octagonal ring. Allen-Bradley Bulletin 800 T.

E. Panel Construction: Route all wiring in Panduit or similar wireways. Protect all wiring across panel hinges. Provide numbered terminal strips for all field wiring terminations.

F. Sump Dimensions: 36-inch x 36-inch x 36-inch.

G. Control Functions: Provide a pump start selector switch and run light for each pump. The pump will be started/stopped by the operator and will remain off until started again by the operator.

PART 3 EXECUTION

3.01 Installation

Installation shall be in strict accordance with the manufacturer's recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

3.02 Surface Preparation and Shop Coating

Pumps and accessories shall be cleaned, shop-primed and epoxy shop-coated per manufacturer’s recommendations.

3.03 Field Painting

Field painting is prohibited

3.04 Inspection and Testing

Following installation, operating tests will be performed to demonstrate to the Engineer that the sump pumps will function in a satisfactory manner. The Contractor shall make, at Contractor's expense, all necessary changes, modifications and/or adjustments required to ensure satisfactory operation.

3.05 **(NOT USED)**

3.06 Cleaning

Prior to acceptance of the work of this Section, thoroughly clean all installed equipment, materials and related areas in accordance with the requirements of Section 01710 of these Specifications.

+++END OF SECTION 11246+++

SECTION 11280
STOP LOGS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishingall labor, materials, equipment, tools and incidentals required for a complete and operable installation of stop logs complete. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and general configurations. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown andspecified.

C. Stop logs shall not be delivered to the site more than 30 calendar days prior to scheduled installation.

D. Related Work Specified Elsewhere:
   1. Division 1 General Requirements

1.2 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Complete description of all materials including the material thickness of all structural components of the stop logs, guide frames and stop log lifter.
   2. Installation drawings showing all details of construction, components required for installation, dimensions and anchor bolt locations.
   3. Maximum bending stress and deflection of the stop logs under the maximum design head.
   4. The location of the company headquarters of the manufacturer and the location of its manufacturing facility. Provide the name of the company that fabricates the equipment if the supplier utilizes an outside source.
   5. Storage instruction and requirements.
   6. Operation and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
   1. OSHA, Occupational Safety and Health Act.

2. ANSI, American National Standards Institute.
3. ASTM, American Society for Testing Materials.
4. AISI, American Iron and Steel Institute.

B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of 20 similar applications that have a demonstrated record of successful operation for a minimum period of 2 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

C. Should the stop logs not perform as required, the Contractor shall repair or replace any units as necessary to meet the Specifications. Costs for unit repair and retesting shall be the Contractor's responsibility.

1.4 QUALITY STANDARDS

A. The stop logs shall be furnished by a single manufacturer who shall assume full responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings. The Contractor shall assign unit responsibility to the stop log equipment manufacturer for equipment specified in this Section. A certificate of unit responsibility shall be provided.

B. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:
1. Rodney Hunt Company
2. Waterman Industries, Inc.
3. Hydrogate
4. Whipps
5. Fontaine
6. Or equal.

1.5 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only.

B. All stop logs, including lift, shall be designed for the conditions shown on drawings, with a minimum safety factor of 5.

C. All stop logs assemblies shall be complete including all stop logs, guides, frames, baseplates, brackets, anchor bolts, and all other necessary appurtenances.

D. Stop logs shall be stainless steel construction as required to meet the specified operating and design conditions. Materials shall be manufacturer's standard except as hereinafter modified or required.

E. When in use, leakage shall not exceed 0.05 gpm/ft of wetted seal perimeter.

F. The stop logs shall incorporate a continuous resilient seal along the bottom edge of each stop log. Vertical seals shall be mechanically fastened to the guide frame rails.

G. Stop logs shall be of the height as shown in the Contract Drawings and shall function properly when stacked in any order.

H. Stop logs shall be designed to be self-draining, non-buoyant, and shall drop into place under their own weight, without any downward pressure necessary.

I. All structural components of the stop logs shall be fabricated of stainless steel and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.

J. All structural components of the guide frames shall be fabricated of stainless steel and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.

K. All welds shall be performed by welders with AWS D1.6 certification.

L. Finish: Mill finish on stainless steel. Weldments shall be passivated to remove weld burn and scale.

2.2 STOP LOGS

A. General: The stop logs shall be constructed of formed stainless steel shapes with a minimum thickness of 1/4-inch.
   1. The stop logs shall be of the heights indicated on the Contract Drawings.
   2. Maximum bending stress shall not exceed 18,000 psi at maximum operating head.
   3. Two slots shall be provided in the top of each stop log for removal and installation via the stop log lifter.
   4. Each stop log shall be outfitted with a stainless steel identification tag indicating the manufacturer, width of the opening and maximum head rating at a minimum. Additional tags shall be included on each stop log that indicate “dry side” and “wet side”. Tags shall be welded to each log.

2.3 SEALS

A. General: Each stop log shall be outfitted with a continuous resilient lip seal along the bottom and both sides to restrict leakage in accordance with the requirements listed in this specification.
   1. The continuous lip seal shall be constructed of urethane or rubber and shall be mechanically retained to the stop log.
   2. The lip seal shall be activated by a combination of the weight of the stop log and the differential water pressure, which pushes the seal against the inside of the groove assembly.
   3. Stop logs that utilize rubber “J” seals or “P” seals are not acceptable.

2.4 ACCESSORIES

A. Lifter: One stop log lifter shall be provided for each different guide frame width.
   1. The lifter shall be constructed of stainless steel and shall be outfitted with UHMW guide bars and stainless steel fasteners.
   2. The lifter shall be provided with lifting hooks designed to engage the slots in the top of the stop logs. A lanyard release will be incorporated into the design.
   3. The lifter shall be capable of installing and removing all stop logs of the same width whether they are installed or at the operating floor level.

B. Anchor bolts: Anchor bolts shall be provided by the stop log manufacturer for mounting the guide frames.
   1. Quantity and location shall be determined by the stop log manufacturer.
   2. If epoxy type anchor bolts are provided, the stop log manufacturer shall provide the studs and nuts.
   3. Anchor bolts shall have a minimum diameter of 1/2-inch.

C. STORAGE RACKS: Storage racks shall be provided to house stop logs while they are not in use. Storage racks shall be constructed of stainless steel and shall be mounted at a pre-approved location near their intended locations.

2.5 MATERIALS

Components:	Materials:
Frame Guides & Invert	Stainless Steel, Type 304L, ASTM A240, ASTM A 276
Stop Logs	Stainless Steel, Type 304L, ASTM A240, ASTM A276
Lip Seal	EPDM
Studs, Fasteners and Nuts	Stainless Steel, Type 304, ASTM A276, ASTM F 593, ASTM F 594

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the stop logs, guide frames and appurtenances shall be done in a workmanlike manner. It shall be the responsibility of the CONTRACTOR to handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's recommendations.

B. The CONTRACTOR shall review the installation drawings and installation instruction prior to installing the guide frames.

C. The guide frames shall be installed in a true vertical plane, square and plumb.

D. The CONTRACTOR shall fill the void in between the guide frames and the wall with non-shrink grout as shown on the installation drawing and in accordance with the manufacturer's recommendations.

3.2 FIELD TESTS

A. After installation, all stop logs shall be field tested in the presence of the ENGINEER and OWNER to ensure that all items of equipment are in full compliance with this Section. The stop logs shall be inserted into the guide frames to confirm that they operate in accordance with the specification. Each stop log assembly shall be water tested by the CONTRACTOR, at the discretion of the ENGINEER and OWNER, to confirm that leakage does not exceed the specified allowable leakage.

3.3 MANUFACTURERS' SERVICES

A. Manufacturers' services shall be provided in accordance with Section 01600, General Material and Equipment Requirements. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum days listed for the services hereinunder, travel time excluded:

1. 0.5 day for installation assistance, inspection, functional and performance testing, and certification of the installation.

+ + + END OF SECTION 11280 + + +

SECTION 11282
FABRICATED SLIDE GATES

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of fabricated slide gates and fabricated weir gates complete. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Power and control wiring may not be available at time of installation. Units shall be connected to power and control wiring as those components are added to the facilities related to these gates.

Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Slide gates shall not be delivered to the site more than 30 calendar days prior to scheduled installation.

D. Related Work Specified Elsewhere:
1. Division 1 General Requirements

1.2 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
1. Relevant experience references.
2. Manufacturer's certification.
3. Manufacturer's data.
4. Dimensioned fabrication drawings.
5. Storage instruction and requirements.
6. Operation and maintenance manuals.
7. Complete wiring and control diagrams, including power loads for operators.

1.3 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the

partial listing below:

1. NEC, National Electrical Code.
2. NEMA, National Electrical Manufacturers Association
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. AISI, American Iron and Steel Institute.
7. AGMA, American Gear Manufacturer's Association.
8. AFBMA, Anti-Friction Bearing Manufacturer's Association.
9. AWWA C561, Fabricated Gate Standard

B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 2 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

C. Should the gates not perform as required, the Contractor shall repair or replace any units as necessary to meet the Specifications. Costs for unit repair and retesting shall be the Contractor's responsibility.

1.4 QUALITY STANDARDS

A. The fabricated gates shall be furnished by a single manufacturer who shall assume full responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings. The Contractor shall assign unit responsibility to the gate equipment manufacturer for equipment specified in this Section. A certificate of unit responsibility shall be provided.

B. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:
1. Rodney Hunt Company
2. Waterman Industries, Inc.
3. Hydrogate
4. WACO
5. Golden Harvest
6. Or equal.

1.5 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only.

B. Specific information relative to the various gates including gate type, identification numbers, design head conditions, gate sizes, and mounting requirements is tabulated within the Table 1: Slide Gate Schedule attached at the end of this Section. All gates, including lift, shall be designed for the conditions shown, with a minimum safety factor of 5.

C. All gates shall be complete including all gates, guides, frames, bench stands, floor stands, baseplates, brackets, anchor bolts, stems, stem guides, operators, and all other necessary appurtenances.

D. Gate shall be stainless steel construction as required to meet the specified operating and design conditions. Materials shall be manufacturer's standard except as hereinafter modified or required.

2.2 SLIDE GATES

A. General:
   1. Gates shall be rising-stem type with guides designed to embed in the concrete or to mount to the face of the concrete, unless otherwise specified or indicated.
   2. Non-machined, submerged ferrous surfaces to be blast cleaned and painted with 2 shop coats of manufacturer’s standard epoxy paint.
   3. Materials for slide and guide frame to be minimum ¼” thick.

B. Guide Frames:
   1. General
      a. The frame and guide rails shall be machined on all bearing and contact surfaces.
      b. Frame and guides shall be designed for the maximum head indicated, with a minimum safety factor of 5 with respect to tensile, compressive and shear strength.
      c. Waterproofing material (grout, gasket etc.) must be certified as compatible for continuous emersion for intended service. Such material shall be a minimum of 1/8” thick.
      d. Guide frames shall be of 316 stainless steel, of the general shapes indicated on the

Drawings and on the Slide Gate Schedule.

e. The vertical guides shall be designed for maximum rigidity and shall extend in one continuous piece from the gate invert to form posts for support of the operator support yoke as required for the gate operators.

f. When guides extend above the operating floor they shall be sufficiently strong so that no further reinforcements are required.

g. Guides shall weigh not less than 9 pounds per linear foot and shall incorporate a replaceable extruded dense polyethylene bearing strip in an extruded retainer slot on both the upstream (seating head side) and the downstream side (unseating head side) of the gate.

h. Vertical guide frames and invert extrusions shall be joined with factory welded corners.

i. Guide slots shall be sized to provide a minimum disc engagement of 1 inch on each side.

j. Guides shall be of sufficient length to support two-thirds the height of the disc, when the gate is fully open. The self-contained gate shall have extended side guides to allow the gate to fully open, and guides shall be sufficiently strong so that no further reinforcing will be required.

C. Disc:

1. The disc plate (sliding member) shall be one-piece 316L stainless steel plate reinforced as required so that the disc will not deflect more than 1/360 of the gate span, when the upstream liquid depth (seating head side) is as shown on Slide Gate and Weir Gate Schedule and the downstream liquid depth is less than ½-inch.

2. Gate disc shall be reinforced with one-piece stainless-steel angles or channel type extrusions welded to the disc plate. Bolted reinforcements are not permitted. Reinforcing ribs shall be of the self-adjusting type required by AWWA C561.

D. Operator Support Yoke:

1. The yoke shall support the operator and shall be attached to the vertical extensions of the guide frames.

2. The yoke assembly shall be constructed from at least two 316L stainless steel angles, or two other suitable extruded shapes, and shall be bolted in place to provide a rigid assembly.

3. Maximum deflection of the yoke assembly shall not exceed ¼-inch under full operator applied loading.

E. Stems:

1. Lifting stems shall be one-piece Type 316 stainless steel, with a minimum diameter of 1-½ inches, and of ample cross-section to prevent distortion.

2. Portion of stem at operator end shall extend 2 inches above the operator when gate is in closed position.
3. Stems shall be sized so that the ratio of the unsupported stem length (L) to the radius of gyration (r), both in inches, shall not exceed 160.
4. Submit gate stem sizes for approval before manufacturing.
5. Stems shall be designed to withstand in compression, without damage, the thrust equal to at least 3 times the rated output of the hoisting mechanism, with a 40-pound effort applied to the handwheel or crank.
6. Where required, operating stems shall be equipped with cast iron, bushed stem guides, mounted on cast iron brackets. They shall be adjustable in two directions and shall be spaced so that the L/r ratio does not exceed 160.
7. All stems shall be furnished with adjustable stop collar for the CLOSED position.
8. Connect stems to the disc plate with an extruded aluminum yoke, bolted to the stem and welded to the disc.
9. Gates having a width greater than twice the height shall have dual stems.

F. Stem Covers
1. Each rising stem type gate shall be provided with a transparent plastic vented pipe stem cover and cap. Provide stem covers with OPEN/CLOSED designators with 1-inch graduations on clear mylar pressure sensitive, adhesive tape, suitable for outdoor application.

2.3 GATE OPERATORS

A. General:
1. Operators provided under this Section include geared and non-geared electric motor operators.
2. Operators shall meet AWWA Specification C501, except as otherwise specified, and shall be designated to meet the operating requirements specified in Table 1 Slide Gate Schedule.

B. Motor Operator:
1. Actuators shall be electric motor driven gear reducer with integral controls and thrust bearing.
2. Each motor operated gate shall include an electric gate actuating unit mounted on and assembled to the gate. The actuator shall be sized to open and close the gate at the operating pressure.
3. Each unit shall consist of a motor, reduction gearing, handwheel gearing, operating limit switches and torque limiting switches within one NEMA 4x rated enclosure. All valve actuators located outdoors shall have thermostatic strip heater to control condensation.
4. Each motor shall be high torque, totally enclosed in a NEMA 4x rated housing. The motor starting torque shall be equal to 2-½ times the running torque. The motor

shall have AIEE standard Class F insulation. The grease tight operation shall be assured by the use of dual motor shaft seals.

5. The gearing shall be combined helical/spur and worm gear type, accurately machined. Helical gears shall be alloy steel, hardened and ground. Gearing shall be grease lubricated, with high speed parts on antifriction bearings. An inspection plate on the housing shall be provided to allow inspection of the handwheel declutching mechanism, the motor gears, and for relubrication.
6. Each unit shall include a handwheel for manual operation of the valve drive sleeve through direct gearing. The handwheel shall not rotate during electrical operation. The motor shall not rotate during hand operation. In no case will the handwheel ever be connected with the motor. When the unit is being operated manually, it shall be automatically returned to the electric operation when the handwheel is released.
7. The transfer from electric to manual operation shall be accomplished by a declutching lever arm which will disengage the motor mechanically but not electrically. The unit shall be capable of being clutched or declutched when operated electrically with no damage to the clutch or gear mechanism.
8. The actuator shall operate on 480 volt, three phase power supply. All controls shall operate on 115 volt AC power and a control power transformer shall be provided within the unit as required.
9. The controls shall provide a reversing actuator, mechanical and electrical interlock, and thermal overload relays. The contactor shall break all lines to the motor.
10. Position limit switches shall be provided for both open and close positions of travel and shall be connected directly to the gate through continuous gearing and follow its position at all times. Mechanisms employing intermittent tooth gearing and rotary drive switches are not acceptable.
11. A double acting, adjustable torque limit switch shall be provided, capable of deleting excessive torque caused during seating, unseating, or obstructions. Torque control accuracy shall be within ± five percent.
12. Where indicated, the controls shall provide for local and remote operation. The local pushbutton control shall be provided with open, close pushbuttons, open and close indicator lights, local/remote selector switch. In "REMOTE" actuator shall accept a form "C" dry contact for OPEN/CLOSE operation. Actuators shall be provided with the following 5 Amp, 120VAC rated dry contacts for connection to SCADA system: OPEN; CLOSED; REMOTE; COMMON FAULT; and IN TRANSITION.
13. Motorized actuators shall be Limitorque L120 Series, EIM M/MG Series or equal

2.4 ACCESSORIES

A. All necessary supports, beams, attaching bolts, anchor bolts, mounting and assembly hardware shall be of Type 316 stainless steel and shall be designed and furnished by the gate manufacturer.

B. Support beams shall be fastened to the walls with corrosion resistant anchor bolts

specifically designed for this application. The anchor bolt design and frequency of anchor bolts recommended shall be sealed by a professional engineer licensed in any state that is governed by the National Council of Examiners for Engineering and Surveying.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insofar as practical, the gate assemblies shall be completely factory assembled, shipped as a unit, disassembled on site and installed in strict conformance with the manufacturer's recommendations. The parts and assemblies that are, of necessity shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final identification and assembly in the field.

B. All anchor bolts and necessary bolt setting plates shall be provided by the manufacturer. Two nuts shall be provided for each anchor bolt, and anchor bolts shall be cast-in-place during concrete placement, unless otherwise shown. Threads shall be protected and shall be cleaned before the nuts are attached and tightened.

C. All stainless-steel bolts shall be coated with an anti-galling compound before the nuts are attached and tightened.

D. All gates shall be thoroughly cleaned and shall operate without vibration or binding.

3.2 FIELD TESTS

A. Field leakage tests shall be performed as specified in Section 6 of AWWA C501. The maximum allowable leakage rate shall be 0.20 gallons per minute per foot of sealing perimeter for the seating and unseating heads specified

B. Field leakage tests shall be conducted with no head on one side of the gate being tested.

3.3 MANUFACTURERS' SERVICES

A. Manufacturers' services shall be provided in accordance with Section 01600, General Material and Equipment Requirements. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum days listed for the services hereinunder, travel time excluded:

1. 0.5 day for installation assistance, inspection, functional and performance testing, and certification of the installation.

Table 1: Slide Gate and Weir Gate Schedule

Tag No[1].	Width	Height	Invert Elevation	Mounting[2]	Head[3]	Opening Span[4]	Comments
11-SG-001A	8.5	10	730	Hybrid	45	22	Requires 30-minute-rated actuator
11-SG-001B	8.5	10	741	Channel	33	10	
11-SG-002A	8.5	10	730	Channel	45	22	(see above)
11-SG-002B	8.5	10	741	Channel	33	10	
11-SG-003A	8.5	10	730	Channel	45	22	(see above)
11-SG-003B	8.5	10	741	Channel	33	10	
11-SG-004A	8.5	10	730	Hybrid	45	22	(see above)
11-SG-004B	8.5	10	741	Channel	33	10	
11-SG-101	8.5	11	730	Channel	45	11	
11-SG-102	8.5	11	730	Channel	45	11	
11-SG-103	8.5	11	730	Channel	45	11	
11-SG-104	8.5	11	730	Channel	45	11	
11-SG-201	8	11	730	Hybrid	45	11	
11-SG-202	6	11	730	Face	45	11	
11-SG-203	8	11	730	Channel	45	11	

+ + + **END OF SECTION 11282** + + +

[1] Actuator tags to be labeled with prefix "CP-"; for example, "CP-11-SG-001".
[2] Gate shall be watertight at top, bottom and sides. "Hybrid" mounting configurations are in corners and must have half the frame embedded in its plane, and the other half face mounted.
[3] Based on operating at 100-yr flood water elevations; subject to change. Head intended here to be seating, unseating, and operating values. Head measured from **invert** of gate.
[4] Opening span equal to distance between elevations of bottom of gate when open and closed

SECTION 11316
SAMPLING PUMPS

PART 1 GENERAL

1.1 SCOPE AND REFERENCES

A. This section covers Sample Pump 11-SM-001. 11-SM-002 is covered under drawing E5-114.

B. The following is a list of standards which may be referenced in this Section:
   1. American Bearing Manufacturers' Association (ABMA).
   2. Hydraulic Institute Standards (HIS).
   3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
   4. Underwriters Laboratory (UL).

1.2 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Anchorage and bracing drawings and catalog information as required by Section 01600, General Material and Equipment Requirements.
      b. Make, model, weight, and horsepower of each equipment assembly.
      c. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
      d. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity.
      e. Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
      f. Power and control wiring diagrams, including terminals and numbers.
      g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
      h. Factory finish system data sheets.

B. Informational Submittals:
   1. Anchorage and bracing calculations as required by Section 01600, General Material and Equipment Requirements.
   2. Special shipping, storage and protection, and handling instructions.

3. Manufacturer's printed installation instructions.
4. Suggested spare parts list to maintain the equipment in service for a period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data: As specified in Section 01300, Submittals, Article Operating and Maintenance Manuals.

PART 2 PRODUCTS

2.1 GENERAL

A. Sample pump 11-SM-001 shall be Grundfos Redi-Flo2 Pump and Motor unit with Grundfos Environmental Variable Frequency Drive.

B. Pump shall be 2" well pump with ½" female NPT outlet. VFD can be connected to 120V or 230V electrical power supply.

C. Redi-Flo2 pump (MP1) motor shall be 0.5 hp, 220V, 3 phase, 400 Hz, 5.5 amp max draw.

D. Seal housing shall be Type 316 L stainless steel and shall position casing O-ring against the casing rim.

E. Pump shall provide with 1-1/4-inch NPT threaded suction connection and 1-inch NPT threaded discharge connection, casing rated for 175 psig working pressure.

F. Pump impeller shall use a semi open design with no front shroud. The impeller shall be Type 316 stainless steel and will be threaded to fit 56 J motor shafts with a front nut lock.

G. Motors: 1.5 hp, 115/230-volt single-phase, 60-Hz, two-pole. Single-phase motors have built in overload with auto reset.

H. Pump shall be supplied with a non-footed Type 316L stainless steel motor adapter.

I. Pumps shall be rated to pump 5 gallons per minute at 70 feet of head. Pump speed shall be 3500rpm.

J. Casing O-ring shall be Viton. Casing vent plug and drain plug shall be **ANSI** Type 316L stainless steel with Viton O-ring. Casing socket head screws shall be AISI 430 stainless steel. Motor bolts shall be plated steel. Deflector shall be BUNA.

K. Manufacturer: Goulds, or approved equal.

L. Equipment Tag Numbers:
1. 11-SM-001

M. Piping and Appurtenances: Yard piping to be 1½" Type K copper tubing routed as shown on the Drawings to tie in to existing sample line at Laboratory building. Ball valve and check valve immediately downstream of pump to be Milwaukee brand, threaded, with minimum pressure rating of 100 psi.

2.2 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

2.3 FACTORY FINISHING

A. Manufacturer's standard finish.

2.4 SOURCE QUALITY CONTROL

A. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Connect suction and discharge piping without imposing strain to pump flanges.

3.2 FINISHING

A. Sample pumps to be shop primed and epoxy coated at by the manufacturer.

3.3 FIELD QUALITY CONTROL

A. Functional Tests:
1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

+++END OF SECTION 11316+++

SECTION 11318
VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable pumping system which includes vertical turbine pumps, respective motors, and constant speed drive controllers.

B. Based on a qualification and cost selection process, FLOWSERVE was selected by the City of Atlanta for the procurement of the vertical turbine pumps for the Water Supply Program and shall provide all the vertical turbine pumps for this Project. All costs to provide, furnish, and install all vertical turbine pumps shall be included in the cost of this Project. Two of the selected pumps were previously procured under an ongoing construction project. Those two pumps are being deleted from the prior project and all costs to provide those pumps is being moved to this project. The City has negotiated with the pump vendor and the commercial terms of the prior procurement will be honored by FLOWSERVE and it's representative for all vertical turbine pumps to be procured for the River Intake Pump Station.

C. All components shall be installed, adjusted and tested by the Contractor in accordance with these Specifications, the Pump Manufacturer's recommendations and as shown on the Drawings.

D. Flow conditioning baskets fitted to the pump suction bells, as well as cones mounted to the floor under the pumps as shown on the Drawings, shall be furnished and installed under this specification.

D. The pumps shall be operated from a constant speed drive system with reduced voltage soft starters (RVSS) to be supplied under Section 16265. Constant speed drives and reduced voltage soft starters will be supplied by the pump supplier or pump manufacturer's authorized representative.

E. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Pump manufacturer shall supply all parts, devices, and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

F. The Base Bid for this project includes provision to provide three (3) vertical turbine pumps (including motors). A 4th pump, identical to the other three (3) provided under

this specification, may be required if the Owner decides to include the work the Optional Bid Item that allows for the installation of a 4th pump and 3rd screen.

Related Work Specified Elsewhere:

1. Division 1 General Requirements
2. GC – 28.6 Operation and Maintenance Manuals
3. Section 09900 Painting
4. Section 16270 Medium Voltage AC Induction Motors – Non-Submersible Type

1.2 SUBMITTALS

D. Submittals shall be made in accordance with the General Conditions and Special Conditions of the Contract Documents including GC – 28.6 Operation and Maintenance Manuals. In addition, the following specific information shall be provided:

1. Head-capacity-efficiency-power curves showing predicted performance for duty condition point specified in Table 11318-1.
2. Provide wire-to-water efficiency for duty condition in Table 11318-1.
3. Pump details and materials of construction, including flow conditioning baskets and cones.
4. Shaft stress, elongation/stretch, accumulated tolerance of couplings/connections, wear ring clearance during transient and steady state operation calculation and shown on Drawing of pump assembly to insure no wear ring interference throughout the pump operation.
5. Description and sketch of proposed test setup for factory test.
6. Certification of unit responsibility assignment specified in article 11318-1.04.
7. Calculations of critical speeds and mass elastic system analysis for pumps as specified in paragraph 11318-2.05B.
8. Certification of satisfactory testing of each unit as specified in article 11318-2.11, containing copies of test logs and resulting performance curves.
9. Manufacturer's certification that the pumping units are fully compatible for the services specified.
10. Manufacturer's certification that the pumping units will meet the vibration and critical speed limitations.
11. Installation and functional test certifications as required under Part 3 of this Section.
12. List of installation similar in size to each of the applications for which equipment is being supplied. Similar installations shall have equipment of comparable size, defined as being within 20% of the horsepower of the subject application. List shall include pump design capacity, horsepower of the driver, length from operating level to pump level, name of installation, name of purchasing entity and contact information.
13. Make, model, weight, and horsepower of each equipment assembly.
14. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

15. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
16. Pump maximum downthrust or upthrust in pounds.
17. Bearing selection calculation.
18. Lateral and torsional analysis indicating no resonance frequencies occurring inside the 120 percent above or below of the operating speed range.
19. Natural frequency separation analysis to confirm 150 percent or more separation between pumping equipment versus supporting floor structure to preclude resonance frequencies of the floor and or the equipment.
20. Pump anchor bolt calculations.
21. Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment. Detailed drawing of pump barrels, including column lengths.
22. Power and control wiring diagrams, including terminals and numbers.
23. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
24. Factory finish system.
25. List of reference installations.
26. Results of finite element analysis of discharge header and support plate and motor support components.

i. Quality Control Submittals:

1. Factory Functional, Mechanical and Performance Test Reports.
2. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Manual for all equipment provided under this Section.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State ordinances, as well as all applicable codes, standards, regulations, and regulatory agency requirements including the partial listing below:

1. AFBMA 9-90, Load Ratings and Fatigue Life for Ball Bearings.
2. AFBMA 11-90, Load Ratings and Fatigue Life for Roller Bearings.

3. ANSI A58.1-82, Minimum Design Loads for Buildings and Other Structures.
4. ASTM A36/A36M-89, Structural Steel.
5. ASTM A48-83, Grey Iron Castings.
6. ASTM A53-90, Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.
7. ASTM A276-90, Stainless and Heat-Resisting Steel Bars and Shapes>
8. ASTM A320/A320M-88, Alloy Steel Bolting Materials for Low-Temperature Service.
9. ASTM B584-90, Copper Alloy Sand Castings for General Applications.
10. Hydraulic Institute Standards, Standards of the Hydraulic Institute, Latest Edition.
11. NEMA ICS 2-88, Industrial Control Devices, Controllers and assemblies.
12. NEMA ICS 6-88, Enclosures for Industrial Controls and Systems.
13. ANSI/AWWA E103-07, Horizontal and Vertical Line-Shaft Pumps

1.04 QUALITY STANDARDS

A. Manufacturers shall submit a letter written and signed by the company senior officer stating that the equipment have been designed and manufactured to meet these specifications. Support calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

B. Equipment specified under this Specification shall be furnished as a complete set by the pump manufacturer who shall be required to select, purchase and coordinate the design of the complete equipment system, including the motor and constant speed drives controllers specified in 16265. A certificate of unit responsibility shall be provided.

C. The motor shall be specifically coordinated by the pump manufacturer for each application and supplied by the pump manufacturer or an authorized representative of the manufacturer. The Pump Manufacturer shall furnish certification, notarized and signed under penalty of perjury by officers of the respective motor manufacturing corporation, attesting to the mutual compatibility of their products for this service.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Equipment provided under this Section shall be shipped to the site of the work in suitable subassemblies in closed containers or protected from the elements by sealing all openings and covering the item in question with tarpaulins which shall be strapped to the item or otherwise held against displacement during movement. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt. Electronic components, control panels shall be in closed, sealed containers. All separate containers shall be clearly identified by equipment number and connecting points to matching subassemblies.

B. Rotors shall be disassembled from stators and bearings and housings shall be removed from shafts or, alternatively, rotors shall be wedged tightly to prevent peening during shipment.

C. Each separately manufactured component such as each motor control cabinet or pump subassembly shall be subject to special monitoring requirements during transport. The special monitoring requirements shall apply for each shipment, from the point of original manufacture to intermediate way points such as location for testing or incorporation into larger assemblies, as well as to the site of the work.

D. Upon arrival of each shipment, the Pump Manufacturer shall immediately notify the Engineer. Each assembly or subassembly shall be dismantled and inspected and tested for damage. All damage shall be corrected to the complete satisfaction of the Engineer before the assembly is incorporated into the work. The Pump Manufacturer shall bear all costs arising from dismantling, inspection, testing, and repair, and reassembly, even if no damage is found.

E. Pump manufacturer shall provide Installing Contractor printed directions for storage and maintenance of each piece of equipment within the scope of supply. Installing Contractor shall be responsible for proper storage and maintenance during storage.

F. The pumps and motors to be furnished and installed under this specification shall not be delivered to the site more than 30 calendar days prior to scheduled installation.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

B. The manufacturer shall provide warranty for a period of 24 months after Substantial Completion of the project, following equipment acceptance testing by the Owner or 36 months after delivery to the project site. The manufacturer shall guarantee that the equipment, products, or material furnished is suitable for the purpose specified and free from defects of design, material and workmanship for the duration of the warranty. In the event the equipment, products, or materials fails to perform as specified, the manufacturer shall promptly repair or replace the defective equipment, products, or material.

PART 2 - PRODUCTS

2.1 GENERAL

A. The pumping units furnished under this Section will be installed in the River Intake Pump Station (RIPS). The equipment will be used to pump raw water from the Chattahoochee River to the associated tunnel conveyance system as shown on the drawings. The RIPS pumps will be driven at constant speed and will be started by reduced voltage soft starters.

B. Each pump shall be the wet pit, vertical-shaft turbine column type with discharge from the pumping element flowing both radially and axially with the shaft. Pumps shall be

enclosed lineshaft, water lubricated. Each pump shall be driven by a vertical, high thrust motor and shall be a diffuser case design with a maximum specific speed of 5,400 (based on US gpm, ft.) at the pump head capacity curve's best efficiency point. Pumps supplied with thrust bearings integral to the discharge head shall not be accepted.

C. Each pump shall have not more than four stages. Pumps having more than four stages are not acceptable. Each stage shall have the same hydraulic characteristics and shall be interchangeable within the pump unit.

2.2 MATERIALS

Component	Material
Suction case, bowl assembly and discharge case	Cast iron, ASTM A48, Class 30
Impeller	Stainless A351 Gr CF3M 316LSS
Pump shaft	Stainless steel, ASTM A276, Type 416
Lineshaft	Stainless steel, ASTM A276, Type 416
Pump bearings	Bronze, ASTM B584
Pump column	Fabricated steel, ASTM A36
Lineshaft bearing	Bronze backed Rubber
Lineshaft Enclosing Tube	Stainless steel, ASTM A276, Type 316
Discharge head	Fabricated steel, ASTM A36
Bolts, studs, and nuts	Stainless steel, ASTM A276, Type 300
Impeller thrust ring	Stainless steel, ASTM A276, Type 416

A. Material employed for the construction of pumping units furnished under this specification shall be as tabulated below. Upon review of water quality information in subsequent paragraphs, manufacturer may recommend substitution materials in consultation with engineer.

B. Pump manufacturer shall review the water constituent information and submit recommended materials of construction to the Engineer for approval.

C. All wetted parts shall meet NSF 61 requirements as well as the requirements of the U.S. Safe Drinking Water Act.

2.3 SERVICE CONDITIONS

A. The pumps and motors shall be suitable for outdoor installation. Expected ambient

variables are as follows:

	Minimum	Maximum
Temperature ^{0} F	15	104
Relative Humidity %	20	95

B. The fluid to be pumped will be raw water from the Chattahoochee River. Pumps shall be suitable for long-term operation under the following conditions:

1.	Duty	Continuous
2.	Fluid temperature (degrees F)	36 to 82
3.	Fluid pH range	6.4 to 7.8
4.	Fluid specific gravity	1.0
5.	Fluid viscosity (absolute, centipoises at 60 °F)	1.14

D. Water constituent data. NOTE: Source water is likely to have varying amounts of grit, in addition to constituents tabulated below.

Constituen	Averag	Maximu
Total Hardness, mg/L	19.8	24.0
Conductivity, µs/cm	79.3	100.3
TDS, mg/L	33.7	87.3
Alkalinity, mg/L as CaCO3	19.3	22.7
Turbidity, NTU	10.14	75

2.4 PERFORMANCE REQUIREMENTS FOR PUMPS

A. The RIPS pumps will discharge through a common header.

B. The RIPS pumps will be operated at constant speed. NPSH margin shall be per HI Standards.

C. Pumping system vibration shall not exceed the acceptable field vibration limits given in the Standards of the Hydraulic Institute.

D. The pump head-capacity curve shall slope in one continuous curve with no points of reverse slope inflection capable of causing unstable operation at any pump operating point.

E. All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure. The complete pumping unit shall operate without overload on any component at any point along the pump's entire full-speed operating curve. Pumps shall not be started while in a reverse flow condition. Pump impeller shall not loosen up during flow reversal.

F. The pumps shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. Pumps shall be designed to operate at variable speed without cavitation or damaging vibration over the entire specified range of flow and head conditions.

2.5 OTHER REQUIREMENTS

A. The equipment shall conform to the following:

1. Pump discharge head shall be 36" diameter.

2. Pump drive equipment support plate shall be designed to carry the pump dead weight, operating loads and the load imposed upon the plate by the pump and drive equipment, a negative pressure under the plate equal to 4.5 feet of water plus a live load of 125 pounds per square foot while spanning an opening of sufficient dimension to allow the withdrawal of the complete pump.

B. The pumping unit, consisting of pump, couplings, motor, and all attached appurtenances including all support structures furnished with the pump, shall have no dangerous critical or resonant frequencies or multiples of resonant frequencies within 20 percent above or 20 percent below the speed range required by the pump to meet the specified operating conditions. In addition, the rotating system shall be analyzed for critical torsional stresses. For the purposes of design, a dangerous critical speed shall be defined as one which produces a torsional stress exceeding 25,000 psi. In addition, the rotating system shall be analyzed for critical torsional speeds. Torsional critical speeds should have +/-10% margin from excitation sources to avoid resonance of torsional critical speeds. If sufficient separation margin is not achieved, then a torsional forced response and fatigue analysis shall be performed to ensure that torsional stresses are below the endurance limit of the shaft material. If the endurance limit criteria is not met, then the shaft design shall be changed such that it meets the above criteria. The manufacturer shall be responsible for the analysis of critical speeds and the complete mass elastic system, which shall be analyzed and certified by a registered professional engineer regularly engaged in this type of work. Analysis shall be at least equal to the techniques developed by Holzer.

C. Manufacturer shall perform the following analyses:

1. 120 percent above and below ground lateral frequency analysis of the full pump and motor assembly using finite element modeling.

2. Stress and deflection analysis of the discharge head with maximum thrust loading applied using finite element analysis software

3. Stress analysis of flanged joints, lineshaft couplings and associated fasteners to confirm suitability of design to support additional static weight and hydraulic thrust in the application.

4. Torsional frequency analysis of the complete pump shaft , +line shaft,+ motor rotor assembly to determine torsional critical frequencies followed by fatigue analysis of shafting if interference points are found at the most common pump forcing frequencies .

5. Rotor lateral critical frequency analysis inclusive of the full pump structure using FEA to precisely determine critical speeds and bearing spacing.

6. Relative shaft stretch analysis to determine the relative displacement of the impeller in the bowl under operating loads.

7. Foundation load calculation for each pump.

8. Natural frequency separation analysis to confirm 150 percent or more separation between pumping equipment versus supporting floor structure to preclude resonance frequencies of the floor and or the equipment.

9. Shaft stress, elongation/stretch, accumulated tolerance of couplings/connections, wear ring clearance during transient and steady state operation calculation and shown on Drawing of pump assembly to insure no wear ring interference throughout the pump operation.

2.6 PUMP

A. All welded joints shall be the work of AWS-certified welders or ASME-certified welders according to ASME Section IX. Welded joints shall be full penetration welds, smooth and free from laps, splatter, gas pockets and skips. All welds shall be ground smooth.

B. The inlet bell shall provide conservative entrance velocities and direct the flow to the impeller. The inner surfaces of the bell shall be smooth and free of sharp projections or cavities which might cause turbulence or cavitation. A streamlined housing, centered and held in the bell by means of rigid vanes, shall be provided to properly direct the flow to the impeller. Dimensions of inlet bell shall be provided to Engineer for design of Werth style, inlet flow condition baskets which shall be fabricated and supplied by the pump

manufacturer.

C. The bowl shall be designed for a flanged, indexed fit to the inlet bell and discharge column to provide proper bearing alignment. The interior surfaces shall be smooth and free of sharp projections, transitions and cavities which might incite turbulence and undesirable vibration. The contours of the bowl shall be designed to closely match the shape of the impeller's vanes and to provide a smooth conversion of kinetic to potential energy. A bearing housing, centered in the bowl by rigid vanes shall be positioned immediately above the impeller to insure minimum shaft deflection at all conditions of service. The vanes shall be ported to permit the lineshaft tubing to drain to the sump.

D. The impeller shall be mounted on the shaft and statically and dynamically balanced prior to final assembly and shall be free of sharp projections, cavities or abrupt transitions which could encourage or incite cavitation or excessive turbulence. The impeller shall be of the semi-enclosed or closed type, with the shroud designed to rotate against wearing rings installed in the bowl assembly. The impeller shall be cast in one piece and shall be selected to provide a head-capacity curve that achieves the requirements of paragraph 11318-2.04D. The impeller shall be securely keyed to the shaft. Split rings and thrust collars shall be provided to prevent axial movement.

E. The suction case, bowl, and lower tube bearings shall be close tolerance, sleeve type. The suction case or inlet bowl bearing shall be water-lubricated.

F. Lineshafts shall be of ample size to operate without distortion in both the forward and reverse direction and shall have a first critical speed not less than 50 percent above maximum operating speed. Individual lengths shall be 10 feet maximum and shall be straight' within 0.005 inch total indicator reading per 10 feet. The pumps shall have a lineshaft enclosing tube to conduct water from the pump mechanical seal stuffing box through the lineshaft and upper bowl bearing and shall be vented through the bowl guide bearing to the sump.

G. Lineshaft bearings shall be bronze backed rubber bushings, retained in stainless steel. The bearings shall be lubricated by water injected under pressure through the tension nut assembly. Manufacturer to recommended duration of pre-lube prior to startup, as well as recommended flow rate and pressure of lubricating water. Lineshaft bearings shall be spaced a maximum of 10 feet apart and sufficient to place the shaft natural lateral frequency at least 150 percent (minimum) from any disturbing frequency resulting from operation at any speed.

H. Lineshaft enclosing tubes shall match the length of the pump column sections.

I. Lineshafts shall be turned and ground smooth, straight and true. The end of each lineshaft section shall be drilled and tapped for insertion of a lifting eye. Lineshaft couplings shall be a perfect butt- fit. They shall be designed with a safety factor of 1-1/2 times the shaft safety factor and shall have a keyed closure with coupling sleeve. Threaded couplings will

not be acceptable.

J. The discharge column shall be round in section, a minimum 0.375-inch wall thickness, and with a rated pressure of 150 psig.

1. Each section shall be fitted with lineshaft bearing housings held by rigid spiders. Each rigid spider shall have provision to attach the lineshaft enclosing tube.

2. A flanged joint with indexing alignment fits shall be provided at each bearing. The interior of the column shall be free of offsets, burrs, discontinuities and irregularities.

3. Each separate assembly shall have not less than three lifting eyes. Provide lugs on the column pipe for use with the column clamp assembly. Provide column clamp assembly sufficient for supporting the entire weight of the pumping unit, column pipe, and lineshaft (with enclosing tube if required).

4. Registered fit, flanged joints with O-ring seals, 10-foot maximum lengths, and fabricated integral, line-bored, line shaft bearing retainers.

K. The discharge head shall be of the above-ground discharge type with a shouldered end for use with grooved end pipe couplings. Discharge heads using flanged pipe connections will not be permitted. The discharge elbow shall be mitered to form a 90-degree transition with centerline radius equal to the pipe nominal diameter. A gutter shall be provided to collect leakage from the packing box and conduct it to drain to the pump sump.

L. The discharge head shall be provided with a subbase or base plate manufactured expressly for connection of the discharge head to the sole plate furnished with the pump. The base plate shall be designed to span an opening sufficient to remove the complete pump, including the bowl and inlet bell assembly. The base plate shall be milled flat after fabrication to provide continuous contact with the sole plate. The base plate shall have a thickness of no less than 2-1/2 inches.

M. The drive equipment support plate shall be designed with an airtight gasketed connection with the sole plate furnished with the pump. The support plate shall be designed to span an opening sufficient to remove the complete pump, including the bowl, and inlet bell assembly. The support plate shall be reinforced with box sections to provide sufficient strength to accommodate the specified loads. If necessary, the support plate shall be designed to be fabricated in two pieces for field assembly at the pumping station site. Mating faces shall be milled flat and shall be designed to prohibit leakage through the base plate to the pump discharge head. A dowelled or rabbeted fit shall be provided to assist in field assembly of the support plate. The support plate shall be milled flat after fabrication to provide continuous contact with the sole plate. The underside of the support plate shall be smooth and shall contain no pockets or crevices which could function as corrosion sites.

N. The drive unit support frame shall be fitted for precision alignment of the drive unit support frame with the pump rotor and bearings. The joint between the support plate and the support frame shall be milled flat, continuous and airtight. A gutter shall be provided to collect leakage from the packing box and conduct it to a tapped drain for connection to a drain pipe.

O. The sole plate shall be a heavy plate, milled flat after fabrication, designed to be cast into the concrete base and incorporating the features indicated. The soleplate shall be not less than 2-inches thick.

P. Anchor bolts shall be designed to be cast into the concrete curb and slab and shall be selected to resist the thrust developed by the pump, with no external restraints, with no more than half of the bolts bearing. The anchor bolt design and frequency of anchor bolts recommended shall be sealed by a professional engineer licensed in any state that is governed by the National Council of Examiners for Engineering and Surveying.

Q. Mechanical Seals:

1. Each pump shall contain a Chesterton 442 split mechanical seal suitable for the maximum operating pressure. All components of the seals shall be split in half including the elastomers, gland, rotary and stationary seal faces, and rotary holder. The non-shaft elastomers shall incorporate a ball and socket to provide easier handling during installation. No glue shall be applied to the elastomers. Mechanical seals shall be able to be installed outside of the stuffing box without any equipment disassembly required.

2. The seal shall be of the rotating, hydraulically balanced, O-ring type. Individual seal components shall be interchangeable. The seal design shall reduce heat generation and face wear and minimize power consumption. This seal design shall provide for positive pressure and vacuum without special configuration.

3. An external flushing water connection to the site utility water supply system shall be provided for cooling the seals. All required seal water piping, pressure reducing valves, flow switches, gauges, flow control valves, isolation valves, and backflow preventer shall be furnished by the installing contractor in accordance with Manufacturer's recommendations to meet appropriate flow and pressure requirements. Seal water piping shall be located so that it cannot be used as a foothold during maintenance.

4. The stationary seal face shall be mechanically loaded with multiple springs to ensure no leakage when the pump is shut off. The springs shall be isolated from the pumped water.

5. The seals shall be installable without sleeve or shaft replacement, even if the pump

was previously packed. A universal adjustable gland shall be provided. Two flush ports with standard NPT tapped connections shall be provided in the gland.

6. The rotary holder shall have a drive pin to ensure positive drive of rotating parts.

7. The seals shall be capable of sealing 200 psig.

8. Mechanical seal materials shall be as follows:

Rotating Seat	99.5 percent Alumina
Stationary Face	Pure unfilled P8412 carbon
Springs	AMS5876 (Elgiloy)
0-rings	Ball & Socket FKM (Viton)
Elastomers	FKM
Gland and Rotary Holder	Type 316 Stainless Steel

9. The seal gland shall have a connection to allow circulation from the seal chamber back to pump suction. The mechanical seal shall be contained in a cast-iron seal box with bronze shaft bearing.

R. Flow conditioning baskets shall be as prescribed by Clemson Engineering Hydraulics for all pumps.

S. The pump nameplate shall contain the following information:

1. Manufacturer.
2. Serial Number.
3. Model Number and Type.
4. Rated Flow in MGD, Head in feet, and Horsepower.
5. Specific Speed.
6. Rated Input Speed.
7. Lubricant Specification.
8. Equipment Number, as listed in this Section.

T. 100-ohm, platinum RTDs shall be provided for bearing temperature protection. Each detector shall have its leads wired to terminals in a separate terminal box and shall have its leads tagged indicating the winding or bearing monitored.

2.7 MOTOR

A. Motors for vertical turbine pumps shall be as specified in Section 16270.

2.8 ACCESS PLATFORM

A. Motor access platform, stairs, supports, floor grating, etc. shall be in accordance with the platforms shown on the Drawings and Specification Sections 05531 and 05600. Platforms shall incorporate removable sections as required to allow for installation, removal, and replacement of the pumps and motors.

2.9 SHOP PAINTING

A. Equipment shall have a shop applied prime coat compatible with the field coats conforming to Section 09900.

B. Interior of equipment, which cannot be painted in the field, shall be shop painted with the coating systems specified in Section 09900.

2.10 FACTORY TESTS

A. General:

1. Each pump system component shall be subjected to factory tests as specified in this paragraph. The Engineer shall have the option of witnessing the factory tests.

2. The Pump Manufacturer shall submit a sketch of the proposed test setup from each component manufacturer, along with a description of the proposed testing procedure to the Engineer for review at least 10 weeks in advance of the proposed testing date. No tests shall be performed until the test procedure has been reviewed and approved by the Engineer and comments, if any, have been furnished to the Pump Manufacturer. In addition, the Pump Manufacturer shall furnish the Engineer with at least 4 weeks advance written notice of the date and location of the performance tests.

3. The Pump Manufacturer shall provide for witnessing of the factory performance testing by two representatives of the Engineer and two representatives of the Owner and shall provide all transportation (economy class air fare), lodging, meals and miscellaneous expenses necessary for the Engineer's representatives to attend the factory performance tests.

4. Test results (both test logs and performance curves) shall be signed and certified correct by an officer of the manufacturing corporation. Certification by technicians alone will not be accepted. Certificates shall state the title of the certifying officer.

5. Upon completion of testing, test logs and curves for each component shall be provided to the Engineer as a submittal. The components shall not be shipped until authorized, in writing, by the Engineer. Final acceptance of the equipment will depend on satisfactory operation after installation at the project site.

6. Prior to shipping each component shall be cleaned and all oil used for testing

drained and replaced with new oil. Air filters shall be removed and replaced with unused filters. Paint damaged by testing shall be touched-up. All water used in bearings or cooling systems shall be drained.

B. Pumps:

1. Certified test reports shall be submitted for approval prior to shipment of the pumps. Tests shall be conducted on each pump with one of the motors being provided under this scope of supply. The test shall be sufficiently comprehensive to develop head, capacity, and efficiency for at least six (6) points on the pump's head capacity curve and shall confirm performance at the guaranteed performance condition for the pump and motor (Primary Rated condition in Table 1). Performance test acceptance criteria will be per ANSI/HI Level 1U with no minus tolerance on flow, head or efficiency. The test reports shall cover the following items:

   a. Capacity vs. head curve in U.S. gallons per minute and feet.

   b. Efficiency vs. flow curve in percent.

   c. Brake horsepower vs. flow curve.

   d. Speed of rotation.

   e. Impeller size and number.

   f. A table with a listing of a minimum of six (6) test points throughout the pump range including shut off, rated capacity, between shut off and 80% of rate capacity, 80% and 120% of rated capacity and run out. Show capacity, total head, BHP, efficiency, and speed. One impeller shall be tested during the model test for minimum submergence factory test.

2. Drives and controls shall be factory tested to demonstrate control logic for pump sequencing, fault conditions, and performance conditions at the drive manufacturer’s facility.

3. If the results of the factory tests fail to demonstrate compliance with the requirements of this Section, the Pump Manufacturer shall modify or replace the deficient pump(s) as necessary, at no additional cost to the Owner and shall resubmit certified factory test reports on each modified or replacement pump.

4. Upon completion of testing, curves shall be produced showing pump performance (head, efficiency, and power required versus capacity) at rated speed.

B. Efficiency Evaluation: An efficiency evaluation shall apply to each pump.

1. The factory test for each pump shall verify compliance with the minimum efficiency quoted and guaranteed at the design flow capacity and pump heads as specified.

2. If the factory test efficiencies of each pump individually show that any of the tested efficiencies is less than the corresponding required efficiency, the Owner may accept the pump equipment at a reduced price.

3. If the efficiency as determined by the factory test is more than 2 percent less than the required efficiency, the Owner may accept the pump at a reduced price as set forth above or may, at its discretion, reject the pump unit altogether.

4. For each full percent that the factory test efficiency is less than the corresponding required efficiency in this Article, the reduction in price shall be $30,000 for each unit that did not meet the specified efficiency. Test results shall be reported to the nearest one tenth percent, and each price reduction shall be calculated proportionately. Each pump shall be evaluated separately. No credit, payment or allowance shall be made for test efficiencies greater than the required efficiencies.

5. It is understood and agreed that the rate of reduction in price is fair and reasonable, and the benefit of such reduction shall be accepted by the Owner in lieu of non-compliance with the indicated efficiencies for the pumps.

2.11 SPARE PARTS

Spare parts to be provided, tagged and stored per Division 1 specifications for each size of pump shall be as follows:

1. One (1) suction bell lower bowl bearing.
2. One (1) set of upper bowl bearings.
3. One (1) set lineshaft bearing assemblies.
4. One (1) set of seals.
5. One (1) set of impellers and wear rings
6. One (1) set special tools required for maintenance.
7. One (1) Discharge head bearing

2.12 PRODUCT DATA

Product data, to be provided after completion of fabrication and testing, shall comprise:

1. Applicable operation and maintenance information for each item of equipment furnished.

2. Calculations of critical speeds and mass elastic system analysis for pumps. Calculations

shall be submitted to the Engineer and Owner prior to fabrication. If the calculations prove that a component did not pass the criteria, it must be corrected and reflected in the fabrication drawing(s).

3. Certification of satisfactory testing of each unit as specified in paragraph 11318-2.11, containing copies of test logs and resulting performance curves.

4. Manufacturer's certification that the pumping units and variable-speed control equipment are fully compatible for the services specified.

5. Manufacturer's certification that the pumping units will meet the vibration and critical speed limitations.

2.13 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material, minimum 1/8-inch-thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the Drawings. Signs shall be installed near guarded moving parts.

2.14 GAGE TAPS, TEST PLUGS AND GAGES

A. Gage taps shall be provided on the discharge sides of pumps. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Divisions 13 and 15, respectively.

2.15 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible location with stainless steel screws or drive pins.

2.16 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type recommended by the Pump Manufacturer and shall be products of the City's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the Pump Manufacturer’s approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the City with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All pumping equipment shall be installed by the Installing Contractor in accordance with the manufacturer's recommended installation procedures. Pump manufacturer shall provide printed instructions so that the pumps shall be aligned, connected, and installed at the locations specified and in accordance with the manufacturer's printed instructions. Installation work shall be performed by millwrights working under the direction of factory trained installation engineers. Installation by carpenters or laborers will not be allowed.

B. Pump manufacturer shall provide a certificate stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation and care of the unit.

C. Mount pumps and/or drivers on existing concrete bases as shown on the Drawings. The size of the concrete bases shall be as shown on the Drawings.

D. Install pumps with the shaft plumb. Level base by means of steel wedges (steel plates and steel shims). Wedge taper shall not be greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for the pump and/or driver base. Secure each pair of wedges in their final positions with one tack weld on each side after leveling is complete. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened. Install the pumps so that connection may be made to the discharge header without any springing or otherwise forcing either the pump or the header. Anchor bolt size and material shall be as recommended by the pump manufacturer. Coat bolt thread projections with lubricant to facilitate future nut removal. Provide double nuts to prevent accidental loosening. Bolts shall be accurately placed with templates.

E. Installing contractor shall adjust pump assemblies such that the driving units are properly aligned. Installing Contractor shall not compensate for misalignment by use of flexible couplings.

F. After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, non-shrinking grout of the proper category, prepared and installed in accordance with Section 03600, GROUT. The arrangement of the column shall be straight and vertical when the installation is complete. Grout thickness to be coordinated with manufacturer recommendations.

G. Contractor shall connect discharge piping without imposing strain to the pump flanges.

H. Pipe up external water flush lines as required for API Plan 32 schema, at manufacturer recommended flow and pressure. Installing contractor to provide valves, gages and any other appurtenances required to meet these conditions.

I. Any evidence of pump misalignment, noisy operation, or other signs of improper setting shall be corrected by the Installing Contractor. Care during storage, installation, and lubrication shall be in strict accordance with the manufacturer's recommendations.

3.2 PAINTING

A. Shop and field painting on all interior and exterior surfaces shall be in accordance with and as specified in Section 09900.

3.3 FIELD TESTS

A. Following installation, operating tests shall be performed to demonstrate to the Engineer that the pumps will function in a satisfactory manner. The Installing Contractor shall make, at Installing Contractor's expense, all necessary changes, modifications and/or adjustments required to ensure satisfactory operation.

B. Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage. Each control device, item or mechanical, electrical, and instrumentation equipment, and control circuits shall be considered in the testing procedures to demonstrate that the equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation. Functional test acceptance shall be certified as specified in Section 01600.

C. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Run pumps in the field witnessed by the manufacturer’s representative, Installing Contractor, and Engineer to verify operation under field conditions.

   a. Measure flow using the proposed water meter or weir after devices have been tested and calibrated.

   b. Measure pressure using calibrated pressure gauges to be supplied by the Installing Contractor. Calibration charts must be submitted to the Engineer by the Installing Contractor.

   c. Provide amperage, voltage, and power factor calibrated meter to be used to measure power input to the pump.

d. Acceptable Fluctuations in the Test Readings in accordance with Hydraulic Institute Standards.

e. Testing to be conducted at the design points specified in Table 1 and at shutoff.

f. Measure vibration at each test point:

i. Vibration levels shall be in accordance with the ANSI/HI-9.6.4-2009 standard for vibration.

ii. Measure vibration levels at the top of the discharge head in the axial, vertical and horizontal position.

iii. Field vibration levels will be 0.17 in/sec rms for operation within the preferred operating range and 0.22 in/sec rms for operation outside of the preferred operating range but within the allowable operating range.

g. All deficiencies to be corrected to the satisfaction of the Engineer.

h. Manufacturer's representative shall instruct plant personnel in operation, repair, and maintenance of the pumps.

i. Pumps will be accepted by the Owner after 5 days of operation (each pump). During the 5-day period, pumps will be monitored for cavitation, vibration, overheating, loss of capacity, and/or head. Each pump shall be operated and monitored separately. Any deficiencies are to be corrected to the satisfaction of the Engineer.

3. Operate pumps at rated speed and take flow, head, voltage, amperage, vibration, bearing and motor temperatures.

D. Performance Test: In accordance with Hydraulic Institute Standards. The performance shall be guaranteed by the factory performance test.

3.4 MANUFACTURERS' SERVICES

A. Furnish the services of a factory representative for two 8-hour days per pump during the installation phase of the equipment. The factory representative shall have full knowledge and experience in the installation of the type of equipment being installed.

1. Supervise installation
2. Check alignment and level and certify
3. Check pump/pipe strain and certify

B. Furnish the services of a factory representative, having complete knowledge of proper operation, startup procedure and maintenance requirements, for three 8-hour day per pump set, to inspect the final installation and supervise a test run of the equipment.

C. Furnish the services of a factory representative, having complete knowledge of the operational and maintenance requirements of the system, for one 8-hour day per pump set. The factory representative shall instruct the Owner's personnel in the proper operation of the equipment.

D. Furnish manufacturer's service agreement that provides the following:

1. The manufacturer agrees to provide visits by factory representative at 6- to 12-month intervals for a five-year period starting from successful startup of the equipment in order to perform operation and maintenance services for the Owner's units. The visits will be announced with a minimum of 3 weeks of notice. The date will be agreed with the Owner.

2. The service includes the completion of any required reports, at all intervals required to maintain compliance with Owner's rules and permit requirements. The service activities will be provided and completed in accordance with manufacturer's terms and conditions and the present contract.

3. Specific activities shall be provided in the service agreement and should at a minimum include the following:
   a. Determine if de-installation of the pump is needed.
   b. Inspect the installation and other components for water tight seals (pipes, elbow etc.).
   c. Review any floats/switches, controls and electrical components in the system for correct operation and functionality.
   d. Inspect the pump duties for proper operation, pressure, and flow.
   e. Inspect any additional system components which have been added.
   f. Record pump cycles, flow, and all other relevant information or system problems.
   g. Issue a report and summarize the service performed, note any conditions which may require additional attention, document any corrections made and any recommendations.
   h. Provide the Owner with a copy of all notes and readings.
   i. Supervise de-installation and loading for shipment to service center. j. Supervise unloading and re-installation.
   j. Check alignment and level and certify.
   k. Check pump/pipe strain and certify.

TABLE 11318-1

VERTICAL TURBINE PUMP
SCHEDULE*

Tag ID:	11-PU-001, 11-PU-002, and 11-PU-003
Duty flow, mgd:	40
Duty head, ft:	125
Discharge diameter, in	36
Pump Support elevation (FFE), ft-msl:	778
Minimum Water Surface Elevation, ft-msl:	732
Maximum Water Surface Elevation ft-msl:	773
Best Efficiency Point:	To the right of duty point
Floor penetration diameter, in:	56

*If elected, the 4th pump provided shall be identical to the other 3 as described above

+++ END OF SECTION 11318 +++

SECTION 11500
TRANSIT TIME FLOW METERS

PART 1 – GENERAL

1.01 SCOPE

Contractor to supply all labor, equipment and materials to furnish and install an ultrasonic, transit time metering device as indicated on the Contract Drawings and as specified herein.

1.02 SUBMITTALS

A. Submittals shall be provided the following items as per Specification 01600:
   1. Materials list of a complete installation including meter, transducers, wiring connections, etc.
   2. Dimensioned drawings and schematics of a complete installation.
   3. Manufacturer's catalog data for the meter, transducers, and all other parts to be provided.
   4. Operation and maintenance manual meeting the requirements of Specification 11500.1.04.
   5. Manufacturer's certification of proper installation and inspection report.

1.03 QUALITY ASSURANCE

A. Manufacturers shall have supplied ultrasonic, transit time meters, similar to the unit specified for this project, that are in satisfactory service for the past two years under similar operating conditions. All equipment hereinafter specified will be considered as components of a single operating unit. The Contractor shall be held fully accountable and responsible for the adequacy and proper operation of each component provided, regardless of original source or manufacturer.

B. Contractor shall retain a factory-trained manufacturer's field representative with demonstrated ability and experience in installation, testing, and operation of instrumentation and control systems. The manufacturer's representative shall perform the following listed services, as applicable:

   1. Supervise installation of equipment.
   2. Test, calibrate and adjust all components of the equipment.
   3. Inspect the completed installation, prepare an inspection report, and certify proper installation.
   4. Instruct Owner's and Contractor's personnel in calibrating, testing, operating and maintaining the equipment as required

1.04 OPERATIONS AND MAINTENANCE MANUALS

A. Provide three (3) bound sets of operation and maintenance (O&M) manuals at the time equipment is delivered to the site.

B. Include in the O&M manual the following types of information on each Control System component and item of equipment:

1. Approved shop drawings.
2. Product information.
3. Installation instructions.
4. Operating procedures.
5. Shut-down procedures.
6. Safety instructions.
7. Calibration instructions.
8. Maintenance and repair instructions.
9. Recommended spare parts list.
10. Special tools list (if any).
11. Name, address and phone number of supplier's local representative.

1.05 PRODUCT DELIVERY AND STORAGE

A. Package all equipment and materials at the factory to protect each item from damage during shipment and storage.

B. Protect painted surfaces against impact, abrasion, discoloration and other damage.

C. Protect equipment and materials stored at the site from the weather, moisture, corrosive liquids and gases, dust and other agents that could cause damage.

PART 2 - PRODUCTS

2.01. Ultrasonic Transit Time Flow Meter

A. Meter Components:

1. General: The metering system shall generally consist of a spool piece of same material and size (48”) as surrounding piping, ultrasonic transducers, a wall mounted processing and display unit, and all other parts and incidentals required to install a complete and functioning ultrasonic transit time flow meter. The metering system shall meet the following requirements:
   a. Fluid to be metered: Raw Water
   b. Fluid temperature: 35° F to 85°F

c. Pressure rating: 250 psi
d. Flow range: See Table 1, Section 11500.3.B
e. Accuracy: ±0.5%

2. Spool Piece: The spool piece shall be provided by the flow meter manufacturer and shall be flanged end spool piece with welded boss assemblies. The spool piece shall be DIP in accordance with Section 02665.

3. Ultrasonic Transducers: The ultrasonic transducers shall mount through radial holes in the spool piece pipe wall. The transducer assembly shall be watertight, rated for 150 psi, 32 deg. F to 120 deg. F and have a sealed acoustic window that allows for transducer replacement while the spool piece is under pressure. Eight transducer assemblies shall be installed in the spool piece to create four chordal ultrasonic paths. Size, type, and location of the transducer installations shall be in accordance with the flow meter manufacturer's recommendations.

4. Wall Mounted Processing and Display Unit: The unit shall consist of power supply, processing units, display, outputs, all necessary software and cabinets to control and process the signals from the transducers. The unit shall have a key pad and display to allow the operator to interface for normal operation and troubleshooting. The display shall show flow rate in million gallons per day (mgd) and system status messages. The unit shall provide a 4 to 20 mA flow signal, and signal alarm set points, contacts, and fault contact for reporting system failures. The unit shall be in a rack suitable for a wall-mounted enclosure as shown on the plans.

5. Miscellaneous Equipment: The Owner shall be provided with all miscellaneous and/or special tools required to perform periodic maintenance of the system, including but not limited to, installing and removing transducer assemblies, all interconnecting cable from the wall mounted processing and display unit to the transducers and junction boxes required for connections at the transducers.

6. Manufacturer:
   a. The wall mounted processing and display unit shall be Model 7700;
   b. The transducer assemblies shall be Model 8510+;
   c. Manufacturer shall be ADS Environmental, Inc. or approved equal.

PART 3 – EXECUTION

3.01 Installation

A. The Contractor shall obtain the services of a manufacturer's trained technician to install the metering system and to the place the equipment in operation with the proper calibration settings. The manufacturer's trained technician shall provide a minimum of

two days of on-site training to the Owner's personnel in the installation, use, and maintenance of all aspects of the metering system.

B. The metering system shall be installed in complete compliance with the manufacturer's recommendations.

Table 1: Flow Meter Schedule

Tag ID	Pipe Size, in	Min Flow, mgd	Max Flow, mgd
10-FM-001	48	6.5	65
11-FM-001	48	40	120
11-FM-002	48	40	120

+++END OF SECTION+++

SECTION 13000
INSTRUMENTATION, CONTROL AND MONITORING SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 SCOPE

A. The Instrumentation, Control, and Monitoring System (ICM) consists of new panel work, modification of existing panels, modification to the existing HMI system, field components and system communication links. The ICM should be provided by one of the following System Integrators:

- MR Systems, Inc.
- Southern Flow
- Control Instruments, Inc. (C2i)
- Revere Controls.

or equal meeting the qualifications of paragraph 1.09.

B. This Section covers the general requirements for furnishing and installing all instrumentation, control and monitoring (ICM) systems complete in every detail for the purposes specified and shall form a part of all other Sections of Division 13 unless otherwise specified. Other Sections of this Division shall supplement this Section as necessary.

1. Work Included

Furnish all tools, equipment, materials, and supplies and perform all labor required to complete the furnishing and installation of, validation, start-up and operational testing of a complete and operable Instrumentation, Control and Monitoring System as indicated on the Drawings and as specified herein.

Provide all the necessary equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to insure that the City receives a completely integrated and operational ICM as herein specified.

2. Work Not Included

Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, air compressors, main air supply headers, and miscellaneous mechanical work as specified in other Divisions.

Electrical power distribution and signal wiring specifically included under Division 16, circuit protection devices, power conduit and wiring indicated, local equipment control stations, and miscellaneous electrical requirements as specified in Division

16.

D. System Responsibility

1. Each Section in this Division shall be provided by a competent, qualified company with ten years minimum experience successfully performing similar work of a similar scope. System installation, including calibration, validation, start‑up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have ten years minimum experience successfully performing similar installations. The System shall be integrated using the latest, most modern proven design.

2. The Contractor may subcontract the work under this Division to qualified Suppliers, but this shall not relieve the Contractor from any responsibility under the Contract.

3. The Contractor shall be responsible for the correct installation of all hardware and systems specified in this Division and shall assure system uniformity, subsystem compatibility and coordination of all system interfaces, submittals, documentation, testing and training.

4. The Contractor shall determine that all components of each section are completely compatible with other required equipment, including the DCS, and shall function as outlined, and the Contractor shall furnish and install such additional equipment, accessories, etc. as are necessary to meet these objectives at no additional cost to the City.

E. Contract Drawings

1. Information on the Drawings

The following information relative to the work of this Division is indicated on the Contract Drawings.

a) Location of all primary elements, cabinets, and final control elements.

b) Instrumentation signal and power conduit runs between control panels and field instruments and devices.

c) Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.

d) Major instrument conduit runs.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be

provided:

B. GENERAL

1. Presubmittal Conference

Arrange a conference between the Supplier of each Section, Contractor, and the Engineer within thirty (30) days after award of the Contract for the purpose of informally discussing in detail and verifying the correctness of the Contractor's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by the Supplier's Engineer, and duly authorized representatives of the Contractor and the Engineer.

2. Draft Submittal

Prepare a draft of the submittal for review. The draft shall include the following, as a minimum:

a) Listing of major items proposed for this Division. Identify items by tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing of the published specifications for the item specified and for the item proposed. Equivalent items shall only be accepted by the City if the specified item is no longer manufactured.

b) Shop Drawings. Before proceeding with any manufacturing, submit Shop Drawings for approval in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Schematics shall be complete with tag and terminal numbers. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing all equipment and tag numbers on all panels. Include material specifications lists where applicable. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

Provide five (5) copies of the following submittals:

1. Catalog Cuts

Catalog information, descriptive literature, wiring diagrams, and shop drawings shall

be provided for all devices, whether electrical or mechanical, furnished under this section. This includes, but is not limited to, primary elements, transmitters, analytical equipment, gauges, valves, controllers, indicators, power supplies, switches, lights, relays, timers, etc.

2. Component Data Sheets

Data sheets, specification sheets, and an instrument list shall be provided for all components provided under this section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., complete part numbers, scales, ranges, service, materials of construction, component location, options, and the individual tag number as noted in the Drawings and Specifications.

Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item may be included on a sheet.

3. Sizing Calculations

Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all differential pressure flow elements and shall include the actual scaling factors and units used.

4. Panel Construction Drawings

a) Shop Drawings and Catalog Cuts

Provide detailed shop drawings and catalog cuts for all panels, instrument racks, and enclosures. Drawings shall show the location of all front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show all major dimensions as well as elevations, in inches from the base up, of all rows of components.

The panel legend shall list and identify all front of panel devices by their assigned tag numbers, all nameplate inscriptions, service legends, and annunciator inscriptions.

The bill of materials shall include all devices including those mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.

5. Panel Wiring Diagrams

Wiring diagrams shall be similar to those diagrams shown in the Contract Drawings,

but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, etc.

Provide complete terminal identification of all external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.

All external wiring that the electrical contractor must provide and wire shall be shown as a dotted line. Special cables that are provided with the instrument shall be clearly identified.

Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show all circuits individually; no common diagrams shall be allowed.

Provide panel power wiring diagrams for all panels. The diagrams shall include all grounding requirements.

6. Interconnecting Wiring Diagrams

   Diagrams shall show all component and Termination Cabinet identification numbers and external wire, fiber, and cable numbers. This diagram shall be coordinated with the Electrical Supplier and shall bear his mark showing that this has been done.

7. Loop Diagrams

   Provide an individual wiring diagram for each analog loop showing all terminal numbers, the location of the DC power supply, signal polarity, the location of any dropping resistors, surge protection, shielding, grounding, etc. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:

   Each loop diagram shall be divided into areas for identification of device locations (e.g. panel face, back-of-panel, field, etc.). Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11-inch by 17-inch Drawings.

8. Instrument Installation Details

   The ICM Supplier shall review the Contract Documents and develop and submit for review, complete installation details for each field mounted device and panel prior to shipment and installation. Common details, not requiring any modification, may be referenced by an index showing the complete instrument tag number, service, location, and device description. Installation details shall be provided as required to adequately define the installation of the ICM components.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Operational Field Acceptance Test Documentation

   The ICM Supplier shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

   After approval of the examples, the ICM Supplier shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active I & C element (except simple hand switches, lights, etc). These sheets shall be submitted after the tests are completed.

   a) Instrument Calibration Sheets

      Provide a written report to the Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include all applicable data as listed below plus any defects noted, correction action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items:

      Facility identification (Name, location, etc.)
      Loop identification (Name or function)
      Equipment tag and serial numbers.
      Scale Ranges and units.
      Test mode or type of test.
      Input values or settings.
      Expected outputs and tolerances
      Actual readings at 10, 50, and 90 percent of span.
      Explanations or special notes as applicable.
      Date, time, and weather.
      Tester's certification with name and signature.

2. Functional Acceptance Test Documentation

   The ICM Supplier shall prepare two types of test procedures and forms as follows.

   a) Loop Test Documentation

      For functions that can be demonstrated on a loop-by-loop basis, the form shall include:

      1) Project Name
      2) Loop number
      3) Loop description
      4) Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.
      5) For each component: tag number, description, manufacturer, and data

sheet number.

6) Space for sign off and date by the Contractor, the ICM Supplier, and the Engineer.

b) Functional Test Documentation

For those functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
Specification page and paragraph of function demonstrated
Description of Function
Test procedure description
Space after each specific test to facilitate signoff on completion of each test.

1.03 TESTING

A. Factory Testing

1. Unwitnessed Factory Testing

a. Prior to the arrival of the Engineer, each panel shall have been completely tested by the manufacturers personnel. Provide report certifying the control panels are operable and meet the Specifications. If upon arrival of the Engineer, the panel(s)tests have not been performed, the Contractor may be liable for back charges for any extra time required by the Engineers services. The necessary panel tests shall be repeated in the presence of the Engineer; the Engineer, shall have the right to check all test observations. The ICM Supplier shall demonstrate, on a spot check basis, that the results of the unwitnessed Factory Tests are accurate. As a minimum, tests shall verify the following:

1) Location of interface wires on terminal blocks.
2) Function of discrete panel components

2. Witnessed Factory Testing

a. Inspection and test of materials and equipment may be made by the Engineer (or his representative) at the place of manufacturer prior to shipment, to verify that the completed control panel(s) meets the requirements of the specifications. Shipment shall not be made until receipt of written approval from the Engineer after satisfactory completion of shop tests.

b. The manufacturer furnishing materials, equipment and labor for the fabrication of the panel(s) shall afford the necessary facilities for such shop inspection and tests. The Contractor shall give the Engineer written notice three (3) weeks prior to the estimated date when the equipment will be ready for the inspection and witnessed shop test.

c. Sufficient time, ample space and necessary assistance shall be provided by the manufacturer to assure inspection and testing to the satisfaction of the Engineer.

d. The ICM Supplier shall furnish all power, labor, materials, and properly calibrated instruments required for the shop tests.

e. The Engineer reserves the right to reject defective materials, poor workmanship and items that do not function in accordance with the requirements of the specifications.

f. The ICM Supplier shall maintain approved copies of all design and testing related submittals at the site of testing for reference.

B. Operational Field Acceptance Testing

1. Installation Supervision

a. Furnish the services of authorized factory personnel specially trained and experienced in the installation of the equipment to: (1) supervise the installation in accordance with the approved Instruction Manual; (2) be present when the instruments and equipment are first put into operation; (3) inspect, check, adjust as necessary, and approve the installation; (4) calibrate the instruments, in accordance with the Specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable.

2. Instrument Calibration

a. Provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration. Each instrument shall be calibrated at 10 percent, 50 percent and 90 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 10 times greater than the specified accuracy of the instrument being calibrated.

b. Provide a list and basic specifications for instruments used for calibration.

3. System Validation

a. Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output.

b. Validate each system by simulating inputs at the first element in loop (i.e.

sensor) of 10 percent, 50 percent and 90 percent of span, or on/off and verifying other loop devices. During system validation, make provisional settings on levels, alarms, etc. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. Verify that all logic sequences operate in accordance with the specifications.

c. Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation. Test equipment for this function shall be as specified under "Instrument Calibration."

d. Immediately correct all defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.

e. Provide a report certifying completion of validation of each instrument system. This report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices. Data sheets shall be similar to those used for calibration.

4. Contractor's Certified Reports

a. Upon completion of all testing, the Contractor, or his authorized representative, shall submit a certified report for each control panel and associated field instruments certifying that the equipment (1) had been properly installed under his supervision, (2) is in accurate calibration, (3) was placed in operation in his presence, (4) has been checked, inspected, calibrated, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactorily, and (6) is fully covered under the terms of the guarantee.

C. Functional Acceptance Testing

1. Upon completion of instrument calibration and system validation, test all systems under actual process conditions in the presence of the Engineer. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems. This testing shall include, but not be limited to, all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and/or mechanical equipment.

2. Testing shall be observed by the Engineer. Notify the Engineer in writing a minimum of 14 days prior to the proposed date for commencing the test. Upon completion of this test the Contractor shall begin or have begun system start-up. Engineer reserves the right to set the schedule.

3. Submit for approval not later than 30 days prior to the functional acceptance test demonstration, a written plan for demonstrating that each system of equipment provided under Division 13 meets the specified operational requirements.

4. The plan shall detail procedures to be used in functional acceptance testing of all systems. The plan shall including a description of test methods and materials utilized for testing each system.

5. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing.

6. Submit three copies of test results and records for all functional acceptance tests.

7. Upon completion of functional acceptance testing, submit certified report, with substantiating data sheets, indicating that total ICM System meets all the functional requirements specified herein. The Engineer will countersign this report and it shall constitute final acceptance of the ICM System.

D. System Commissioning Assistance

1. Provide the services of a factory trained and field experienced instrumentation engineer to assist City's personnel during startup of the system. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

E. Final Acceptance

1. Approved completion of the following shall constitute Final Acceptance of the ICM System.

a. Certified Functional testing Report countersigned by the Engineer.
b. Final Documentation.
c. Spares and expendables delivery.
d. Training.

1.04 OPERATION & MAINTENANCE MANUALS

A. Furnish six (6) sets of Instruction Manuals and Part Lists for instrumentation equipment provided under Division 13. Obtain distribution method instructions from the Engineer.

B. Schedule

1. Deliver two (2) copies of manuals not later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to Engineer.

B. Material Content

1. Include in the manuals not less than the following applicable information for each instrument, equipment, subsystem and/or control loop. The O&M Manuals shall

consist of, at least, the following material:

a. Bill of Materials

1) A listing of all the panels, racks, instruments, components, and devices supplied. The list may be similar to the Instrument List in the Supplements. All components shall be grouped by component type, with the component types identified in a similar manner to the component identification code used in these specifications. The list shall contain, as a minimum:

Instrument, panel, rack or device tag number
Description
Quantity supplied
Reference to component data sheet and/or catalog cut
Component type

b. Component Data Sheets

See 1.02 B.2 specified herein before.

c. Catalog Cuts

See 1.02 B.1 specified herein before.

d. Component O&M Manuals

An O&M manual shall be submitted for all instruments and devices supplied. The O&M manuals shall contain, as a minimum:

Operating procedures
Installation procedures
Maintenance procedures
Troubleshooting procedures
Calibration procedures
Internal device schematics and wiring diagrams
Shut-down procedures
Component parts list
Detailed circuit operational description including programmable controller ladder diagrams.

e. Spare Parts and Expendables List

The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.

f. "As-Shipped" Drawings

1) Drawings shall be a record of work "As-Shipped" from the factory and shall be labeled as "As-Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As-Shipped" drawings as a minimum:

Panel Fabrication Drawings.
Panel Wiring, Loop, and Interconnection Drawings.

1.05 FINAL "AS-INSTALLED" DOCUMENTATION

A. Reproducible Drawings

1. Contractor shall submit one (1) set of reproducible's of complete schematics, wiring diagrams and installation drawings to include all installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "AS-INSTALLED". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.

2. Loop Diagrams

See 1.02 C.7 specified herein before.

3. Panel Fabrication and Wiring diagrams

See 1.02 C.4 and 1.02 C.5 specified herein before.

4. Interconnecting Wiring Diagrams

See 1.02 C.6 specified herein before.

5. Instrument Installation Details

See 1.02 C.8 herein before.

B. Process and Instrumentation Diagrams

1. The Engineer will supply the ICM Supplier with one set of the P&ID's for revisions to reflect the final installed system to be updated by the ICM Supplier. The ICM Supplier may use these drawings for producing the final documentation.

C. Software Documentation

1. In addition to the reproducible hard copy of drawings and literature generated specifically for the project, one (1) set of 3.5 inch, 1.44 meg capacity diskettes shall

be submitted to the Engineer with a copy of all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc using computer assisted drawing (CAD). Drawing format shall be "AutoCAD Release 11". Diskettes shall be clearly identified by the following:

a) Project Name
b) Volume Number
c) Software Program Name and Version used to generate the files.

d) Labeled "AS-INSTALLED"

1.06 TRAINING REQUIREMENTS

A. General

1. Provide the services of a factory trained and field experienced instrumentation engineer to conduct group training of City's designated personnel in the operation of each instrument system. Obtain Engineer's written consent that the training has been adequate. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands on" operation. The text for this training shall be the P & ID's, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.

2. Duration

a. Training specific to the system hardware. This training shall be for a minimum time period of two (2) days, one day of which may be performed during the operational testing period.

C. Maintenance Training

1. Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments. Manufacturer trained instruction shall be given for the following:

a) Level Element, Submersible
b) Level Element and Transmitter, Radar
c) Level Element and Transmitter, Ultrasonic

1.07 POST-CONTRACT SYSTEM SUPPORT

A. Maintenance Contract

1. Duration

a. Provide a 1 year maintenance contract for all components furnished.

2. The ICM integrator must be located within 50 miles of site and be able to respond on-site to emergencies within 2 hours. The ICM integrator must have a dedicated service group of at least 3 field engineers based out of the Atlanta area.

3. Schedule

a. Develop a program of preventive maintenance visits that includes verification of instrument performance on a monthly basis and complete calibration of instruments on a semi-annual basis. After every visit, submit to the Engineer records of instrument verification and calibration on appropriate forms. For clarification the ICM integrator will include 12 site visits after substantial completion.

1.08 GUARANTEE AND WARRANTEES

A. Guarantee all work of Division 13 in accordance with the Conditions of Contract and Division 1. With respect to instruments and equipment, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by City misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to Engineer with City named as beneficiary.

1.09 ICM INTEGRATOR QUALIFICATIONS

A. The ICM integrator shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. The ICM integrator shall be Control Instruments, Inc. (C2i), MR Systems, Inc., Southern Flow, Polytron, Revere Controls or equal meeting the qualifications below. For the purposes of this Specification Section, a “systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:

B. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience.

C. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the PCSI.

D. The system integrator must have completed at least 3 water/wastewater treatment

projects of at least 1 million dollars each. One of the projects must be a water/wastewater treatment plant of at least 2 million dollars.

E. Has been actively engaged in the type of work specified in this Specification Section for a minimum of ten years.

F. The ICM integrator shall maintain a permanent, fully staffed and equipped service facility within 50 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSI shall be capable of responding to site within 2 hours of notice.

G. PCSI shall hold a valid UL-508 and UL-698 certification for their panel fabrication facility (Must have their own in house production facility).

H. The ICM integrator shall be GE Solution Partner.

PART 2 - PRODUCTS

2.01 HARDWARE REQUIREMENTS

A. Job Conditions

1. Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to overcome structural interferences. Verify dimensions and conditions at the place of work, and install materials and equipment in the available spaces.

B. Materials and Standard Specifications

1. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities; i.e., all instruments in the plant, supplied by the Contractor, of the same type shall be by the same manufacturer. This allows the stocking of the minimum number of spare parts.

C. Product Delivery, Storage, and Handling

1. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

D. Mountings

1. Mount and install equipment as indicated. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with supplier's recommendation. Where mounted in control panels, mount according to manufacturer recommendations.

2. Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor higher than five (5) feet above walkways, platforms, catwalks, etc. All such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in NEMA 4X cases unless otherwise noted.

E. Instrument Identification

1. All components provided under this section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

2. Nameplates for panels and panel mounted equipment shall be as specified under Section 13200, Panels.

3. Field mounted tags shall be 16-gauge, 304 stainless steel with 3/16 inch high characters.

4. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gage stainless steel wire.

5. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In all cases the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

F. Electronic Equipment

1. If the equipment is electronic in nature, provide solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppressor directly to the instrument, the arrestor shall be so mounted.

G. Equipment Operating Conditions

1. All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:

2. Power.
   a. Electrical. 110 Vac +/- 10%, 60 Hz +/-1 Hz except where specifically stated otherwise on the drawings or in the specifications.

3. Field Instruments:

   a. Outdoor Areas:
   Ambient Temperature: 0°C to +50°C
   Ambient Relative Humidity: 5% to 100%
   Weather: Rain, wind, sun and blowing sand.
   Provide, as necessary, enclosures, and sunshields, etc. to assure normal operations under these conditions.

   b. Indoor Environmentally Uncontrolled Areas:
   Ambient Temperature: -15°C to +50°C
   Ambient Relative Humidity: 5% to 80%

   c. Indoor Environmentally Controlled Areas:
   Ambient Temperature: 0°C to +50°C
   Ambient Relative Humidity: 5% to 60%

H. Power Supplies

1. Provide electrical instruments and control devices for operation on 110 Vac, 60 Hz current.

2. Output overvoltage and overcurrent protective devices shall be provided for DC power supplies to protect instruments from damage due to power supply failure and to power supply from damage due to external failure. Power supplies shall be provided with NEMA 1 enclosures. Power supplies shall be mounted such that dissipated heat does not adversely affect other components. Source of operating power shall be 110 Vac, 60 Hz commercial power. Units shall be mounted within the control panels.

I. Signal Isolators, Converters and Conditioners

1. Insure that input-output signals of all instruments and control devices (whether furnished by the Contractor or not) are compatible. Analog signals between field and panels shall be 4 to 20 mA dc unless specifically approved otherwise. Granting such approval does not relieve the Contractor from the compatibility requirement above.

Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

J. Auxiliary Contacts by Others

1. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

K. Painting

1. Provide factory paint for all instruments and equipment except where in pipelines. Provide paint as required in Division 9 for non-stainless steel structural supports, brackets, etc.

L. Electrical

1. The construction work shall include all the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Division 16.

2. Wiring installations shall include cables, conductors, terminals, connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the work of other Divisions.

3. Provide the materials and complete all the required installations for equipment grounding as specified in Division 16 of these Specifications and indicated on the Electrical Drawings.

4. Incidental items not specifically included in the Contract Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Contractor at no additional cost to the City.

5. Field Wiring. For wiring materials, refer to Division 16 and Details on the Electrical Drawings. Ring out signal wiring prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type heat shrink or equal for each termination.

M. Process Connections

1. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be Type 316 stainless steel. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of

the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under Section 15060, Piping and Appurtenances, but coordinated by this Division.

N. Electrical Transient Protection

1. All instrument and control equipment mounted outside of protective structures (field mounted equipment) or that have interconnecting lines from outside the protective structure shall be equipped with suitable surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Both power and signal circuits shall be protected with surge and transient protectors installed at the source and destination ends of the circuits. Protective devices used on 120V ac inputs to field mounted equipment shall be secondary valve surge protectors conforming to the requirements of IEEE Standard 28-1972 (ANSI C62.1-1971).

2. Surge and transient protectors shall be grounded according to Division 16, ELECTRICAL.

3. Field 4 wire surge protectors are to be Edco SLAC-12036 in NEMA 4X polycarbonate enclosure. Field 2 wire surge protector are to be Edco SS64-036-1

O. Spares and Maintenance Materials

1. Furnish the following items as specified herein. Deliver to Engineer, as directed, with itemized list in a letter of transmittal accompanying each shipment.

2. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.

3. One Fuse of each size and type for every five used but no less than five of each type.

4. One Relay of each type for every five used but no less than two of each type.

5. One Panel Indicating Light Bulb for every five used but no less than four of each type.

6. One Transient Protector for every five used but no less than four of each type.

+++ END OF SECTION 13000 +++

SECTION 13100
INSTRUMENTATION, CONTROL AND MONITORING SYSTEM
LOOP DESCRIPTIONS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements specified in the General and Special Conditions of Contract and Divisions 1, 11, 13, 15, and 16 form a part of this Section. It is the intent of this Section to also supplement where applicable, other Sections of Division 13. It is the intent of this Section to briefly describe each main system in order that the ICM Subcontractor, as well as suppliers of packaged systems and subsystems shall be aware of the magnitude of the total ICM System. Certain systems described are supplied as package systems furnished under other divisions or by the City and are so identified. Interfacing with these systems is a part of the work of this Division.

1.02 INSTRUMENTATION AND CONTROL PHILOSOPHY

A. The instrumentation and control equipment for the River Intake Pump Station, as described herein, is based on providing sufficient measurement, indication and/or automatic control to enable process operation within the design criteria. Automatic control loops are specified only where necessary and include manual bypass control options. Adequate monitoring equipment is specified to permit complete process operational management and evaluation and for operator protection. In general, automatic controls are confined to level, time, water quality, flow and where necessary, quality type controls. Other more sophisticated controls may be included in some packaged systems of mechanical equipment.

1. Automatic Motor Control

   Except when specifically described otherwise, all motors specified for automatic operation shall be provided with Hand-Off-Auto (H-O-A) selector switches. In the Hand position, the motor shall operate continuously and automatic interlock if any, shall be by-passed. In the Off position, the motor shall be stopped. The Auto position, operation of the motor shall be dependent on the status of the output contact of the control circuit to be described for the individual equipment.

2. Alarm Processing

Alarms shall be hardware and software generated. When an alarm is detected, the alarm status shall be indicated on the local operator interface. In addition, external alarm horn will be sounded locally when the operations mode needs to be changed. All alarms shall be automatically retransmitted to the Central Control and Monitoring System where the condition will be logged and the operator alerted. Provisions shall be provided to allow the alarms to be acknowledged locally or remotely.

Unless otherwise noted, all external generated alarms shall be activated upon the opening of the contact.

3. Auxiliary Contacts

Unless otherwise noted, all contact driven inputs and outputs shall be of the dry isolated SPDT relay type.

1.03 PROCESS INSTRUMENTATION, CONTROL & MONITORING FUNCTIONS.

A. The overall function of the Instrumentation, Control, and Monitoring System shall be to provide an efficient control and monitoring interface between plant operations and treatment processes by presenting visual and audible information of plant operating parameters, equipment status and wear, and alarm conditions. It provides automatic control of critical parameters or parameters which would require frequent operator attention. The system shall provide means for manual override operation of any automatic function when required and shall permit control of the operation of motors and valves that are pertinent to satisfactory process performance. Control and monitoring shall be accomplished locally or remotely by the Central Control and Monitoring System. The system shall provide the following described functions in accordance with the process and instrumentation diagrams ("I"-Drawings).

B. Included herein are functional descriptions of the process instrumentation and control systems which specify the responsibility of the Process Instrumentation, Control & Monitoring System Supplier. These descriptions are to supplement the Process and Instrumentation Drawings and neither is complete without the other. If the ICM Subcontractor requires devices other than shown on the Drawings and/or specified herein to achieve the result required by the system description, provide these devices to obtain the required result.

C. The intent of these Specifications is to secure systems that have 4-20 mA dc analog signals between control panels and field devices throughout the plant except where specified otherwise.

D. The system descriptions herein cover all processes in general even though no specific ICM work is required in a given system. These descriptions are provided

for completeness and to indicate the relationship of the ICM work to other divisions. Where specific functions are described as to be performed under the Division 13, Electrical, they shall be as binding upon the Contractor as if written in the Electrical Division Sections.

1.04 SYSTEM DESIGNATIONS

A. To provide for drawing simplicity, when identical process equipment loops are shown, only the last unit is generally shown in detail with the third digit of the loop number representing the last process equipment unit. The descriptions herein shall also only discuss the last unit in detail; previous equipment is understood to be identical in function.

+++ END OF SECTION 13100+++

SECTION 13130
POWER SUPPLY AND CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of power supply and conditioning equipment required to support the instrumentation and communication systems. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents, drawings, information and technical data for all equipment as required in Section 13000 and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

1. Wiring diagrams.

1.03 QUALITY ASSURANCE

A. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

C. References:

1. References are listed in Section 13000. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

1.05 PLANT ELECTRICAL SUPPLY SYSTEM

A. Electric power for instrumentation and communication systems shall be obtained from the power distribution system specified in Division 16. This power is not regulated, wave forms may be distorted, and significant amounts of electrical noise may be present. All power supply and conditioning equipment necessary to provide electrical power at the required voltages and current capacities, and of adequate quality to ensure reliable operation of the instrumentation and communication systems shall be provided. Unless otherwise specified, the power supply required for the instrumentation systems shall be 120 volts plus or minus 15 percent, 60 hertz plus or minus 3 hertz, 5 percent maximum harmonic distortion.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded.

2.02 NOISE-SUPPRESSION ISOLATION TRANSFORMERS

A. Isolation transformers shall be provided for AC powered instrumentation loads containing solid state circuitry where electrical isolation is not included within the instrument. Isolation transformers shall be of the triple box shield type. Each coil shall be completely enclosed in a grounded conductive faraday shield, and the overall transformer enclosed in a faraday shield. Common mode noise attenuation between primary and secondary shall exceed 140 dB at 1.0 kHz. Isolation transformer dielectric strength shall be 2500 volts minimum.

B. Isolation transformers serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Isolation transformers serving individual instruments shall have a load capacity not less than 125 percent of the connected load.

C. Power loss in the isolation transformer shall not exceed 2.0 percent of the maximum load rating. Harmonic distortion introduced by the isolation transformer shall not exceed 0.1 percent. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Isolation transformers shall be Topaz series or equal.

2.03 DIRECT-CURRENT POWER SUPPLIES

A. Direct-current supplies for bulk 24-volt nominal instrumentation power shall be convection-cooled switching type. Line regulation shall be 0.4 percent for line variations from 105 to 132 volts, and load regulation shall be 0.4 percent for load variations from 0 to full load. Ripple and noise shall not exceed 100 mV peak-to-peak. Hold-up time at maximum load shall be not less than 16 milliseconds. Efficiency shall be better than 70 percent. Power supply shall be rated for continuous duty from 0 to 50 degrees C at rated load. Output shall be electronically current limited, and overvoltage crowbar shutdown shall be provided. Power supply output voltage shall be rated 28 volts DC, adjustable plus or minus 5 percent, and shall be set to provide 26.4 volts on the panel direct current bus. Each PLC based control panel shall have dual power supplies with a redundant diode module. Each power supply shall be equipped with 120VAC, 5 Amp rated "DC OK" dry contact for connection to the SCADA system. Power supplies shall be Lambda LJA series or approved equal.

2.04 SURGE PROTECTION

A. Surge arresters and capacitors shall be provided on the primary winding of isolation transformers supplying power to solid state systems. Surge protectors shall be mounted in a separate, NEMA 1 enclosure adjacent to the transformer and the incoming line passed through this enclosure. Surge arresters shall be General Electric 9L15EC or equal. Surge capacitors shall be General Electric 9L18B, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions unless otherwise specified. Line side disconnect switches shall be provided for power supply and conditioning equipment. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70. Disconnect switches shall comply with Section 16440. Power supply and conditioning equipment not designed for exposed mounting shall be housed in panels in compliance with Section 13110.

B. Small Equipment:

1. Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.

C. Large Equipment:

1. Power supply and conditioning equipment larger than 5 kVA load capacity supported from surfaces other than concrete shall be provided with sound isolators. Final raceway connections shall be a flexible conduit in compliance with Section 16111.

3.02 TESTING

A. Testing shall be in accordance with paragraph 13000-3.02.

+++ END OF SECTION 13130 +++

SECTION 13200
GENERAL REQUIREMENTS FOR
PROCESS INSTRUMENTATION SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. This section specifies general requirements which are applicable to all process instrumentation systems consisting of process sensors, monitoring and control instruments, and accessories required to provide a complete and functional monitoring and control system.

B. Work Included:

1. The Contractor shall provide, calibrate, and test the complete process instrumentation system. The Contractor shall also place the completed system in operation including tuning loops and make final adjustments to instruments as required during plant start-up. The Contractor shall provide the services of instrument technicians for testing and adjustment activities.
2. The Contractor shall examine the mechanical drawings and specifications to determine actual locations, sizes, materials and ratings of process connections.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. Drawings, information and technical data for all equipment as required in Section 13000 and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

1. Data sheets for all instruments and accessories to be provided. Data sheets shall be in accordance with ISA S20. All applicable entries on the data sheet shall be completed.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

D. References:

1. References are listed in Section 13000. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

PART 2 - PRODUCTS

2.01 INSTRUMENT SCHEDULE – Not used; all relevant data shown on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Installation shall be in accordance with Section 13000, this section, subsequent sections of this division, and as shown on the drawings.

B. Electrical Power Wiring:

1. Electrical power wiring shall be in accordance with paragraph 13000-3.01.

C. Signal Wiring:

1. Signal wiring shall be in accordance with paragraph 13000-3.01.

D. Process Connections:

1. Process connections shall be in accordance with paragraph 13211-3.01.

E. Tubing:

1. Tubing shall be installed in accordance with paragraph 13211-3.01.

F. Signal Transmission:

1. Signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Milliampere signals from field shall be converted to a 1 to 5 volt signal by dropping across a 0.1%, 250 ohm, 1/2 watt resistor at the external terminals of each panel. All instruments within the panel shall be parallel wired. Measurement loops shall be grounded at external terminals by bonding to the instrument panel signal ground bus. Isolating amplifiers for field equipment possessing a grounded input or output shall be provided.
2. High frequency (greater than 1 kHz) pulse rate signals from field transmitters shall be converted to DC voltage signals at the panel.
3. Platinum resistance temperature detector (RTD) outputs shall be carried to the control panel and converted to a dc voltage signal unless otherwise specified or shown.
4. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the instrument schedule, paragraph 3.03 of this section. When transmitters with non-standard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.

5. Two wire equipment located in hazardous areas shall be made safe for the specified conditions by use of equipment and barriers approved by Underwriters Laboratories, Inc. (UL), Canadian Standards Association (CSA), or Factory Mutual (FM).

3.02 TESTS AND INSPECTIONS

A. General Requirements:

1. Materials, equipment, and construction included under this specification shall be inspected in accordance with the procedures set forth in the General and Special Conditions sections of the Contract Documents, Section 13000, and this section. Testing shall be performed in accordance with Section 13000, this section, and subsequent sections of this division.

B. Installed Tests and Inspection:

1. Test Reports: Test reports shall conform to the requirements of reference forms 13000-A through 13000-K included in paragraph 3.02C of this Section.
2. Test Equipment: Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Each test instrument shall be calibrated prior to the commencement of a testing activity and at the completion of a testing activity. Certified calibration reports traceable to the National Bureau of Standards shall

be included with the test report. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.

3. Testing Stages:

   a. General: Each instrument loop shall be tested in the following sequence:

Testing sequence	Form reference
Wiring	Section 01600
Individual components	Section 01600
Individual loops	Section 01600
Loop commissioning	Section 01600

Testing of piping and wiring and individual components shall be completed with certified test reports provided to the Engineer prior to commencement of individual loop testing, which shall be completed with certified test reports provided to the Engineer prior to commencement of loop commissioning.

   b. Individual Component Calibration and Test: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test report form. Alarm trips, control trips, and switches shall be set to initial values specified in paragraph 3.03 of this section at this time. Final elements shall be checked for range, dead band, and speed of response.

Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

   c. Loop Test: Each instrument loop shall be tested as an integrated system. This test shall check operation from transmitter to readout components. Signals shall be injected at the signal connection to primary measuring elements.

If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly

   d. Closed Loop Commissioning Test: Commissioning test shall demonstrate stable operation of the loop under actual plant operating conditions. This test shall include adjustment of loop tuning parameters.

Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide

1/4 amplitude damping unless otherwise specified. A chart recording showing loop response to a step disturbance shall be provided for each loop. Two charts shall be made for cascade loops, one showing the secondary loop response with its set point on manual, and the second showing overall loop response. Each control loop with "batch" feature shall be adjusted to provide optimum response following start-up from an integral action saturation condition. Chart recording shall be provided showing this response. Chart recordings shall be made at sufficient speed and amplitude to clearly show 1/4 amplitude damping and shall be annotated to show loop number and title, and settings of parameters and set point.

+++ END OF SECTION 13200 +++

SECTION 13211
PROCESS TAPS AND PRIMARY ELEMENTS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of instrumentation elements which form a part of the process control systems specified in Section 13200. Application requirements are specified in the instrument schedule, paragraph 13200-3.03. All instrumentation elements shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Operating Requirements:

1. The devices specified in this section quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. In accordance with paragraph 13000-1.04 F, record documentation shall include the data sheets specified in paragraph 13200-1.04 B.

1.03 QUALITY ASSURANCE

A. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

C. References:

1. References are listed in Section 13000. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. Specific requirements for instruments included in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

2.02 VALVES

A. Isolation Valves:

1. Valves shall be full port ball valves with ASTM A276, 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Whitey series 40, Hoke Flowmite, or equal.

B. Gauge Valves:

2. Gauge valves shall be globe or angle pattern units machined from ASTM A276 bar stock and shall be provided with two 1/2-inch NPT ports. Valves shall be Anderson, Greenwood & Company M9 series, Hoke 2100 series, or equal. Valve material shall be compatible with that of the gauge

C. Root Valves:

1. Root valves shall be ASTM A276, type 316 stainless steel bar stock with ½-inch NPT male process connection and three ½-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM

A276, type 316 stainless steel bleed valve. ASTM276, type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5A VS-44, Hoke 6802L8Y, or equal.

D. Manifolds:

1. Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from ASTM, type 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, _-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4T VS, HEX 8123F8Y, or equal.

2.03 TUBING AND TUBING FITTINGS

A. Instrument tubing between the process connection and instruments shall be ½-inch x 0.035-inch seamless annealed ASTM A269 type 316 stainless steel.

B. Tubing fittings shall be type 316 stainless steel and shall be the double-ferrule swage type. Flare, ball sleeve compression or single-ferrule swage type are not acceptable. Fittings shall be Crawford "Swagelok", Hoke "Gyrolok", or equal.

2.04 CHEMICAL SEALS

A. Diaphragm:

1. Seal shall be the diaphragm type with flushing connection, type 316 stainless steel body and type 316L diaphragm unless otherwise specified. Fill fluid shall be DC200 silicone oil unless otherwise specified. Seal shall be Mansfield and Green type SG, Ashcroft type 101, or equal.

B. Annular:

1. Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 PSIG with not more than 5-inch WC hysteresis. Fill fluid shall be DC200 silicone oil unless otherwise specified. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or equal.

2.05 BUSHINGS AND THERMOWELLS

A. Bushings or thermowells shall comply with SAMA PMC13-10. Temperature taps shall be 1 inch NPT, and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be brass unless otherwise specified. To ensure proper fit, thermowells shall be provided by the same supplier as the instrument or device to be installed therein.

2.06 PURGE ASSEMBLIES

A. Air:

1. Air purge assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 SCFH rotameter. Assembly shall be Moore Products 62VA, Fischer & Porter 10A3137N-3BR2110, or equal.

B. Water:

1. Water purge assembly shall consist of a strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter. Assembly shall be Moore Products 63BD4A, Fischer & Porter 10A3137N-53BR2110, or equal. Strainer shall be 155 micron wye-type, ASCO 8600A2, Crane, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

B. Process Connections:

1. Unless otherwise specified, process taps shall comply with API RP550. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

C. Tubing:

1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least _-inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening. Ends of tubing shall be square-cut and deburred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:

1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 3 feet in accordance with paragraph 13000-3.01.

3.02 TESTING

A. General:

1. General requirements for testing of primary elements specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

B. Process Connections:

1. Process connection piping and tubing shall be tested in accordance with Division 15.

3.03 Instruspec Sheets (starts on next page)

3.03.1 INSTRUMENT SPECIFICATION SHEET-INSTRUSPEC

Instrument Identification LW	
Instrument Function	Liquid level measurement accessory
Instrument Description	Stilling Well
Power Supply:	N/A
Signal Input	N/A

Signal Output	N/A
Process Connection	N/A
Product Data	Stilling well shall be installed in wet wells to protect level measurement devices and to provide a dampened measurement medium. Stilling wells shall be continuous over the range of the measurement device the stilling well is being installed for and a minimum of 3 inches below the end of the measurement device. Stilling wells shall be constructed of SCH 80 PVC pipe cut in half lengthwise. Well shall be attached to the wet well wall by the means of 1/8 inch by 1 inch 316 stainless steel straps anchored to the wet well wall. Straps shall be anchored by 1/2 inch by 3 inch concrete anchor bolts. Straps shall be installed no less than 6 feet on center and no fewer than 3 on each well. The stilling well shall be connected to the strap by 1/4-inch diameter by 3/4-inch long, 316 stainless steel bolts. Bolts shall be no more than 6 inches apart with a minimum of 2 per strap. Minimum radii to specified in paragraph 13200-3.03.
Instrument Identification	LW (continued)
Wet Wells	Stilling wells to be installed in all wet wells shall have an end cap with flow holes. End caps shall be solvent weld attached to the pipe before the pipe is cut. One row of holes shall be drilled directly above the cap but not to direct flow of liquid directly at the measurement instrument. Holes shall be 3/4 inch diameter, one at least every 4 inches on center and one 3/4 inch hole on the bottom for complete drainage.
Execution	
Installation	Stilling wells shall be installed in the location shown on the drawings.
Test	N/A
Approved Manufacturers	N/A

3.03.2 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification PG	
Instrument Function	Pressure Measurement
Instrument Description	Pressure Gauge
Power Supply	N/A
Signal Input	N/A
Signal Output	N/A
Process Connection	½-inch male NPT
Product Data	Pressure gauges shall be 4-½-inch glycerine-filled, solid-front units with phenolic turret cases, bourdon tube elements, 270-degree milled stainless steel movements, and shatterproof glass windows. Bourdon tube shall be bronze unless otherwise specified. Gauges shall be manufactured to Grade 2A accuracy (+0.5%) in compliance with ANSI specification B40.1. Gauges shall be provided with a porous metal type snubber unless otherwise specified. Snubber material shall be compatible with that of the gauge.
Execution	
Installation	Install in accordance with manufacturer's instructions, the recommendations of API RP550, paragraph 13200-3.01, and the specified functional requirements. Pressure gauges may be supported from the process tap if this location permits observation from the floor or a permanent work platform. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Ashcroft Figure 1279, U.S. Gauge Figure 1980L, or equal.

3.03.3 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification TMI	
Instrument Function	Temperature Measurement
Instrument Description	Bi-metal temperature indicator
Power Supply	N/A
Signal Input	Process
Signal Output	N/A
Process Connection	½-inch male NPT
Product Data	Temperature indicators shall be operated by the expansion or contraction of a bimetallic element. Temperature indicators shall be hermetically sealed, with an external zero adjuster. Case, ring, and stem material shall be type 304 stainless steel. Dial shall be 5 inch, 270-degree movement, with an acrylic window. Scale shall be marked at least every 2 degrees F. Major scale divisions shall be at 10 degree F. intervals and scale shall be numerically noted at 20 degree F. intervals. Dial angle shall be adjustable over a 90 degree arch with respect to the stem. Stem length shall not exceed 4 inches and diameter shall not exceed 1/4 inch unless otherwise specified. Accuracy shall be plus or minus 1 percent of span, or better.
Execution	
Installation	Install in thermowells specified in paragraph 2.05 of this section in accordance with the manufacturer's instructions, paragraph 13200-3.01, the recommendations of API RP550, and the specified functional requirements. For pipelines less than 4-inch diameter, thermowell shall be installed in a pipeline elbow if possible. Where elbow is not available, a wye fitting shall be installed in the pipeline for installation of the thermowell at a 45-degree angle with the flow.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Ashcroft Model 50EI42E, or equal.

3.03.4 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification TRE	
Instrument Function	Temperature Measurement
Instrument Description	Resistance temperature element (RTD), insertion type
Power Supply	N/A
Signal Input	N/A
Signal Output	RTD
Process Connection	½-inch male NPT
Product Data	Element shall be a 100-ohms nominal at 0 degree C, tip-sensitive, three-wire, platinum RTD in a 1/4-inch ASTM A269, type 316 stainless steel sheath with watertight connection head. Time constant in agitated water shall not exceed 6.0 seconds. RTD shall comply with PMC5-10 and PMC21-4, curve PR278. Error shall not exceed the greater of 0.5 degrees F and 0.5 percent of reading. RTDs for installation in wells shall be provided with a spring loading device and union coupler. RTD extension cable shall be No. 16 AWG triads as specified in Section 16120.
Execution	
Installation	Install in thermowells specified in paragraph 2.05 of this section in accordance with the manufacturer's instructions, paragraph 13200-3.01, the recommendations of API RP550, and the specified functional requirements. Union couplers shall be provided so that the element may be removed without turning. For pipelines less than 4-inch diameter, thermowell shall be installed in a pipeline elbow if possible. Where elbow is not available, a wye fitting shall be installed in the pipeline for installation of the thermowell at a 45-degree angle with the flow.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.

3.03.5 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification FS	
Instrument Function	Flow Switch
Instrument Description	Thermal type
Power Supply	N/A
Signal Input	N/A
Signal Output	Contact
Process Connection	3/4-inch NPT with a standard "U" length suitable for mounting in a 3/4-inch threaded tee. The unit shall be designed to mount in horizontal piping in a side-mounted configuration.
Product Data	Thermal flow switch, liquid service only. Contacts: SPDT 5 amp resistive at 120 VAC. Response Time: Unit shall guarantee less than 10 seconds response time for the line sizes, flow rates and other conditions as installed in this application. Materials of Construction a. Wetted Parts: 316 stainless steel. b. Electronics Enclosure: Cast aluminum with epoxy coating, suitable for outdoor service.
Execution	
Installation	Provide rigid mounting for thermal flow switches. Weight of switch shall not be supported by the pipe on which the flow switch is mounted.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	FCI, STI or approved equal.

+++ END OF SECTION 13211 +++

SECTION 13216
PROCESS SWITCHES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of process activated switches which form a part of the process control systems specified in Section 13200. Application requirements are specified in the instrument schedule, paragraph 13200-3.03. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. drawings, information and technical data for all equipment as required in Section 13000 and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

1. In accordance with paragraph 13000-1.04 F, record documentation shall include the data sheets specified in paragraph 13200-1.04 B.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

D. References:

1. References are listed in Section 13000. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, switches shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm.

2. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment.

3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC.

4. Contacts monitored by electro-magnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300.

5. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.

6. Switch electrical enclosures shall be rated NEMA 250, type 4 minimum.

7. Contacts in Class 1, Division 1 and Class 1, Division 2 areas shall be made safe by suitable intrinsic safety barriers or relays as specified in paragraph 2.02 of this section.

8. Switch range shall be selected so that the specified set point is at least 30 percent, but not more than 70 percent of the span between the upper range limit and the lower range limit.

2.02 INTRINSIC SAFETY BARRIERS AND RELAYS

A. Intrinsic safety barriers for process switches shall be dual type; Cooper MTL 787, Panalarm 201-BR2, or equal. Intrinsic safety relays shall be Gems, Square-D, Warrick, or equal.

2.03 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. Specific requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General requirements for installation of instruments specified in this section are given on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.02 TESTING

A. General requirements for testing of instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.03 INSTRUSPEC SHEETS (starts on the next page)

3.03.1 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	LFS
Instrument Function	Level measurement
Instrument Description	Float switch, free-floating
Power Supply	N/A
Signal Input	Process
Signal Output	Contacts in accordance with paragraph 2.01 of this section
Process Connection	N/A
Product Data	Switch shall be free-floating type, suspended from a PVC-coated, multi-core connecting cable which also contains the conductors. The float shall contain mercury switches and shall be foam-filled, hermetically sealed and PVC coated.
Execution	
Installation	Install in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Kari, Enviroquip series 2900, Anchor Scientific, or equal.

3.03.2 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	PS
Instrument Function	Pressure measurement
Instrument Description	Pressure switch
Power Supply	N/A
Signal Input	Process
Signal Output	Contacts in accordance with paragraph 2.01 of this section
Process Connection	¼-inch female NPT
Product Data	Pressure switches shall consist of a pressure transducer and precision switches. Pressure transducer shall be the diaphragm or bellows type with wetted materials as recommended by the switch manufacturer, or as specified in paragraph 13200-3.03. Differential pressure transducer shall be provided when specified in paragraph 13200-3.03. The range spring and piston shall be isolated from process fluids by the diaphragm or bellows. Switch housing shall be cast aluminum rated NEMA type 4 with 3/4-inch conduit connections unless otherwise specified. Approximate set point and, if applicable, reset point shall be indicated on calibrated scales. Repeatability and sensitivity shall be 1.0 percent of operating range or better. Unless otherwise specified, switches shall be non-adjustable dead-band, automatic reset type. Unless otherwise specified, two independently adjustable, SPDT switches shall be provided in each unit. In the case of manual reset, or low range switches (80 inches WC or less) only one SPDT switch is required.
Execution	
Installation	Install in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Ranges greater than 80 inches WC: United Electric Series H402, or equal. Ranges 80 inches WC or less: United Electric Series H400, or equal.

3.03.3 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	TS
Instrument Function	Temperature measurement
Instrument Description	Temperature switch
Power Supply	N/A
Signal Input	Process
Signal Output	Contacts in accordance with paragraph 2.01 of this section
Process Connection	N/A
Product Data	
General:	Temperature switch assembly shall consist of a SAMA PMC6-10, Class 2 filled thermal element and pressure switch connected by a capillary tube or, close coupled as specified. The temperature switch assembly shall be housed in a cast aluminum enclosure rated NEMA type 4, unless otherwise specified.
Switch:	Approximate set point shall be indicated on internal, calibrated scales. Repeatability and sensitivity shall be 1 percent of range, or better. Unless otherwise specified, switches shall be non-adjustable deadband, automatic reset type. Two independently adjustable, SPDT switches shall be provided.
Execution	
Installation	Install in accordance with the manufacturer's instructions.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	United Electric Series 402, Asco series SC, or equal.

+++ END OF SECTION 13216 +++

SECTION 13271
SIGNAL CONDITIONING MODULES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of panel mounted signal conditioning modules which form a part of the process control systems specified in Section 13200. Application requirements are specified in the instrument schedule, paragraph 13200-3.03. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. Drawings, information and technical data for all equipment as required in Section 13000 and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

1. In accordance with paragraph 13000-1.04 F, record documentation shall include the data sheets specified in paragraph 13200-1.04 B.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

D. References:

1. References are listed in Section 13000. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, signal conditioning modules shall comply with the following requirements:

1. Analog signal inputs shall be 1 to 5 volts DC into 20M ohms.

2. Analog signal outputs shall be 1 to 5 volts DC into 20k ohms.

3. Discrete output contacts shall be SPDT rated 5 amperes at 117 volts AC and 28 volts DC.

4. Unless otherwise specified, power supply shall be 24 volts DC plus or minus 10 percent. Power supply effect shall not exceed 0.005 percent per 1.0 percent change.

5. Electronic trips shall be arranged so that output contact opens in case of loss of signal or loss of power supply.

6. Modules shall be plug-in printed circuit boards.

7. Modules shall be rated for continuous operation in an ambient temperature of 0 to 80 degrees C. Ambient temperature effect shall not exceed plus or minus 0.01 percent per degree C within that range.

8. Span and zero adjustments shall be made by front accessible multi-turn potentiometers.

9. Electronic trip modules shall be provided with LED indicators for relay status.

10. Printed circuit card cages shall be suitable for 19-inch EIA RS310C rack or panel mounting as required.

11. Modules shall withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25 percent calibration effect. Modules shall also be provided with traps on the terminals to shunt conducted radio frequency interference to ground.

12. Signal and power supply terminals shall be galvanically isolated from the card cage frame.

13. All plug-in modules specified in this section shall be the product of a single manufacturer and shall be of matching construction to permit unlimited mixing within the card cages.

2.02 INSTRUMENTATION SPECIFICATION (INSTRUSPEC) SHEETS

A. Specific requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General requirements for installation of instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.02 TESTING

A. General requirements for testing of instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.03 INSTRUSPEC SHEETS (starts on the next page)

3.03.1 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	YAS
Instrument Function	Signal conditioning module
Instrument Description	Analog summer
Power Supply	24 Vdc, unless otherwise specified
Signal Input	1 to 5 Vdc in accordance with paragraph 2.01 of this section, unless otherwise specified.
Signal Output	1 to 5 Vdc in accordance with paragraph 2.01 of this section, unless otherwise specified.
Process Connection	N/A
Product Data	Function modules shall be of the same manufacture and model throughout the work and shall be of plug in construction suitable for 19-inch EIA dimension card files. Span and zero adjustments shall be by multi-turn potentiometers. Frequency response shall not be down more than 3 dB at 50 hertz. analog summer shall provide algebraic addition of two to four inputs with an accuracy of 0.5 percent of span or better, time constant 50 milliseconds or better, temperature drift 0.02 percent of span per degree C or less over a range of 0 to 50 degrees C. Power supply effect shall not exceed 0.1 percent of span with power supplies provided.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Moore Industries, AGM Electronics, or equal.

3.03.2 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	YAT
Instrument Function	Signal conditioning module
Instrument Description	Absolute signal trip
Power Supply	24 Vdc, unless otherwise specified
Signal Input	1 to 5 Vdc in accordance with paragraph 2.01 of this section, unless otherwise specified.
Signal Output	Contact in accordance with paragraph 2.01 of this section.
Process Connection	N/A
Product Data	Modules shall monitor input signals and produce an isolated output when the signal rises above the set point. Set point adjustment shall be by multi-turn potentiometer. Pickup set point shall be adjustable from 0.5 to 99 percent of span on a calibrated scale. Accuracy shall be 1.0 percent and repeatability of 0.5 percent of span or better. Deadband shall be adjustable over at least 20 percent of span, and shall be set at 2.0 percent of span unless otherwise specified. Time constant shall be 50 milliseconds or less, temperature drift 0.02 percent of span per degree C or less over a range of 0 to 50 degrees C. Power supply effect shall not exceed 0.1 percent of span with power supplies provided.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Moore Industries, AGM Electronics, or equal.

3.03.3 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	YCC
Instrument Function	Signal conditioning module
Instrument Description	Current to current isolation amplifier
Power Supply	24 Vdc, unless otherwise specified
Signal Input	4 to 20 mAdc
Signal Output	4 to 20 mAdc into 0 to 1000 ohms, isolated
Process Connection	N/A
Product Data	Modules shall be of the same manufacture and model series throughout the work and shall be of plug-in construction suitable for 19-inch EIA dimension card racks. Load presented to input signal shall not exceed 5 ohms. Accuracy shall be 0.5 percent of span or better, time constant 50 milliseconds or less, and temperature drift 0.02 percent of span per degree C or less over a range of 0 to 50 degrees C. Power supply effect shall not exceed 0.1 percent of span with power supplies provided.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Moore Industries, AGM Electronics, or equal.

3.03.4 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	YSS
Instrument Function	Signal conditioning module
Instrument Description	Signal selector
Power Supply	24 Vdc, unless otherwise specified
Signal Input	1 to 5 Vdc in accordance with paragraph 2.01 of this section, unless otherwise specified.
Signal Output	1 to 5 Vdc in accordance with paragraph 2.01 of this section, unless otherwise specified.
Process Connection	N/A
Product Data	Accuracy shall be 0.25 percent of span or better, time constant 50 milliseconds or less, temperature drift 0.02 percent of span per degree C or less over a range of 0 to 50 degrees C. Power supply effect shall not exceed 0.1 percent of span with power supplies provided. Frequency response shall be down not more than 3 dB at 50 hertz. Unit shall select and retransmit the higher or lower of two, three, or four inputs as specified. Module shall be Moore Industries, AGM Electronics, or equal.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Moore Industries, AGM Electronics, or equal.

3.03.5 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	YVC
Instrument Function	Signal conditioning module
Instrument Description	Voltage to current isolation amplifier
Power Supply	24 Vdc, unless otherwise specified
Signal Input	1 to 5 Vdc in accordance with paragraph 2.01 of this section.
Signal Output	4 to 20 mAdc into 0 to 1000 ohms, isolated
Process Connection	N/A
Product Data	Modules shall be of the same manufacture and model series throughout the work and shall be of plug-in construction suitable for 19-inch EIA dimension card racks. Accuracy shall be 0.5 percent of span or better, time constant 50 milliseconds or less, temperature drift 0.02 percent of span per degree C or less over a range of 0 to 50 degrees C. Power supply effect shall not exceed 0.1 percent of span with power supplies provided.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Moore Industries, AGM Electronics, or equal.

+++ END OF SECTION 13271 +++

SECTION 13275
MISCELLANEOUS PANEL INSTRUMENTS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of miscellaneous panel- mounted instruments which form a part of the process control systems specified in Section 13200. Instruments specified in this section are required to provide an interface between the operator and the process. Application requirements are specified in the instrument schedule, paragraph 13200-3.03. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. Drawings, information and technical data for all equipment as required in Section 13000 and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

1. In accordance with paragraph 13000-1.04 F, record documentation shall include the data sheets specified in paragraph 13200-1.04 B.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

D. References:

1. References are listed in Section 13000. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

PART 2 - PRODUCTS

2.01 INSTRUMENT SPECIFICATION (INSTRUSPEC) SHEETS

A. Specific requirements for instruments included in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General requirements for installation of instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.02 TESTING

A. General requirements for testing of instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.03 INSTRUSPEC SHEETS (starts on the next page)

3.03.1 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification	KIC
Instrument Function	Miscellaneous panel instrument
Instrument Description	Single loop control station
Power Supply	120 Vac, 60 hertz nominal unless otherwise specified
Signal Input	4 to 20 mAdc unless otherwise specified
Signal Output	4 to 20 mAdc into 0 to 500 ohms unless otherwise specified
Process Connection	N/A
Product Data	
General	The Single loop control station shall be a microprocessor-based unit suitable for flush panel mounting. Control station dimensions shall be nominally 3-3/4 inches high by 3-3/4 inches wide by not more than 8 inches deep. Sampling rate shall be 250 milliseconds and indicating accuracy shall be ± 0.25 %, ± 1LSD, or better. Process input and control output circuits shall be isolated from each other. All settings and adjustments shall be made by means of the front panel controls.
Display	Display functions shall include process variable, set point, and output value. The process variable and set point displays shall be in engineering units and shall be 4 digit, 7 segment red LED.
Control Functions	The set point value and upper and lower set point limits shall be adjustable from 0 to 100 % of range. The proportional band shall be adjustable from 0.5 to 999.0 %, integral shall be adjustable from 0 to 6000 seconds, and derivative shall be adjustable from 1 to 6000 seconds. Controller output shall be selectable for either automatic or manual modes and the set point source shall be selectable for remote or local.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	West Model 2075, Yokogawa Model UT35, or equal.

3.03.2 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification	KLI
Instrument Function	Miscellaneous panel instrument
Instrument Description	Loop powered indicator
Power Supply	N/A
Signal Input	4 to 20 mAdc unless otherwise specified
Signal Output	N/A
Process Connection	N/A
Product Data	The loop-powered, two-wire indicator shall a 3-1/2 digit, 7-segment, 0.8-inch high liquid crystal display. Zero shall be adjustable from - 1999 to + 1999 counts and span shall be adjustable from 100 to 4000 counts. A switch-selectable dead zero shall allow display readings to + 19990. Four decimal point positions shall be available and switch-selectable. The enclosure shall be rated Nema 4X, suitable for outdoor mounting. The enclosure shall be suitable for in-line conduit mounting, unless otherwise specified. The indicator shall be suitable for operation within a temperature range of -15 to + 150 degrees F. Accuracy shall be + 0.1 percent of span + 1 count. Voltage drop shall not exceed 4 volts at 40 mA. A/D conversion time shall be no greater than 500 milliseconds and display update time shall be no greater than 0.5 seconds.
Execution	
Installation	Install in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Action Instruments Visipack V560, or equal.

3.03.3 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification	KSI
Instrument Function	Miscellaneous panel instrument
Instrument Description	Solid state indicator
Power Supply	120 Vac, 60 hertz nominal unless otherwise specified
Signal Input	4 to 20 mAdc, unless otherwise specified
Signal Output	N/A
Process Connection	N/A
Product Data	The indicator shall be a 100-segment, LED, vertical bar-graph type. The display shall be red in color and shall be approximately 4 inches long. Calibrated accuracy shall be plus or minus 1 percent of scale. Indicators shall be suitable for group mounting.
Execution	
Installation	Install in panels specified in Section 13110 in accordance with the manufacturer's instructions, paragraph 13200-3.01, and the specified functional requirements.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Crompton Instruments series FG, Sigma Instruments model 9270, or equal.

+++ END OF SECTION 13275 +++

SECTION 13300
INSTRUMENTATION, CONTROL AND MONITORING SYSTEM COMPONENTS

1.01 SCOPE

A. Requirements of the General and Special Conditions of the Contract, Division 1 and Section 13000 form a part of this Section. This Section specifies primary and secondary elements of process instrumentation, auxiliary equipment, and supplies directly related to the installation of and operation of these elements, to perform the required functions in conjunction with information and equipment specified in other Sections of Division 13. Schedules indicating required information are attached at the end of this Section, but shall not be construed as Bills of Material or as a complete listing of all required devices.

1.02 QUALITY ASSURANCE

A. Manufacturer

1. In addition to requirements of Section 13000, instrumentation and control equipment shall be manufactured by a firm regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.

B. Maintainability

1. All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation

1. Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified.

D. Operations and Maintenance Manuals

1. Provide three (3) bound sets of operation and maintenance (O&M) manuals at the time equipment is delivered to the site.

2. Include in the O&M manual the following types of information on each

Control System component and item of equipment:

1. Approved shop drawings.
2. Product information.
3. Installation instructions.
4. Operating procedures.
5. Shut-down procedures.
6. Safety instructions.
7. Calibration instructions.
8. Maintenance and repair instructions.
9. Recommended spare parts list.
10. Special tools list (if any).
11. Name, address and phone number of supplier's local representative.

1.03 STORAGE AND PROTECTION

A. Package all equipment and materials at the factory to protect each item from damage during shipment and storage.

B. Protect painted surfaces against impact, abrasion, discoloration and other damage.

C. Protect equipment and materials stored at the site from the weather, moisture, corrosive liquids and gases, dust and other agents that could cause damage. Instrumentation and control components and accessories shall be stored and protected in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 LEVEL SWITCH, FLOAT

A. The level switch shall be a 5-1/2 inch diameter Type 316 stainless steel float switch with an internal mercury switch and flexibly supported by a PVC jacketed, heavy-duty cable. The floats shall be mounted on a vertical 1 inch diameter corrosion resistant, rigid pipe attached to the structure wall with corrosion resistant brackets and 316 stainless steel hardware. The switch shall be rated at 20 amps at 115 VAC and shall be SPST-NO or SPST-NC as required. The float switch shall be Model M-GRE-XXX-T as manufactured by Warrick Controls or approved equal.

2.02 LEVEL TRANSMITTERS – ULTRASONIC OPEN CHANNEL FLOW

A. Operating Principle: Microprocessor-based, echo time of flight. All signal

processing performed at the sensor.

B. System Specifications

1. Measuring Range: 1 to 39 ft
    - Minimum dead band: 1 ft.
2. Sensor Housing Material: Corrosion and chemical-resistant UPVC
    - Sensor rated to withstand full immersion.
3. Sensor Cable: Integral to sensor, PVC sheathed 2 core screened cable with sufficient length to reach the controller.
4. System Power: 115V AC
5. Manufacturer: Siemens Rosemount Model 3491 or approved equal for Universal Controller
6. Sensor Power (via Universal Controller): 12 to 30V DC
7. Sensor communication to Universal Controller: HART
8. Primary Output: 4-20mA configurable for Level or Volume
    - Additional Outputs: Five (5) SPDT relays with 5 A, 120VAC rated contacts.
9. System Configuration Options:
    - Integral Keypad
    - Handheld Communicator
10. Sensor Operating Temperature: -20 to 140 degrees F
11. Universal Controller Operating Temperature: -40 to 130 degrees F
12. Sensor Operating Pressure: Atmospheric to 43 psig
13. Speed of Sound Correction: via thermistor integral to sensor
14. Sensor Mount: 316 SST Mounting Bracket for suspended mount

C. Accessories:

1. Submersion Shield.

2.03 LEVEL TRANSMITTER - SUBMERSIBLE PRESSURE TYPE

A. Manufacturer: Endress & Hauser
Sensor Model: Waterpilot FMX21
Measured Error: +/- 0.2% of the span
Temperature Range: -10 to 70 degrees Celsius
Material: Stainless Steel
Transmitter Model: RIA 46
Transmitter Supply Voltage: 120 VAC
Signal Output: 4 to 20 mA
Relay Outputs: 2 SPDT (can be inverted)
Applications: Water Level.

2.04 GAGE AND ABSOLUTE PRESSURE TRANSMITTERS

A. Provide diaphragm type actuated, low hysteresis, gage or absolute pressure indicating transmitters of the two-wire, loop powered, electronic type with a 4-20mA dc current output. Transmitter to have the high pressure port connected to sensor capsule. Other side of the Sensor capsule shall be connected to an absolute pressure chamber for absolute pressure transmitters and atmospheric pressure for gage pressure sensors. The sensor shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic sensor construction for measuring range up to 600 PSIG/ A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001-inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to full vacuum. Alternatively, the sensor shall utilize a monosilicon sensing element with a metal process diaphragm (constructed of Type 316 stainless steel, Alloy C276 or other specified materials) for measuring ranges up to 10500PSIG/A. Sensor shall have over-range protection built-in. Transmitter must be able to withstand the maximum process pressure. Transmitter to be resistant to EMI/RFI interference.

B. Transmitter shall comply with the following performance requirements.
   1. Maximum measurement error shall not exceed ± 0.075% of span, including combined effects of linearity, hysteresis and deadband. The transmitter may be turned down from the nominal sensor range 100:1 or higher upon request. Alternatively, the transmitter accuracy shall be 0.05% of calibrated span.
   2. The sensor shall incorporate all of the calibration and characterization data so as to be completely replaceable and interchangeable without the need for recalibration. The 0.075% accuracy shall be maintained on the interchanged sensor. The electronics shall also be replaceable without the need for recalibration on the sensor. The calibration of the transmitter shall be via external push-buttons which will allow the transmitter to be reranged without the need for any pressure source or other external handheld devices.
   3. Zero shifts shall not exceed ± 0.5% of upper range limit for a temperature shift of 100 F.
   4. Temperature effect at maximum span; Zero error: ± 0.5% of span per 100^{o}F. Total effect including span and zero errors: ± 1.0% of span per 100^{o}F. ref ISA S71.01).
   5. Vibration effect ± 0.1 of upper range limit per g to 200 Hz in any axis.
   6. Power supply effect less than 0.05% of calibrated span per volt (ref ISA S71.02).
   7. Wetted materials shall be: Isolating diaphragm Type 316L stainless steel drain and vent valves Type 316 stainless steel, process flanges/adapters Type 316 stainless steel and Viton O-rings.

C. Transmitter shall produce an output signal of 4-20 mA dc. Minimum output signal shall be equal to zero percent of span and maximum output signal shall be equal to 100% of span. Provide local indication in engineering units.

D. Transmitter shall be factory calibrated as needed for specific application.

E. Zero position and span of input shall be field adjustable within selected range of transmitter. Zero adjustment shall allow for zero-based, suppressed, elevated or compound ranges.

F. Measurement connections shall be 1/2-inch NPT (default) or 1/4-inch NPT as specified. Gage pressure transmitters shall optionally allow the reference side of the measuring capsule to be connected to a filled wet leg or other means of non-atmospheric pressure reference.

G. The transmitter shall have versions which allow the ceramic sensor to be mounted flush with the process connection. The process connection and process seal gasket wetted parts shall be interchangeable and replaceable on-site without the need for recalibration. There shall also be options which allow no metal contacting the process.

H. Transmitter shall have Type 316 stainless steel diaphragm and trim, unless application requires other materials of construction.

I. The housing shall be rated NEMA4X and shall be available in Type 316 stainless steel and poly-coated aluminum versions.

J. Absolute and Gage Pressure Indicating Transmitters shall be Rosemount Model 2088 or approved equal.

2.05 WATER QUALITY METER AND PROBES

A. The Water Quality control system shall include:
   1. A multi-parameter microprocessor based sensor controller that works with the following digital sensors:
      - pH / Temperature sensor
      - Dissolved Oxygen sensor
      - Conductivity sensor
      - Nitrate sensor.

B. Probe modules of the controller shall be capable of networking together to accommodate more than eight sensors on one network. Each probe module shall be equipped with EtherNet communication. The probes shall be rated for the actual application and installation.

C. Performance Requirements:
   1. When paired with an enabled sensor, the overall status of the sensor performance is displayed as a percentage value via a measurement indicator
   2. When paired with an enabled sensor, the overall time remaining until maintenance tasks are due for the sensor is displayed in days

D. Certifications
   1. EMC: CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits)
   2. Safety: General Purpose UL/CSA 61010-1 with cTUVus safety mark
   3. IP65 dust and water ingress ratings

E. Environmental Requirements
   1. Operating temperature: -4 to 131 °F (-20 to 55°C)
   2. Storage Temperature: -4 to 158 °F (-20 to 70°C)
   3. Humidity Requirements: 0 to 95% relative humidity, non-condensing

F. Warranty
   1. Warranted for 12 months from the date of shipment from manufacturer's defects

G. Maintenance Service (Unscheduled Maintenance)
   1. Clean controller keypad
   2. Calibrate mA output signals.

H. Manufacturer
   1. Hach Model sc1000 Multi-parameter Universal Controller or approved equal.
   2. Hach 1200-S sc Digital pH sensor or approved equal
   3. Hach 3400 sc Contacting Conductivity Sensor or approved equal
   4. Hach 5740 sc Membrane Dissolved Oxygen Sensor or approved equal
   5. Hach N-ISE Nitrate Sensor or approved equal.

I. The Multichannel transmitter shall be mounted in an Instrumentation control panel LCP-IE with Turbidity Meter, Particle Counter and Alkalinity Analyzer. The control panel enclosure and associated accessories shall be provided by System Integrator. See Instrumentation and Controls Drawings for details.

2.06 PARTICLE COUNTER

A. General. The Particle Counter shall include Differential Head devices, interconnecting cabling, RS232/485 converter with power supplies, and all necessary components for a complete and operable system as shown on the drawings and as described herein.

B. Sensor/Counter. The particle counter sensor shall be an on-line real-time continuous monitoring instrument utilizing light extinction technology for sizing and counting particles. The sensor light source must be a solid-state laser diode (780 mm infrared) capable of counting particles from 2 to 800 microns. The system must be capable of sorting particles into 5 or 15 user-adjustable channels depending on software used. The particle counter must have a maximum particle concentration limit of at least 20,000 particles/mL at 10% coincidence. Maximum concentration must be based on both optical and electronic coincidence limits. All sensors must be calibrated per ASTM 658. Calibration materials must be traceable to USA NIST.

C. Sensor Count Matching. All sensors must be count matched during factory calibration to guarantee performance of ±10% from sensor to sensor.

D. Calibration Verification. The sensor must facilitate a simple on-site calibration verification procedure by the user to validate the sensor is sizing and counting particles correctly. The calibration verification process should not require the sensor to be taken off-line.

E. Sensor I/O. Each sensor shall accept five 4-20 mA output signals representing particle counts in adjustable size ranges, total counts, and flow or sensor status. The sensor shall have two 4-20 mA input signals from other instruments such as turbidimeters. The particle counter system should also have network hardware that will accept additional 4-20 mA input signals from other instruments.

F. Internal Flowmeter. The particle counter system will have an internal flow meter that will continuously monitor flow and notify the controlling system if the flow rate is below or above acceptable limits.

G. Diagnostics. The sensor must track and indicate its need for periodic cleaning or maintenance automatically, either by communicating to the dedicated data acquisition system (PLC or computer) and/or by external alarm light. Each sensor shall have an LED indicator for power, sensor, sample cell and flow status (for sensors with an internal flow meter).

H. Sensor. The sensor optical windows shall be constructed of sapphire so that repeated cleaning with a brush will not cause damage to the sensor. Sensors using quartz optical windows shall not be allowed due to potential scratching on window surfaces exposed to sample. Quartz wetted surfaces also have a tendency to stain or form deposits resulting in poor performance or failure. To avoid clogging and maintain high concentration limit the sensor sample cell shall be no smaller than 1 x 2 mm in size. The sensor sample cell must be suitable for brush cleaning and accept a minimum sample flow rate of 200 mL/min. Slower sample rates will not be accepted due to the possible settling of suspended particles resulting in clogged sample cells and high maintenance. A capillary cleaning brush must be included with every sensor. There shall be no aluminum, brass or other materials which cause corrosion and optical surfacing fouling.

I. Sample Delivery. The flow rate of each sensor shall be held constant at 100ml/min. A flow control weir shall be provided with each counter to control the sample flow rate through the sensor without the use of valves or other constrictions in the sample line. This constant flow device shall function without the need for operator interaction outside of routine maintenance. A means of electronically reporting and audibly enunciating a low sample flow condition shall be provided in the system. Each counter shall measure particles continuously for the specified sample interval with no interruptions for data processing or printing. The constant flow device shall utilize a flush valve to eliminate excessive solids build-up from raw and settled water sources. A cleaning kit shall be included with each sensor.

J. Compliance. All sensors shall be designed to meet the UL/CSA safety and CE standards for both national and international safety and emission requirements.

K. Enclosures. The Particle Counter shall be mounted in an Instrumentation control panel LCP-IE with Turbidity Meter, Multichannel Controller for pH, temperature, DO, Conductivity and Nitrate and Alkalinity Analyzer. The enclosure shall house all counter electronics and electrical connections. Each counter shall have a local backlit display mounted on the front of the enclosure. LED's for power and communications are also located on the front of the enclosure for easy viewing. The display shall be an integral part of the counter, consisting of a single instrument containing sensor and all particle sizing electronics.

L. Communication. The particle counting system shall communicate using RS485 Serial Communication. Particle counting system shall provide OPC server software to interface with the HMI. Sensors or other network devices may be located up to 4000 feet from the data collection system (PLC or computer). The sensor must be designed so that a sensor may be disconnected, removed for calibration or service, without interrupting the data transmission from other sensors. Junction boxes shall not be required.

M. The Particle Counter shall be HACH Model 2200 PCX or approved equal.

2.07 TURBIDITY METER

A. The turbidimeter shall be a continuous reading, on-line instrument using the nephelometric method of measurement. The design shall meet or exceed performance criteria as specified in USEPA Method 180.1. It shall utilize a single silicon photodiode to detect 90° scattered light. Digital display with automatic decimal point placement shall read from 0-9999 NTU. Accuracy shall be better than ± 5% from 0-2000 NTU and ± 10% from 2000-9999 NTU. Resolution shall be 0.01 NTU. Calibration shall be based on formazin, the primary turbidity standard. The turbidimeter shall consist of two main component parts: a sample unit and a control unit, connected with an 11-conductor cable.

B. All optical and hydraulic components shall be housed in the sample unit. The light source shall be directed on the surface of the water sample, eliminating the use of a glass window or flow cell. The sample unit shall be constructed of corrosion resistant structural plastic. It shall be powered from the control unit and require no separate power source.

C. The control unit shall provide a digital LED display with four digits and automatic decimal positioning. The control unit shall also provide a linear output signal which can be programmed to span all, or any portion of the 0-999 NTU range. A 4-20 mA current output and selectable voltage outputs of 0-10 mV, 0-100 mV and 0-1 Vdc shall be provided. Two set-point alarm systems shall be fully adjustable over the entire range of the instrument and actuate SPDT normally open/normally closed dry relay contacts. A bubble rejection circuit shall be provided to eliminate spikes in

measurement due to transient sample conditions. Self-test diagnostics shall be provided to automatically indicate possible instrument malfunctions.

D. The turbidimeter shall be listed by ETL to UL 1262 and ETL certified to CSA 22.2 No. 142. The instrument shall be certified to IEC 1010-1 per 73/23/EEC for safety; for emissions, it shall be certified to CISPR-11/EN 55 011 "A" limits per 89/336 EEC; and for immunity, it shall be certified to EN 50 082-1 (IEC 801-2, 801-3, 801-4).

E. The Turbidimeter shall be mounted in an Instrumentation control panel LCP-IE with Particle Counter, Multichannel Controller for pH, temperature, DO, Conductivity and Nitrate, and Alkalinity Analyzer. The control unit and sample unit shall be housed in NEMA-4X and NEMA-12 industrial plastic enclosures suitable for installation inside an enclosure. Power requirement shall be 115 VAC, 50/60 Hz. The manufacturer shall warrant the turbidimeter against defects in materials and workmanship for two years from date of shipment.

The turbidimeter shall be Hach Models Surface Scatter 6 or approved equal.

2.08 ALKALINITY ANALYZER

A. Performance Requirements
   1. Measurement range
      a. Total alkalinity as calcium carbonate:
         1 to 500 mg/L
      b. Phenolphthalein alkalinity as calcium carbonate: 5 to 250 mg/L
   2. Accuracy: ± 5 percent of reading or ±1.0 mg/L, whichever is greater
   3. Repeatability: ±3% of reading or ±0.6 mg/L, whichever is greater
   4. Response time: less than 10 minutes for 90% response to step change at sample inlet (single channel instruments)
   5. Cycle time: 8 minutes (average)
   6. Detection limit: less than or equal to 0.10 mg/L.

B. Certifications

   1. Safety standards
      a. UL 3101-1
      b. CSA C22.2 No. 1010.1
      c. EN61010-1 (IEC 1010-1)
   2. Class A limits for radio and noise emission as specified by the FCC and EN55011 (CISPR11).

C. Environmental Requirements

   1. Operating and sample temperature: 5 to 50 °C (41 to 122 °F)
   2. Sample pressure: 0.5 to 30.0 psig (0.03 to 2.04 bar)
   3. Sample flow: 100 to 2000 mL/min. maximum
   4. Sample inputs: up to two sample streams.

D. Equipment

1. The analyzer uses m-cresol purple and bromcresol green indicators for colorimetric measurement of alkalinity at a wavelength of 600 nm.
2. The analyzer has a digital display in a numeric or graphical format.
3. The analyzer is capable of automatic calibration, cleaning, and self-priming.
4. Samples are continuously purged to assure fresh sample to the analyzer and reduce analysis lag time. E. An automatic burette is used to dispense metered volumes of sample, standards, and reagents.
5. Sample, standard, and reagent flow are directed to the detector module by a rotary valve.
6. Grab-sample (10 mL) analysis is possible without interrupting continuous sample flow to the analyzer.
7. The analyzer is equipped with the following communications capabilities.
    a. Fourteen user-defined internal recorders, of which four can be used for PID control.
    b. Two user-selectable recorder/controller outputs of 4-20 mA, with expansion capability up to 14.
    c. Recorder output span is user-adjustable over the entire span of the analyzer.
    d. Fourteen user-defined alarms. Alarms may be programmed for sample concentration alarms, analyzer system warning, and analyzer system shutdown.
    e. Two unpowered SPDT relays, with expansion capability up to 14, for internal alarms.
    f. Two relay contacts rated for 5 A resistive load at 230 Vac.
8. Analyzer components are assembled to a NEMA-4X(indoor)/IEC 529 (IP66) plastic enclosure.
9. All standards and reagents are isolated from the analyzer electronics in separate drip-proof plastic containers.
10. Power requirement are 95 to 240 Vac, 50/60 Hz.
11. Accessories
    a. Cable Termination Kit
    b. Digital Display Module (DDM)
    c. Power Supply
    d. Serial Input/Output Module (SIO)
    e. Signal Output Module (SOM)
    f. Installation Kit
    g. Tool Kit
    h. Maintenance Kit.

E. The Alkalinity Analyzer shall be mounted in an Instrumentation control panel LCP-IE with Particle Counter, Multichannel Controller for pH, temperature, DO, Conductivity and Nitrate, and Turbidimeter.

F. Manufacturer:
- Hack Model APA 6000™ Alkalinity Process Analyzer or approved equal.

2.09 ULTRASONIC TRANSIT TIME FLOW METERS

A. See Section 11500 Transit Time Flow Meters

2.10 SELECTOR, WATERTIGHT, NEMA 4X

A. Units shall be heavy duty, watertight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous. The switches shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have standard size, black field, legend plates with white markings. Operators shall be black knob type. Units shall have the number of positions and contact arrangements shown. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.

B. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or equal.

2.11 PUSHBUTTON, MOMENTARY, WATERTIGHT, NEMA 4X

A. Units shall be heavy duty, watertight/oiltight, industrial type pushbuttons with momentary contacts rated for 120V ac service at 10 amperes continuous. The pushbuttons shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have standard size, legend plates with black field and white markings. Button color shall be as required. Units shall have the contact arrangements as required. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.

B. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or equal.

2.12 INDICATING LIGHTS, WATERTIGHT, NEMA 4X

A. Units shall be heavy duty, watertight, push-to-test, industrial type with integral transformer for 120V ac applications, and full voltage type for 24V dc applications. The lights shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have factory engraved standard size, black field, legend plates with white markings. Units shall have screwed on prismatic lenses in colors as shown. When a common lamp test function is specified, the push-to-test feature will not be required. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.

B. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or equal.

2.13 FLASHING LIGHT AND HORN, COMBINATION

A. The flashing light and horn shall be a one-piece unit operating on 120V ac. Unit shall be made of heavy-duty chrome finished steel housing with aluminum retaining band and heat-tempered globes. The flashing mechanism shall be solid state flashing at 60 to 80 flashes per minute. The lamp shall be incandescent. Horn shall be rated 100db at 5 feet. Light color shall be red unless noted otherwise. Unit shall be suitable for 1" stanchion mounting.

B. Unit shall be as manufactured by Benjamin Thomas Model KL-5011-120, Signal Division Federal Signal Corporation Model LV Siren with Model 121S light.

2.14 MISCELLANEOUS MECHANICAL

A. Solenoid Valves: Solenoid valves shall be packless construction two-way, three-way or four-way as required, and shall be correctly sized for the application. They shall be for normally energized or deenergized operation as required. Valve bodies shall be forged brass unless otherwise recommended by the manufacturer for a particular application. The solenoids shall be rated for continuous operation at 110 percent of rated voltage. They shall be 120VAC, 60 Hz operated. All coils shall be housed in NEMA 4 cases with provision for 1/2-in. electrical conduit Solenoid valves shall be as manufactured by ASCO, Skinner, Magnetrol, or equal.

B. Pressure Control Valves (Self Contained): Pressure control valves of the spring loaded self contained type shall be provided as shown on the Drawings and/or specified herein. The valves shall be for regulating back pressure or discharge pressure as shown on the drawings. Wetted materials shall be entirely suitable for the process fluid as shown in the Schedule. The body shall be bronze or steel unless specified otherwise. The valves shall be sized in accordance with the required flow rate, pressure differential, inlet or outlet pressure range as shown in the Schedule. The pressure control valves shall be as manufactured by Fischer Controls, GA Industries or equal.

C. Limit Switches shall be provided to sense limiting positions of equipment such as valves, as shown on the Drawings and/or specified in the schedules. The limit switches shall be SPDT or DPDT as required for the specified operations or as scheduled herein. The switches shall be rated for 5 amperes minimum at 120 Vac and shall be enclosed in a NEMA 4 housing unless explosion proof (XP) is specified in the schedule. Provision shall be made for 1/2" electrical conduit connection. The switches shall incorporate actuators and mounting brackets which are fabricated appropriately for the mechanical equipment being monitored. Switches shall be as manufactured by Microswitch or equal.

2.15 PRESSURE AND VACUUM GAUGES

A. Units shall be bellows or Bourdon tube actuated pressure gauges. Gauges shall be stem mounting with 4-I/2-inch dial size, unless otherwise noted. Scale range shall be as noted and accuracy shall be plus or minus 1/2 percent of span.

B. The sensing element material shall be phosphor-bronze, unless otherwise noted.

C. For unit ranges below 10 psi, units shall be bellows actuated and shall be Ashcroft "General Service Series 1180", Robert Shaw "Acragage", or equal.

D. For unit ranges above 10 psi, units shall be Bourdon tube actuated and shall be Ashcroft "Duragauge", Robert Shaw "Acragage" or equal.

2.16 PRESSURE SWITCHES

A. General. Pressure switches shall sense gauge pressure and incorporate bourdon tubes, diaphragms, or bellows as the sensing and actuating element.

B. Construction. The actuating element shall be 316 stainless steel. The actuating point shall be readily field adjustable in the range specified, and shall be of the adjustable differential (dead band) type. Switches shall be SPDT, rated at 10 amperes minimum at 120 vac. Enclosures shall be suitable for NEMA 7 & 9 explosion-proof (XP) applications. Process connection shall be 1/4-inch NPT.

C. Manufacturers. The pressure switches shall be as manufactured by Mercoid, United Electric, ASCO, or equal.

2.17 PRESSURE SEAL, DIAPHRAGM

A. Units shall consist of corrosion-resistant lower housing and diaphragm, and instrument mounting upper housing. Lower housing shall have NPT female process and flushing connections and shall be 316 stainless steel, unless otherwise noted. Diaphragm shall be 316 stainless steel, unless otherwise noted. Upper housing shall have bleed screw, NPT female instrument connection, and shall be steel, unless otherwise noted. Filling fluid shall be as noted.

B. Where noted, capillary assembly shall be furnished to connect diaphragm seal to instrument with length as noted.

C. Wherever practical, pressure seal shall be factory filled and assembled to sensing element (i.e., pressure switch, pressure transmitter)

D. Units shall be Ametek, Mansfield and Green Division, Type SG; Ashcroft Type 101 or equal.

2.18 PRESSURE SEAL, ANNULAR

A. Unit shall be of the pressure-sensing, pipe spool type suitable for measuring dirty or corrosive fluids. Unit shall consist of a carbon steel pipe spool and an elastomer liner with a space between filled with the noted fluid. Unit shall be arranged and designed to directly transmit the process pressure by means of the fluid through an opening in the spool wall to a pressure-sensing device attached and sealed to the spool by a drilled and threaded boss. Unit shall be sized as noted and have ANSI 150-pound flanges, unless otherwise noted. Seal shall be suitable for fluid pressures to 200 psig and shall be furnished with a Buna-N flexible cylinder, unless otherwise noted. Unit shall have fill connections and other features required to permit refill of the seal volume in the field.

B. Wherever practical, pressure seal shall be factory filled and assembled to sensing element (i.e., pressure switch, pressure transmitter)

C. Unit shall be Ronninger-Petter Ful-Stream Pressure Sensor, Red Valves Series 40 or equal.

2.19 INDICATOR, FIELD MOUNTING

A. Indicators shall be suitable for wall mounting. The unit shall receive a 4-20 mA dc analog signal proportional to a process variable on a mirrored 4-inch minimum scale. Scale range shall be as noted. Indication accuracy shall be plus or minus 2 percent of span. Input impedance shall be less than 50 ohms.

B. Indicator housing shall be NEMA 4 unless otherwise noted with a gasketed viewing window or door. Unit shall be similar to Transmation Model IS210M; or equal.

2.20 ROTAMETERS

A. Rotameters shall have boro-silicate glass tubes and stainless steel floats. The body may be anodized aluminum or stainless steel. End fittings shall be stainless steel and selected to suit the application. O-rings shall be Viton and tube shield shall be clear plastic. The meter scale shall be linear and direct reading in gph or ccpm. Scale length shall be 5 inches minimum. Furnish needle valves on rotometers for adjustment of flow. The size and capacity shall be as shown on the Drawings or as recommended by the pump manufacturer, but not less than 10 gph. Rotometers shall be as manufactured by F&P, Brooks Instrument or equal.

2.21 TEMPERATURE SWITCH

A. Temperature switch shall be ambient compensated, filled system type with snap-action SPDT contacts rated for 10 amperes, continuous, at 120V ac. Unit shall be automatic reset type with adjustable deadband.

B. Adjustable setpoint range shall fall between 30 and 70 percent of the adjustable range. Span shall be at least 100 degrees F.

2.22 UNINTERRUPTABLE POWER SUPPLY

A. See Spec 13310 for UPS system requirements.

+++ END OF SECTION 13300 +++

SECTION 13310
UNINTERRUPTABLE POWER SUPPLY (UPS)

1 GENERAL

1.1 SUMMARY

A. These specifications describe requirements for an Uninterruptible Power System (UPS) optimized for maximum efficiency. The UPS shall automatically maintain AC power to the critical load within specified tolerances and without interruption during failure or deterioration of the normal power source.

B. The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions at the site. The UPS shall include all equipment to properly interface the AC power source to the intended load and shall be designed for unattended operation.

1.2 STANDARDS

A. The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:

1. The UPS shall be UL listed per UL Standard 1778, Fourth edition, Uninterruptible Power Supplies, and shall be CSA Certified.
2. The UPS shall be provided with a Short Circuit Withstand Rating (SCWR) label denoting the maximum source fault short circuit current that is applicable to the unit. The withstand rating shall be independently verified by a nationally recognized, third-party lab.
3. The UPS shall withstand input surges to both the rectifier and bypass when configured as a dual-input unit without damage as per the criteria in EN62040-2 (4kV). The manufacturer shall provide evidence of compliance upon request.
4. The UPS shall comply with FCC Rules and Regulations, Part 15, Subclass B, Class A. This compliance is legally required to prevent interference with adjacent equipment. The UPS shall have a label stating FCC compliance. The manufacturer shall provide evidence and test data of compliance upon request.
5. The UPS shall be compatible with the wiring practices, materials and coding in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit for top and bottom access to input, output, bypass and DC connections. Connection cabinets shall

provide for wiring gutter and wire bend radius as defined by the NEC and UL.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. The UPS shall be sized to provide a minimum of 15 kVA output (unity load power factor rating)
2. The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to unity. The UPS shall also work from unity power factor to 0.5 leading power factors subject to derating.
3. Load voltage and bypass line voltage shall be 208VAC, three-phase, four-wire plus ground. Input voltage shall be 208VAC, three-phase, four-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service.
4. The battery shall support the UPS at 100% rated kW load for at least 90 minutes at 77°F (25°C) at startup.
5. The UPS shall have an active power factor-corrected IGBT converter/rectifier, capable of maintaining input power factor and input current total harmonic distortion (THDi) within specifications without an additional input filter.
6. The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module. Optional transformers in cabinets or otherwise external to the basic UPS module shall be permissible to provide isolation and/or voltage transformation.

B. Modes of Operation:

1. The UPS shall operate as an on-line reverse transfer system in the following modes:

    a. Normal: The critical AC load shall be continuously powered by the UPS inverter. The rectifier/charger shall derive power from the utility AC source and supply DC power to the DC-DC converter, which in turn shall supply the inverter while simultaneously float charging the battery.
    b. ECO Mode: The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality.

c. Battery: Upon failure of utility AC power, the critical load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant via the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

d. Recharge: Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the batteries. This shall be an automatic function and shall cause no interruption to the critical load.

e. Bypass: If the UPS must be taken out of service, the static transfer switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash and in compliance with OSHA requirements.

f. Off-Battery: If the battery only is taken out of service, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker (in the case of external batteries). The UPS shall continue to function and meet all of the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

C. Performance Requirements:

1. The solid-state power components, magnetics, electronic devices and overcurrent protection devices shall operate within the manufacturer's recommended temperature when the UPS is operating at 100% critical load and maintain battery charging under either of the following conditions:

a. Any altitude within the specified operating range up to 3300 ft. (1000m) elevation

b. Any ambient temperature within the specified operating range of 32°F to 104°F (0°C to 40°C).

D. Input

1. Voltage: Input/output voltage specifications of the UPS shall be:

a. Rectifier AC Input: 208/120V, three-phase, four-wire-plus-ground
b. Bypass AC Input: 208/120V, three-phase, four-wire-plus-ground
c. AC Output: 208/120V, three-phase, four-wire-plus-ground

2. Voltage Range: +20%, -15% at full at full load; -40% at half load
3. Frequency Range: 40 - 70Hz
4. Maximum Inrush Current: UPS inrush current not to exceed 1.5 times rated input current
5. Power Factor: Minimum 0.99 at full load with nominal input voltage
6. Current Distortion: Less than 5% THD at full load input current in double-conversion mode
7. Surge Protection: Sustains input surges of 4kV (Line to ground) without damage as per criteria listed in EN 61000-4-5: 1995
8. Short Circuit Current Rating: Units shall carry as standard 65kA Short Circuit Withstand Rating. All ratings shall be certified and a label shall be applied to the unit clearly identifying this rating as required by the National Electrical Code.

E. AC Output

1. Load Rating: 100% of load rating at 104°F (40°C) for any load from 0.5 lagging to unity
2. Voltage Regulation:

a. ±1% RMS average for a balanced, three-phase load
b. ±2% for 100% unbalanced load for line-to-line imbalances

3. Voltage Adjustment Range: ±5% for line drop compensation adjustable by factory service personnel.
4. Frequency Regulation:

a. Synchronized to bypass: ±2.0Hz default setting, (adjustable by factory service personnel)

5. System Efficiency (defined as output kW/input kW/input kW at rated lagging load power factor; and not less than the values listed below:

	Efficiency (%)			
kVA Rating	25% Load	50%Load	75% Load	100% Load
15	88.90	92.80	93.90	94.10

6. Phase Imbalance:

a. Balanced loads 120° ±1°
b. 100% unbalanced loads 120° ±2°

7. Voltage Transients (average of all three phases):

a. (0-100% or 100-0%) Response Meets IEC 62040-3: 2010 Figure 2 Curve 1, Class 1 Meets ITIC and CBEMA Curve Requirements
b. (10-100% or 100-10%) Transient Voltage Deviation, RMS 5%

8. Overload at Full Output Voltage with ±1% voltage regulation:

a. 100% continuously
b. 105% - 110% of full load for 60 minutes at 104°F (40°C) ambient
c. 110% - 125% of full load for 10 minutes at 104°F (40°C) ambient
d. 125% - 150% of full load for 60 seconds at 104°F (40°C) ambient
e. >150% of full load for a minimum of 200 milliseconds at 104°F (40°C) ambient.

F. Grounding

1. The UPS chassis shall have an equipment ground terminal.

1.4 ENVIRONMENTAL CONDITIONS

A. The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

1. Operating Ambient Temperature

a. UPS: 32°F to 104°F (0°C to 40°C) without derating
b. Battery: 77°F (25°C), ±5°F (±3°C)

2. Storage/Transport Ambient Temperature

a. -4°F to 158°F (-20°C to 70°C)

3. Relative Humidity

a. 0 to 95%, non-condensing

4. Altitude

a. Operating: To 3300 ft. (1000m) above Mean Sea Level without derating (compliant with IEC/EN 62040-3 at altitudes exceeding 1000m). Consult factory for derating above 3300 ft. (1000m) elevation.
b. Storage/Transport: To 50,000 ft. (15,000m) above Mean Sea Level

5. Audible Noise Level

a. 59 dBA measured 4.6 ft. (1.4m) from the surface of the unit

1.5 SUBMITTALS

A. Proposal Submittals

1. Submittals with the proposal shall include:

a. Descriptions of equipment to be furnished, including deviations from these specifications.
b. Document stating compliance with FCC requirements.
c. Document stating listing to UL, including edition used for listing.
d. Document showing compliance with required SCCR and labeling.
e. System configuration with single-line diagrams.
f. Detailed layouts of customer power and control connections.
g. Functional relationship of equipment, including weights, dimensions and heat dissipation.
h. Information to allow distribution system coordination.
i. Size and weight of shipping units to be handled by contractor.

B. Order Submittals

1. Submittals supplied at time of order shall include:

a. All of the documentation presented with the proposal, per Section 1.5.1 above.
b. Detailed installation drawings including all terminal locations.
c. Interconnect wiring diagrams showing conduit wiring with terminal numbers for each wire.

C. UPS Delivery Submittals

1. Submittals upon UPS delivery shall include:

a. A complete set of submittal drawings.

b. Two (2) sets of instruction manuals. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.6 WARRANTY

A. UPS Warranty

1. The UPS manufacturer shall warrant the unit against defects in workmanship and materials for 12 months after initial startup or 18 months after the shipping date, whichever comes first.

B. Warranty – End User

1. Warranties associated with items not manufactured by the UPS supplier but included as part of the system shall be passed through to the end user.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. A minimum of 20 years' experience in the design, manufacture and testing of solid-state UPS systems shall be required.
2. The quality system for the engineering and manufacturing facility shall be certified to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

B. Factory Testing

1. Before shipment, the manufacturer shall fully and completely test the UPS unit to ensure compliance with the specification.
2. The UPS unit shall be tested at the system-specified capacity. Testing shall be done using load banks at part-load and the full kW rating of the unit.
3. Operational discharge and recharge tests to ensure guaranteed rated performance.
4. System operations such as startup, shutdown and transfers shall be demonstrated.
5. A certified copy of the test results shall be available for each system as indicated on the order.

C. Manufacturer

1. The UPS Cabinet shall be provided by Emerson / Liebert® Model eXM™ or approved equal.

2 PRODUCTS

2.1 FABRICATION

A. Materials

1. All materials of the UPS shall be new, of current manufacture, high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semiconductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat.

B. UPS Internal Wiring

1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electric Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

C. Field Wiring

1. All field wiring power connections shall be to tin-plated copper busbars for connection integrity. Busbars shall have adequate space to allow two-hole, long-barrel, compression type lugs forming a permanent connection between field wiring and field-installed lugs.
2. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass and DC connections. In conformance with the NEC, connection cabinets shall provide for adequate wire bend radius.

D. Construction and Mounting

1. The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for

hoisting, jacking and forklift handling. Maximum cabinet height shall be 78.7 in. (2000mm).

2. The UPS shall be NEMA Type 1-compliant, with front doors open to enable safe change of air filters without the need for shutdown.

E. Cooling

1. Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings.
2. Temperature sensors shall be provided to monitor the UPS's internal temperature. Upon detection of temperatures in excess of the manufacturer's recommendations, the sensors shall cause audible alarms to be sounded and visual alarms to be displayed on the UPS control panel. Air filters shall be located at the point of air inlet and shall be changeable. No service clearance or ventilation shall be required in the rear of the system.

2.2 EQUIPMENT

A. UPS System

1. The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and three-phase, transformer-free inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

B. Surge Protection

1. The UPS shall have built-in protection against surges, sags and overcurrent from the AC source. The protection shall meet the requirements of ANSI C62.41 A3 and B3 including:

   a. 6kV, 100kHZ ring wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground
   b. 6kV, combined wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground.

C. Output Protection

1. The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in

protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting, current-limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

2.3 COMPONENTS

A. Rectifier

1. The term rectifier shall denote the solid-state equipment and controls necessary to convert alternating current to regulated direct current to supply the inverter and charge the battery. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.

    a. Input Current Harmonic Distortion

2. The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for an additional passive input filter. Input current THD shall be less than 5% at rated load and nominal voltage in double-conversion mode.

    a. Dynamic Current Input Limit Reduction

3. The rectifier, in conjunction with the other UPS controls and circuitry, shall adjust the current demanded for battery charging as a function of UPS wattage load and input voltage level.

B. DC-DC Converter

1. The term DC-DC converter shall denote the equipment and controls to regulate the output of the rectifier to the levels appropriate for charging the battery and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power and, for increased performance, shall be a pulse width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The DC-DC converter shall control charging of the battery. The AC ripple voltage of the charger DC shall not exceed 1% RMS of the float voltage.

a. Battery Recharge

2. In addition to supplying power for the load, the rectifier/charger shall be capable of supplying a minimum of 5% of the module full load power rating for recharging the battery. The battery recharge rate capability shall be sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time while running at 95% of full load at nominal voltage, provided that the battery can accept recharge at that rate. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

a. Battery Equalize Charge

3. A manually initiated equalize charge feature shall be provided to apply an equalize voltage to the battery. The duration of equalize charge time shall be adjustable from 8 to 30 hours. A method shall be available to deactivate this feature for valve regulated battery systems.
a. Stop Battery Charging Function

4. Battery charging may be stopped by a shunt trip of the battery cabinet breaker when over-temperature is sensed in the battery cabinet, on generator or when environmental contact is closed.

a. Overvoltage Protection

5. There shall be DC overvoltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass or shall disconnect the battery via the DC breaker(s) in the battery string.

a. Temperature-Compensated Charging

6. The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. When multiple sensors are used, the voltage shall be based on the average temperature measured. Excessive difference in the temperature measurements shall be reported and the charging voltage adjusted to protect the batteries from excessive current.

a. Battery Load Testing

7. The UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier shall reduce charging voltage to force the batteries to carry the load for a short time. If the curve of battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.

C. Inverter

1. The term inverter shall denote the equipment and controls to convert direct current from the rectifier or battery via the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state, capable of providing rated output power and, for increased performance, the inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). To further enhance reliable performance and efficiency, the inverter shall not require an inverter output series static switch/isolator for the purposes of overload or fault isolation or transfers to bypass.

   a. Overload Capability

2. The inverter shall be able to sustain an overload across its output terminals while supplying full rated voltage of up to 150% for 60 seconds. The inverter shall be capable of at least 200% current for short-circuit conditions including phase-to-phase, phase-to-ground and three-phase faults. After the fault is removed, the UPS shall return to normal operation without damage. If the short circuit is sustained, the load shall be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.

   a. Output Frequency

3. The inverter shall track the bypass continuously, providing the bypass source maintains a frequency of 60Hz ±1% (0.6 Hz).

   a. Phase-to-Phase Balance

4. The inverter shall provide a phase-to-phase voltage displacement of no worse than ±3% with a 100% unbalanced load.

   a. Inverter Fault Sensing and Isolation

5. The UPS shall be provided with a means to detect a malfunctioning inverter and isolate it from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits.

    a. Battery Protection

6. The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.

D. Inverter Bypass Operation

1. When maintenance is required or when the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC (bypass) source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform a transfer. The inverter bypass circuit shall consist of a continuous duty bypass static switch and an overcurrent protection device to isolate the static bypass switch from the bypass utility source. The bypass static switch shall denote the solid-state device incorporating SCRs (silicon controlled rectifiers) that can automatically and instantaneously connect the alternate AC source to the load.

    a. Static Bypass Switch Rating

2. The static bypass switch shall be rated for continuous duty operation at full rated load for highest reliability without the use of mechanical devices as used with a momentary rated device.

    a. Manual Load Transfers

3. A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break, utilizing the inverter and the bypass static switch.

    a. Automatic Load Transfers

4. An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load to the inverter only after the load has returned to a level within the rating of the inverter source and the alarm has been acknowledged.

    a. Momentary Overloads

5. In the event of a load current inrush or branch load circuit fault in excess of the inverter rating, the bypass static switch shall connect the alternate AC source to the load for at least 600 milliseconds, allowing up to 1000% of the normal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed before the end of the 600-millisecond period, the bypass static switch shall turn Off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source is to be completed.

    a. Back-Feed Protection

6. As required by UL1778 and CSA, the static transfer switch shall not back-feed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The purpose of this requirement is to prevent the risk of electrical shock on the distribution system when the normal source of power is disconnected or has failed. If a shorted SCR is detected, the static transfer switch shall be isolated by an internal automatic circuit breaker and an alarm message shall be annunciated at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the bypass static switch.

    a. Active ECO-Mode

7. When selected, this mode of operation shall transfer the load to the bypass source and maintain it there as long as the bypass source frequency, slew rate and voltage are within the adjusted operating parameters. While in this mode, the inverter shall remain operating to demonstrate the ability to instantaneously assume the load without interrupting the output voltage. Should the bypass source go outside the adjusted limits, the bypass static switch shall turn Off, isolating the load from the bypass while the inverter

assumes the full critical load. The load shall be transferred from the bypass source to the inverter while maintaining the output voltage within the ITIC and CBEMA curves.

E. Display and Controls

1. UPS Control Panel

a. The UPS shall be provided with a microprocessor-based control panel for operator interface (may also be referred to as User Interface, or UI) to configure and monitor the UPS. The control panel shall be located on the front of the unit where it can be operated without opening the hinged front door. A backlit, menu-driven, full-graphics, color touchscreen liquid crystal display shall be used to enter setpoints for the battery test (duration and end voltage), display system information, metering information, a one-line diagram of the UPS and battery, active events, event history, startup instructions and transfer and shutdown screens.

b. No mechanical push buttons shall be used.

2. Logic

a. UPS system logic and control programming shall reside in a microprocessor-based control system with nonvolatile flash memory. Rectifier, inverter and system control logic shall utilize high-speed digital signal processors (DSPs). CANbus shall be used to communicate between the logic and the User Interface as well as the options. Switches, contacts and relays shall be used only to signal the logic system as to the status of mechanical devices or to signal user control inputs. Customer external signals shall be isolated from the UPS logic by relays or optical isolation.

3. Metered Values

a. A microprocessor shall control the display and memory functions of the monitoring system. All three phases of three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accuracy to ±3% of voltage, ±5% AC current. The following parameters shall be displayed:

i. Input voltage, line-to-line
ii. Input current per phase

iii. Input frequency
iv. Input apparent power (kVA)
v. Battery voltage
vi. Battery charging/discharging current
vii. Output voltage, line-to-line
viii. Output frequency
ix. Bypass input voltage, line-to-line
x. Bypass input frequency
xi. Load current
xii. Load real power (kW), total and percentage
xiii. Load apparent power (kVA), total and percentage
xiv. Load percentage of capacity
xv. Battery temperature, each battery string
xvi. Battery state of charge.

4. Power Flow Indications

a. A power flow diagram shall graphically depict whether the load is being supplied from the inverter, bypass or battery and shall provide, on the same screen, the status of the following components:

i. AC Input Circuit Breaker (optional)
ii. Battery Circuit Breaker, each breaker connection of complete battery complement, complete disconnection and partial connection (one or more, but not all breakers open.)
iii. Maintenance Bypass Status.

5. Main Display Screen

a. The following UPS status messages shall be displayed:
i. Rectifier (Off / Soft Start / Main Input On / Battery Input On)
ii. Input Supply (Normal Mode / Battery Mode / All Off)
iii. Battery Self Test (True / False)
iv. Input Disconnect (Open / Closed)
v. EPO (True / False)
vi. Charger (On / Off)
vii. Output Disconnect (Open / Closed)
viii. Maint. Disconnect (Open / Closed)
ix. Bypass Disconnect (Open / Closed)
x. Inverter (Off / Soft Start / On)
xi. Bypass (Normal / Unable To Trace / Abnormal)

xii. Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable)
xiii. Inverter On (Enable / Disable).

6. HMI Control Buttons

a. Buttons shall be provided to start and stop the inverter. A pop-up message requesting confirmation shall be displayed whenever a command is initiated that would change the status of the UPS.
b. Other buttons shall be provided to reset faults and silence the alarm buzzer.

7. Event Log

a. This menu item shall display the list of events that have occurred recently while the UPS was in operation. The Event Log shall store up to 2048 events, with the oldest events being overwritten first if the log's capacity is reached.

8. Battery Status Indicator

a. A battery status indicator shall display DC alarm conditions, temperature, battery state of charge, the present battery voltage, total discharge time, status of last battery test and battery time remaining during discharge.
b. The UPS shall provide the operator with controls to perform the following functions:

i. Configure and manage manual battery test.
ii. Modify test duration and minimum voltage
iii. Start battery test
iv. Monitor test status and progression
v. Stop battery test
vi. Battery test status

9. Alarms

a. The following alarm messages shall be displayed:

i. Mains Voltage Abnormal
ii. Mains Undervoltage
iii. Mains Freq. Abnormal
iv. Charger Fault

v. Battery Reversed
vi. No Battery
vii. Parallel Comm. Fail
viii. Bypass Unable To Track
ix. Bypass Abnormal
x. Inverter Asynchronous
xi. Fan Fault
xii. Control Power Fail
xiii. Unit Over Load
xiv. System Over Load
xv. Bypass Phase Reversed
xvi. Transfer Time-Out
xvii. Load Sharing Fault
xviii. Bypass Over Current.

10. Controls.

a. System-level control functions shall be:
i. Start Inverter (and transfer to inverter)
ii. Stop Inverter (after transferring to bypass)
iii. Startup Screen
iv. Battery Test Setpoint Adjustment
v. Configure Manual Battery Test
vi. Initiate Manual Battery Test
vii. System Settings (Time, Date, Language, LCD Brightness, Password, Audio Level)
viii. Alarm Silence Command
ix. Fault Reset Command
x. ECO mode.

11. Manual Procedures

a. Load Transfers: HMI buttons (START INVERTER, STOP INVERTER) shall provide the means for the user to transfer the load to bypass and back on UPS.

F. Self-Diagnostics

1. Event Log File - The control system shall maintain a log of the event conditions that have occurred during system operation. Each log shall contain the event name, event time/date stamp and a set/clear indicator.

G. Remote Monitoring and Integration Capabilities

1. LIFE™ Services: The UPS manufacturer shall provide as an option LIFE services, which provides 24x7 continuous monitoring of events and parametric data, event and data analysis reports and dispatch of factory trained field service personnel. The UPS shall be able to initiate periodic and critical event-driven communication with a remote service center to transfer event and parametric data for analysis and action. The remote service center shall be staffed with factory-trained service personnel who are capable of receiving, analyzing and interpreting the communicated events and data. The remote service center personnel shall also be capable of dispatching factory-trained field service personnel to the location of the UPS.
2. Communication Card: The UPS can be equipped with EtherNet communication card for connection to the site SCADA system.
3. Output Alarm Contacts: Dry contact outputs shall be provided for Summary Alarm, Bypass Active, Low Battery and AC Input Failure.
4. Customer Input Contacts: The UPS shall have four discrete input contacts available for the input and display of customer-provided alarm points or to initiate a pre-assigned UPS operation. Each input can be signaled by an isolated, external, normally open contact.
5. When an assembly is selected as a pre-assigned UPS operation, the following actions shall be initiated:

    a. Transfer to Bypass—Manual command to transfer from inverter operation to static bypass operation.
    b. Fast Power Off—Emergency Module Off (EPO) command to stop UPS operation.
    c. Acknowledge Fault—Acknowledge a UPS alarm condition and present faults will be reset.
    d. Bypass/Inverter Off—Emergency Power Off (EPO) command to stop UPS operation.
    e. External Maintenance Bypass Breaker (MBB) status (open or closed).

H. Battery Disconnect Breaker

1. The battery cabinet shall have a properly rated circuit breaker (600VDC) to isolate it from the UPS. This breaker shall be in a separate NEMA 1 enclosure or in a matching battery cabinet. When this breaker is open, there shall be no battery voltage in the UPS enclosure. The UPS shall be automatically disconnected from the battery by a shunt trip of the battery cabinet breaker when signaled by other control functions.

I. Battery Plant

1. The battery plant shall comply with the specifications of:

a. Matching Battery Power Pack, or
b. Valve-Regulated, Sealed Cell Battery System on Rack.

2. Matching Battery Power Pack (VRLA Battery)

a. The battery power pack shall consist of sealed, valve-regulated batteries and a properly rated circuit breaker (288VDC nominal, 600VDC maximum) for isolating the battery pack from the UPS. The battery cells and disconnect breaker shall be installed and housed in a NEMA-1 cabinet, matching the UPS style and design.
b. The battery system shall be sized to support a 15 kVA load for 90 minutes. The battery system shall provide 100% initial capacity upon delivery.

c. The battery shall be lead-calcium, sealed, valve-regulated type with a 3-year full warranty and a 7-year pro rata warranty under full float operation. The battery design shall utilize absorbent glass mat (AGM) technology to immobilize the electrolyte.

J. Optional Accessories and Features

1. Load Bus Sync

a. The Load Bus Sync (LBS) shall enable two independent single-module UPS units to stay in sync when operating on battery or unsynchronized input sources. The LBS shall determine the master and slave relationship between UPS units. The LBS shall be installed within each single-module UPS.

2. Communication Card

a. A communication card shall provide Web-based UPS monitoring and management capabilities and one or two of the following remote monitoring protocols: SNMP (v1, v2, v3), Modbus, EtherNet or BACnet for remote monitoring.

3. Relay Contact Card

a. A relay contact card shall provide output dry contact signals communicating the following UPS states: Summary Alarm, Bypass Active (On Bypass), Low Battery, AC Input Failure (UPS Fault) and On UPS.

3. EXECUTION

3.1 FIELD QUALITY CONTROL

1. The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS startup.

   a. Visual Inspection

      i. Inspect equipment for signs of damage.
      ii. Verify installation per drawings supplied with installation manuals or submittal package.
      iii. Inspect cabinets for foreign objects.
      iv. Verify that neutral and ground conductors are properly sized and configured per manufacturer's requirements as noted in the approved shop drawings supplied with installation manuals or submittal package.
      v. Inspect each battery jar for proper polarity.
      vi. Verify that all printed circuit boards are configured properly.

   b. Mechanical Inspection

      i. Check all control wiring connections for tightness.
      ii. Check all power wiring connections for tightness.
      iii. Check all terminal screws, nuts and/or spade lugs for tightness.

   c. Electrical Inspection

      i. Check all fuses for continuity.
      ii. Confirm input and bypass voltage and phase rotation are correct.
      iii. Verify control transformer connections are correct for voltages being used.
      iv. Ensure connection and voltage of the battery string(s).

3.2 UNIT STARTUP

A. Energize control power.
B. Perform control/logic checks and adjust to meet manufacturer's specification.

C. Verify DC float and equalize voltage levels.
D. Verify DC voltage clamp and overvoltage shutdown levels.
E. Verify battery discharge, low battery warning and low battery shutdown levels.
F. Verify fuse monitor alarms and system shutdown.
G. Verify inverter voltages and regulation circuits.
H. Verify inverter/bypass sync circuits and set overlap time.
I. Perform manual transfers and returns.
J. Simulate utility outage at no load.
K. Verify proper recharge.

3.3 MANUFACTURER'S FIELD SERVICE

A. Service Personnel

1. The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory-trained field service personnel dedicated to the startup and maintenance of UPS and power equipment.
2. The manufacturer shall provide a national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours a day, 7 days a week and 365 days a year. If emergency service is required, on-site response time shall be 4 hours or less within 150 miles of the nearest services center.
3. Two local customer engineers shall be assigned to the site with a regional office as a backup. Escalation procedures shall be in place to notify Power Technical Support if a site is not functioning within 24 hours.

B. Automated Site Monitoring

1. The UPS manufacturer shall provide as an option an automated site monitoring service. This service shall be staffed by a qualified support person 24 hours a day, 7 days a week and 365 days a year. At the detection of an alarm within the UPS, the controls shall initiate communication with the monitoring service. The monitoring service shall be capable of interpreting the communicated alarms to allow dispatch of a service engineer.

C. Replacement Parts Stocking

1. Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the country.
2. Spare parts shall be stocked by local field service personnel with backup available from national parts centers and the manufacturing location. A

Customer Support Parts Coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

D. Maintenance Contracts

1. A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available.

+++ END OF SECTION 13310 +++

SECTION 13400
INSTRUMENTATION, CONTROL AND MONITORING SYSTEM
PROGRAMMABLE LOGIC CONTROLLER

PART 1 - GENERAL

1.01 Scope

A. This section covers the specific work necessary for engineering, furnishing, installing, adjusting, testing, documenting, and starting up of the Programmable Logic Controller (PLC) of the Instrumentation and Control System.

B. A Programmable Logic Controller (PLC) shall be furnished complete with all materials, equipment, and work required to implement a complete and operating system.

C. The PLC subsystem shall be furnished integral to panel LCP-Q and LCP-H and shall include a local color graphics operator interface for monitoring and modifying control parameters.

D. The unit shall be provided with all necessary hardware and software to communicate over EtherNet. It shall be the responsibility of the Instrumentation Subcontractor to coordinate and establish the software interface requirements with the City. Final acceptance of the PLC subsystem shall be contingent upon successfully demonstrating communications.

E. The Instrumentation Subcontractor shall provide the PLC system and software as specified herein and as required of other sections of Division 13.

F. Refer to the input/output schedule at the end of this Section for a summary of the minimum I/O requirements excluding spare I/O. Twenty-five percent installed spare I/O points of each type used shall be calculated and furnished after the operational requirements of the system have been satisfied.

1.02 Submittals

A. In addition to the detailed submittal requirements of Section 13000 of this Specification, the following shall also be provided:

1. All accessories.
2. Listing of all PLC hardware.
3. I/O arrangement drawings.
4. Software program listing and I/O address mapping.
5. System block diagram and cabling requirements.

1.03 Equipment and Services

A. In order to operate the River Intake Pump Station, an integrated control system utilizing a programmable logic controller (PLC) shall be required. This specification is intended to procure a complete control system including but not limited to:

1. Programmable Logic Controller (PLC).
2. PLC programming services.
3. PLC hardware and software system test and start-up.
4. Operator training.
5. System warranty.

PART 2 - PRODUCTS

2.01 HARDWARE REQUIREMENTS

A. General:

1. A programmable logic controller (PLC) shall be provided as specified herein and/or on the Drawings. PLC shall be installed, wired, and tested as an integral part of control panel LCP-QR and LCP-H. PLC shall receive, condition, act upon, and output analog and discrete signals required to provide a complete and functional operating system as specified.

2. The PLC shall consist of a memory section for program instruction storage, a central processing unit (CPU) to act upon the instructions as a function of external inputs, and an input/output section to interface to field devices.

3. The controller shall be modular and all circuit elements shall be solid state unless otherwise specified. The memory and input/output capacity shall be selected to adequately provide the required operations, with at least 25% additional unused I/O and memory after the system is fully operational.

4. The operating environment shall be 0^{o}C to 60^{o}C with a relative humidity of 5% to 95% non-condensing.

5. PLC shall be as manufactured by Allen-Bradley Model ControLogix.

B. System Memory Requirements

1. The standard storage medium shall consist of battery-backed read/write random access memory (RAM), and erasable/re-programmable read only memory (EPROM). The processor and associated memory shall be incorporated into the same enclosure. Under normal operating conditions, the PLC RAM shall retain a program for no less than one week in the event of power failure. Memory shall be

sufficient to accommodate the final program plus twenty-five percent spare programmable capacity.

C. Central Processing Unit

1. The CPU shall plug directly into the I/O base and require no additional wiring to the base, power supply or the local I/O system. The unit will have indicators on the front bezel that monitor the PLC operation, the PLC battery, the CPU's mode of operation. The CPU shall incorporate all necessary logic ability to sequentially scan the inputs, the instruction memory, temporary internal memory (if any) and the outputs; and to perform all necessary logic to execute the solution of the logic equations entered via the stored instructions. The CPU shall be capable of performing PID instruction for process control applications.

2. Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down.

3. Provide Allen Bradley Model: 1756-L62

4. The PLC's for both LCP-Q and LCP-H shall be redundant and utilize an Allen-Bradley system redundancy module part number 1757-SRM.

D. PLC I/O Subsystem

1. General

a. All inputs and outputs shall be isolated from the field components. Modules and their rack assemblies shall contain all circuitry for interfacing inputs and outputs to the PLC system. The CPU shall allow user-configurable I/O mapping. I/O modules shall be able to be plugged into any location of any I/O base. I/O modules shall be capable of being removed from the I/O base without disconnecting field wiring through the use of removable terminal block assemblies. Standard I/O module features shall include optical isolation, load side indicators and fused outputs. I/O modules provided shall be of a consistent type for both analog and discrete signals.

b. As a standard feature, the PLC shall have the capability of addressing remote I/O modules up to 3,300 cable feet from the processor. The communication link between the CPU and the I/O chassis shall be via a twin axial cable or fiber optic link.

c. A malfunction in any remote I/O channel shall affect the operation of only the operation of only that channel and not the operation of the CPU or any other channel.

d. The I/O rack assemblies will provide mounting slots for the processor, power supply and I/O modules. Units shall be designed specifically for 19 inch rack mounting.

2. I/O Modules

a. The following standard I/O modules shall be utilized:

1) a. Discrete Inputs:
Unless otherwise noted, all digital input modules shall be eight or sixteen channel 120V ac type.

b. Provide Allen Bradley Model: 1756 IA16I

2). a. Discrete Outputs
Discrete outputs shall be eight or sixteen channel modules. Interposing relays as specified in Section 13200, shall be utilized for all outputs.

b. Provide Allen Bradley Model: 1756-OA16

3) a. Analog Outputs
Unless otherwise noted, all analog output modules shall be of the isolated type.

b. Provide Allen Bradley Model: 1756-OF6I

4) a. Analog Inputs
Unless otherwise noted, all analog input modules shall be of the isolated type.

b. Provide Allen Bradley Model: 1756-IF6I

3. EtherNet Communication Link

a. An EtherNet communication interface module shall be provided.

b. Provide Allen Bradley Model: 1756-ENBT

4. Terminations

All I/O wiring to field components shall pass through dedicated terminal block assemblies as specified in Section 13200. Direct connection from I/O modules to field mounted components will not be accepted.

E. Graphic Operator Interface

1. A local operator interface unit shall be provided on panel LCP-Q and LCP-H to allow non-technical personnel to make authorized changes in setpoints controlling the process equipment. The unit shall be an intelligent interface and may be used as a stand alone operator interface.

2. Graphic Terminal shall have a 15 in. flat-panel color display with 640 x 480 resolution (minimum) and 18-bit graphics. This terminal shall support operator input via keypad (40 function keys), via touch screen or via keypad and touch screen. Unit shall be suitable for panel mounting.

4. Unit shall be connected to the control panel EtherNet switch via EtherNet link.

5. Unit shall be Allen-Bradley Bulletin 2711P PanelView™ Plus 1500 or equal.

F. Computer workstation.

1. Computer workstation shall be provided at River Intake Pump Station Electrical Room.

2. The workstation shall meet the following requirements:

- Dell Precision Workstation T3400: Intel Core 2 Duo Processor E7400, 2.8GHz/1066MHz/3MB L2/375W
- Operating System: Genuine Windows Vista Business Bonus-XP Professional downgrade
- Memory: 4GB, DDR2 SDRAM memory, 800MHz, ECC (4 DIMMS)
- Graphics Cards: 256MB PCIe x16 NVS 290, dual DVI capable
- Hard Drive Configuration: C1 – All SATA drives, No RAID for 1 hard drive
- Boot Hard Drive: 250GB SATA 3.0Gbps w/NCQ and 8MB DataBurst Cache
- Additional Network Card: Broadcom NetXtreme 10/100/1000 Gigabit Enet Controller-PCIe card
- Floppy Drive Options: No floppy drive
- CD-ROM, DVD & RW Devices: 16x DVD +/-RW w/CyberLink PowerDVD and Roxio Creator Dell Ed
- Sound Card: Sound Blaster X-FI XtremeMusic w/Dolby#173
- Speakers: Dell AX510PA Sound Bar for Entry Flat Panel Displays
- Keyboard: USB entry Quietkey, no hot keys
- Mouse: Dell USB Optical mouse with scroll

- Resource CD: Resource DVD – contains diagnostics and drivers
- Warranty: 3-year Basic Limited Warranty and 3 Year NBD onsite service
- Productivity Software: Microsoft Office 2007 Professional
- Monitor: Dell 24in Widescreen Flat Panel w/adjustable stand, G2410.

G. Spare Parts.

1. Ten percent (rounded up to nearest whole number but a minimum of one) of each type I/O module used (analog and discrete). This requirement is in addition to the installed spare capacity specified herein above.

2. Five fuses of each size and type per every 20 used (minimum of five each).

3. One EtherNet communication interface module designed to be housed in the I/O chassis.

2.02 SOFTWARE REQUIREMENTS

A. PLC

1. PLC System Programming

a. The PLC software shall perform all logic and interlock functions presented in the Process and Instrumentation Drawings and Specifications in Section 13100.

b. The method of programming shall permit entering of instructions by keyboard. The programming language shall consist of symbols and/or short English words and abbreviations representing relay contacts (switches), relay coils (outputs) and boolean algebra operators and/or their equivalents. Special functions such as timers, counters, shift registers, comparators, stepping switches, and relays shall be generated by pre-programmed instructions, addressable and controlled by the main program, or generated by detailed instructions written in the main program at the election of the Vendor.

c. All programming services and software programs necessary to provide a complete and operational system including minor software additions during startup, whether or not specified herein, shall be included in the original bid price.

2. Math and Data Functions.

The logic program shall be capable of containing up to three comparisons on one

line of logic. It shall be possible to perform a block data transfer of relay ladder logic. Math functions shall include addition, subtraction, multiplication, division and square root capable of generating an answer in the range -32,767 to +32,767. In the event these limits are exceeded, an overflow bit will be set, indicating that numerical conditioning is necessary to generate an accurate result. Image registers and shift registers shall operate on a first-in, first-out (FIFO) basis. There shall be an instruction that emulates an electro-mechanical drum operation.

3. Alarm Functions

a. Not in Auto Alarms

1. Before operating any field device, the PLC program shall check to see that the device has been switched to the "AUTO" mode. If the device is not in "AUTO", the PLC shall set an error bit and suspend control of the device until it is switched to "AUTO". The CCM system shall use the error bit to log a "Not in AUTO" alarm.

b. No Response Alarms

1. If at any time a field device fails to respond to an output command from the PLC, the PLC shall set an error bit. The CCM shall use the error bit to log a "No Response" alarm.

4. Timers

The preset values for all PLC timers and process setpoints shall be operator accessible and adjustable from the operator interface. Values shall be capable of being changed remotely by the CCM operator.

B. The existing HMI software package at both the Hemphill and Chattahoochee Water Treatment Plants currently installed is GE Proficy iFix SCADA version 5.1

The ICM integrator is to provide a new iFix/ IClient runtime package for the new River Intake PC.

All existing nodes shall be upgraded to display the new graphic as required for the upgrades.

The existing GE I/O driver (IGS for Rockwell) must be upgraded to latest version.

C. Graphics Meeting

1. The graphical interface shall be developed with direction from the Engineer. Programming services shall include as a minimum, two (2) meetings with the Engineer to develop the interactive graphic displays.

2. The first meeting will be used to present the capabilities of the software and to provide the Engineer with vendor recommended sketches of the displays he proposes to furnish. The displays shall include the following information as a minimum:

   a. Pump Station Overview Graphic including the operating status of all major equipment (Run, Stopped, Failed), levels, and flows (10 object oriented displays minimum).
   b. Alarm History (1 display).
   c. Specific Equipment Data Access Displays for control and monitoring (as required).
   d. Motor Elapsed Time Display (1 display).
   e. Number of motor or equipment starts display (as required).

   See Process and Instrumentation Diagrams for any additional HMI indication/controls requirements.

3. The second meeting will be to review the agreed format of displays generated from the first meeting and to agree on what information will be communicated to and from the CCM system.

+++ END OF SECTION 13400 +++

SECTION 13940
COMMUNICATION LINKS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements of Section 13000 form a part of this Section.

B. Provide fiber optic and wire communication links to interconnect components of the PLC system, security (access) system and fire alarm system. See the SCADA Block Diagram, drawings for additional communication link requirements, including equipment locations and quantities.

C. Items provided under this Section are installed in enclosures provided under Section 13110, Panels and in wireways provided under Division 16, Electrical or existing.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer installation recommendations for all products. Provide complete installation procedures that will be followed for this work.
2. Test procedures prior to testing. Provide test documentation after testing.
3. Training procedures prior to training.
4. Catalog cut sheets.

1.03 FINAL DOCUMENTATION

A. Provide final documentation required by Section 13000.

B. Provide all test documentation.

1.04 TRAINING

A. Provide one day of training for City personnel during installation. Provide one day of training for City personnel during post-installation testing.

PART 2 - PRODUCTS

2.01 FIBER OPTIC COMMUNICATION LINKS

A. Fiber Optic Cable:

1. Each cable shall contain a minimum of 18 functional fibers after installation, connection, and testing are complete.

2. Fiber shall be a single mode, graded index, solid glass waveguide, and shall be coated to preserve the intrinsic strength of the glass. Each fiber shall be color coded. Fiber shall have the following characteristics:

Core diameter:	62.5 microns
Cladding diameter	125 microns
Refractive index delta	2.0 percent
Numerical aperture (NA)	0.275
Attenuation at 1300 nm	1.0 dB/km maximum
Bandwidth at 1300 nm	500 MHz/km minimum
Attenuation at 850 nm	3.75 dB/km maximum
Bandwidth at 850 nm	160 MHz/km minimum

3. Cable shall include a buffer tube surrounding the fibers, one or more strength members, and an outer jacket. Cable components shall be of continuous material with no factory splices, holes, blisters, or other imperfections. Cable shall have the following characteristics:

Material	non-metallic
Tensile load rating	600 lb minimum, long term
Bend radius rating	5 inches maximum unloaded (0-180 lb); 10 inches maximum loaded (181-600lb)
Diameter	0.5 inches nominal

4.. Buffer tube shall allow for free fiber movement and thermal expansion. Buffer tube shall be flooded internally with a gel compound to prevent fiber contamination and freezing stress from moisture.

5. Strength members shall protect fibers from mechanical stress during installation and required service.

6. Cable shall be for outdoor installation in conduit.

7. Fiber optic cable shall be 18; or equal.

B. Fiber Optic Connectors:

1. Provide a connector on each end of each fiber.

2. Type: ST (bayonet twist-lock keyed).

3. Typical attenuation: 0.2 dB.

4. Maximum attenuation: 0.4 dB.

5. Loss repeat: less than 0.2 dB per 1,000 reconnects.

6. Fiber optic connector shall be AT&T, model P2020C-C-125; or equal.

C. Fiber Optic Patch Panels:

1. Provide a patch panel at each fiber optic cable termination.

2. Patch panel shall include coupling panel(s), bayonet/threaded couplings, and a lockable door. Patch panel shall totally enclose the connectors and patch cords. Provide 19-inch rack mounting brackets.

3. Mount 2 patch panels side-by-side in enclosures provided under Section 13200, Panels as required. Terminate each fiber optic cable at a separate patch panel.

4. Going clockwise around the site, terminate the incoming cable at the left patch panel and the outgoing cable at the right patch panel.

5. Fiber optic patch panel shall be AT&T, model 200A LIU; or equal.

6. Coupling panel shall be AT&T, model 10A; or equal.

7. Couplings shall be AT&T, model C2000A-2; or equal.

8. Mounting bracket shall be AT&T, model 742A; or equal.

D. Fiber Optic Patch Cords:

1. Provide patch cords to interconnect two cable fibers between panels (pass through jumper) or to connect cable fibers to converters as indicated on the Block Diagram. Each patch cord shall have 2 fibers for 2 direction communication.

2. Patch cord fibers shall be 62.5-micron with associated attenuation and bandwidth parameters as specified. Each fiber shall have an individual thermoplastic tight buffer tube, strength member, and a thermoplastic jacket.

3. Provide a minimum of 20 percent spare or 2 spare patch cords, whichever is greater, of each type and length.

4. Fiber optic patch cords shall be AT&T, model FL2E-E; or equal.

E. Fiber Optic Splice Enclosures:

1. Fibers shall not be spliced except where specifically approved in writing by the Engineer. The following shall not be acceptable reasons for splicing fibers: cable length availability or cost; cable installation convenience or cost.

2. If used, splice enclosures shall protect spliced fibers from moisture, soil, strain, or other damage. At each splicing location, sufficient cable length shall be provided to properly rack and splice the cables and to allow for additional future splices.

3. Ground splice enclosures to earth per Division 16, Electrical.

4. Fiber optic splice enclosure shall be AT&T, Model 2600LG; or equal.

2.02 WIRE COMMUNICATION LINKS

A. Industrial Twisted Pair (ITP) Fast Ethernet Cables – CAT 6

1. ITP cable shall have two cores stranded with two dummy elements to form a pair.
2. Each pair shall be sheathed in plastic film and shielded with two plastic-clad aluminum foils.
3. The outer shield braid shall be made of tinned copper wires around all pairs.
4. The plastic sheath shall be PVC.
5. The ITP cable shall be a standard 9 pin cable with RJ45 type connectors.
6. ITP Cables shall be Siemens Industrial Twisted Pair standard cable or equal by AT&T or Belden.

2.03 CELLUAR MODEM

A. The ICM integrator shall provide a cellar based WAN communication network consisting of Secomea WAN clients at the Hemphill and Quarry sites.

B. Provide Secomea model 3439 (P/N: 26928) which consists of 3G/GRPS modem, 5 device agents, 4 Ethernet ports, 1 2.0 USB port, 1 RS232 serial port, 2X2 digital IO ports, 4 status LEDS. Coordinate the exact required model with the City.

C. The sim card for each unit will be provided by the city. The clients are to communicate to the City of Atlanta's Secomea gate manager. The ICM integrator is to provide all necessary configurations as required.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Provide all equipment, instrumentation, and supplies necessary for installation.

2. Remove wire from existing wireways as required.

3. Install fiber optic communication links to ensure a minimum number of splices. Fiber splices shall be made only with written approval from the Engineer prior to implementation. Wire conductors shall not be spliced.

4. Provide a minimum of 5 feet spare cable (fiber optic and wire) coiled at each cable access point (manholes, handholes, and trenches).

5. Provide cable supports in manholes and handholes according to requirements in Division 16, Electrical. Existing cable supports may be used where available and not damaged.

6. Tag all cables, fibers, and conductors according to Division 16, Electrical, Section 16120, Conductors. Provide tag documentation.

7. Pull a 200-pound tensile strength polyolefin cord through each conduit where cable is pulled.

8. Install all cable according to manufacturer recommendations. Pull all cable through conduit at the same time. Do not exceed the manufacturer recommended pulling tension. See Division 16, Electrical, Section 16120, Conductors for additional requirements.

B. Fiber Optics:

1. Demonstrate to the Engineer that manufacturer installation recommendations are strictly followed for all fiber optic components.

2. Fiber optic cable fibers shall be "fanned out" and each individual fiber shall be sleeved over with a kevlar reinforced furcation tube. At the convergence point of all furcation tubes, provide fiber strain relief with a fan-out collar. Provide fiber strain relief at each connector. Provide cable gel blocking. Provide dust caps on each fiber connector until final assembly. Provide dust caps on each connector that is not coupled.

3. Attenuation for a single fiber optic connection point (connector through coupling through connector) shall be 0.7 dB maximum.

4. Where fiber optic splices are necessary and approved, fibers shall be fusion spliced. Attenuation for a single splice shall be 0.2 dB maximum. Test each splice with an Optical Time Domain Reflectometer (OTDR) bi-directionally to verify compliance at the time of splicing. Splices not conforming to these specifications shall be redone to meet specifications. Provide cable moisture protection during splicing operations.

5. Attenuation for each fiber optic link shall be 13 dB maximum, as required for a minimum gain margin of 4 dB. The gain margin is the decibel difference between the gain of the fiber optic converters (17 dB per Section 13900) and the loss budget of the fiber optic link (fiber optic cables, connectors, patch cords, and splices).

3.02 TESTING

A. Provide all equipment, instrumentation, and supplies necessary for testing. The Engineer shall have the option to witness and actively participate in the on-site tests.

B. Fiber Optic Pre-installation Testing:

1. Prior to installing each cable, provide an Optical Time Domain Reflecto-meter (OTDR) test for each fiber at 1300 nm wavelength on the shipping spool. The OTDR test shall verify that each fiber meets the manufacturer attenuation specifications and that the cable was not damaged during shipping. Provide hard copy test documentation, including traces. Obtain approval from the Engineer prior to cable installation.

C. Fiber Optic Post-Installation Testing:

1. After cables and connectors are installed, OTDR test each fiber in both directions at 1300 nm wavelength. Provide hard copy and diskette test documentation.

2. After patch cords and couplings are installed, end-to-end attenuation test each fiber between transceiver connectors in both directions at 1300 nm wavelength. Use a stabilized light source and an optical power meter. Provide test documentation, including reference power reading.

3. Provide test documentation to the Section 13900, DCS supplier including detailed specifications for all cables and connectors used.

D. Fiber Optic Test Documentation:

1. Test documentation shall include cable and fiber identification; fiber length; test direction; test wavelength; traces; fiber attenuation; attenuation breakdown for each fiber segment, connector, and coupling; and splice attenuation if applicable.

E. Wire testing:

1. Test wire per Section 16999, Acceptance Testing and Calibration of Division 16, Electrical.

+++ END OF SECTION 13940 +++

SECTION 14600
BRIDGE CRANE AND HOIST

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete design and installation of all bridge cranes, trolleys and hoists. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:

1. Section 05120, Structural Steel.
2. Section 09900, Painting.
3. Section 16150, Electric Motors.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's certifications, including crane and hoist rated capacity, and certification per 14600.1.04.B..
2. Product and equipment data for bridge crane, hoist, trolley, load chain, hook, and all other equipment to be provided as part of the complete system.
2. Design calculations signed and sealed by a Professional Engineer registered in the State of Georgia. Structural calculations shall show deflection of bridge beam.
3. Information on all electrical items.
4. Operation and maintenance manuals.
5. Complete wiring and control diagrams.
6. Detail drawings to show all connections to building structures.
7. Operational start up and load testing results.

1.03 QUALITY ASSURANCE

A. Reference Standards:

1. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

   a. NEC, National Electric Code.
   b. NEMA, Standards of National Electrical Manufacturers Association.
   c. OSHA, Occupational Safety and Health Act.
   d. ANSI, American National Standards Institute.
   e. ASTM, American Society for Testing Materials.
   f. AISI, American Iron and Steel Institute.
   g. NFPA, National Fire Protection Association.
   h. MMA, Monorail Manufacturer's Association.
   i. AWS, American Welding Society.

2. Comply with the Crane Manufacturer's Association of America (CMAA) Standards as specified below:

   a. CMAA Specification No. 70 for electric overhead traveling cranes.
   b. CMAA Specification No. 74 for top-running and under-running single girder electric overhead travelling cranes.
   c. All single girder cranes and trolleys shall be designed for Service Class A or C as specified by CMAA.
   d. All hoists shall be designed for Service Class H1 as described in the Hoist Manufacturer's Institute (HMI) Specifications.
   e. All electrical and control components shall conform to NEC 610.

B. Experience: Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. This reference list shall be submitted with the shop drawings.

1.04 QUALITY STANDARDS

A. The bridge crane, trolley and hoists shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers:

1. Kone Cranes
2. Hoist and Crane Systems, Inc.
3. ACCO Wright/Louden
4. Or equal

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 EQUIPMENT NUMBERS

Equipment	Equipment Numbers
Bridge Crane	RIPS BC-1

PART 2 - PRODUCTS

2.01 GENERAL

A. Supports and Auxiliaries: Crane assembly shall include all overhead track, trolley, hoist, end stops, anti-sway mechanism and other track accessories as required for a complete system.

B. Runway beams, brackets, and associated framework will be furnished and installed under Section 05120, Structural Metals and as shown on the Drawings. Patented beams and associated framework, required for dewatering building hoist and any other equipment shall be included and installed under this Specification.

C. Design Parameters:

1. Design of travelling crane assembly shall be based upon the use of a safety factor of 5, with capacity load, on all mechanical parts of the system. The safety factors shall be based upon the ultimate strength of the materials used.

2. Calculations of all structural members shall include an allowance for vertical impact

and an allowance for lateral impact in accordance with the Crane Manufacturers Association of America.

3. Bridge girder deflection shall not exceed 1/600 of the span.

D. All crane, hoist, trolley and monorail equipment shall be designed to occupy the space provided, as shown on the Drawings. All dimension shall be verified at the site.

2.02 SERVICE CONDITIONS

A. The indoor equipment shall be suitable for exposure to 95% relative humidity conditions and for operation in ambient air temperature ranging from 50^0 F to 110^0 F. The outdoor equipment shall be suitable for exposure to weather conditions.

2.03 PERFORMANCE REQUIREMENTS

A. Bridge Crane Requirements

Equipment Number	RIPS BC-1
Location	River Intake Pump Station
Type	Outdoor
Rated capacity, tons	15 Ton
Span, feet	90’-0"
Lift, feet	42’-0" available
Operating speeds with rated load, feet per min.	
a. Hoist	10 ft/min stepless(ESR 12.5 ft/min
b. Trolley	65 ft/min stepless
c. Bridge	100 ft/min stepless

Motor horsepower a. Hoist b. Trolley c. Bridge	TBD by Manufacturer
Reeving	Double
Power supply	480v/3 phase/60hz 40 amp maximum

2.04 HOIST AND CRANE TROLLEY REQUIREMENTS:

A. The hoist trolley shall be low headroom type.

B. Trolley Frame: Welded rolled steel, cast steel, or forged steel construction, or a combination thereof. Rigidly constructed and designed to transmit the load to the bridge rails without undue deflection.

C. Trolley Wheels: Shall be double-flanged, with treads accurately machined or ground to size. The wheels shall be hardened to 250 minimum Brinell Hardness Number. Wheels with over 20,000 pound load shall be forged or rolled steel. The wheels shall be equipped with single row ball bearings.

D. Trolley Drive:

1. Trolley shall be propelled by a driving head mounted on the load bar of the load carrying member, with steel wheels gear driven on both sides.

2. All gearing, except pinions meshing with gears on driven wheels, on rail shall be enclosed and provided with suitable means for lubrication.

3. Brakes shall be designed for assembly on driving motor shaft or gear train to stop the rotation of the armature without causing driving wheels to lock too quickly. The selection of motors and controllers and other electrical equipment shall comply with the requirements described under article 14600-2.08, Motors and article 14600-2.09.

2.05. BRIDGE CRANE REQUIREMENTS

A. Bridge crane components shall conform to the following detailed requirements:

1. End-trucks shall have carriers with hardened wheels equipped with anti-friction bearings. Trucks shall be provided with bumpers at each end to engage stops on the crane runway.

B. Bridge Girders: Bridge girders shall be designed in accordance with the requirements of the paragraph 14600-2.01 C.

C. Bridge Drive: Individual drives on crane endtrucks.

D. Welding: Welding shall be done by certified welders and shall be in accordance with the American Welding Society standards.

2.06 HOIST REQUIREMENTS

A. Electrical Hoist: Electric hoist shall comply with the standard specifications for wire rope electric hoists, as issued by the Hoist Manufacturer's Association.

B. Drums: Shall be high-grade cast iron or equal, designed to withstand maximum bending and crushing loads; not less than 2 complete wraps of hoisting rope shall remain in the grooves when the hook is as its lowest position. Drum grooves shall be turned from the solid metal.

C. Idler Sheaves: Pitch diameters shall be not less than 1/2 the diameter of the running sheaves.

D. Hoisting ropes: 6 x 37 hemp center, improved plow steel preformed, designed for crane service.

E. Head Block Frame: Shall be steel.

F. Hook: Shall be forged steel, supported on a ball or roller thrust bearing. Hook shall rotate freely on the thrust bearing. Hook shall have a safety latch.

G. Gearing: Shall be of steel, conforming to AGMA Standards.

H. Shafts: Shall be of rolled or forged steel.

I. Bearings: Shall be roller or ball type. All bearings shall be provided with oil-bath or pressure lubrication. Bearings shall be of a design which, as far as practicable, excludes dirt and prevents leakage of oil or grease.

J. Brakes: Unit shall be provided with two (2) means of braking. One brake shall apply directly to hoist motor shaft or another shaft in the hoist gear-reduction and shall automatically set where current is interrupted to the hoist motor. The second braking

method shall be mechanical to control the speed during lowering to prevent undue acceleration.

K. Hoist Motor Brake (Alternating Current): Each hoist motor electric brake shall be of the shoe or disc type, electrically released. The rated torque of the brake shall be not less than one hundred fifty percent (150%) of the full load torque of the motor. The brake mechanism shall be so designed as to require a minimum of adjustment and provide equal clearance, as well as pressure, on both sides.

2.08 Motors

A. Motors shall be capable of handling full rated load for the full lift, or travel, at all rated speeds without overheating of the motor or controls. All motors shall be sized to operate at a maximum of eighty percent (80%) of rating when moving one hundred percent (100%) of rated load. No motor shall be provided which shall be loaded beyond its full rating with a full load on the crane. Motor shall conform to the following requirements:

Insulation Class	"F"
Rating	30 minutes NEMA
Enclosure	TENV or TEFC
Temperature Rise	85^0 C above ambient (40^0 C ambient)
Bearings	Anti-friction

B. Motors and horsepowers shall be established by the crane manufacturer. No hoist motor shall be loaded beyond eighty percent (80%) of its capacity disregarding cable, sheave, gear and bearing friction.

2.09 CONTROLS

A. Magnetic Controls: All motor starters shall be of the combination type. All motors shall be protected by thermal overload switches with automatic reset. A pushbutton station shall be suspended from the festoon system and shall rated NEMA 4X enclosure with button protectors and a two speed push button for each direction of travel. The main line contactor shall be controlled from the pushbutton.

B. Resistors: Resistors shall be edge-wound with adjustable taps, shall not be less than NEMA Class 152 for use on the hoist and bridge, and NEMA Class 151 for use on the trolley. The thermal rating of the resistors shall take into consideration the size of motors as well as the length of time the resistors are in the circuit. The resistors shall be securely

mounted and shall be protected.

C. Hoist Limit Switch: The hoist limit switch shall be so designed that when the hoist block reaches its upper limit of travel the hoist limit switch will either directly, or indirectly through a magnetic contactor or other device, interrupt the current to the hoist motor in the hoisting direction and allow the hoist motor brake to set. The limit switch shall be connected to the circuit in such a manner that it will be possible to lower the hoist block by reversing the controller into the lowering position.

D. Bridge crane conductors shall be of the enclosed bus bar type and trolley conductors shall be of the festooned cable type. The bridge and trolley conductor voltage drops from the runway supply taps shall permit the crane motors to operate satisfactorily when building system is at minus 5% of design voltage.

E. Power: Bridge Crane and hoist shall be furnished with a control panel for single point power connection of 480 Volt, 3 phase, 60 Hz.

F. Controls: The operator controls for the assemblies shall be contained in a pendant control box suspended from a separate festoon system mounted on the bridge. All controls including relays, timers, starter coils, and associated control components shall be operable by 120-volt, single-phase, 60-Hz power. Pushbuttons shall be labeled and identified for compass direction of travel. The pendant control box shall contain certain pushbuttons for control of the crane, hoist and trolley and an ON/OFF switch to operate a main line contactor which shall remove all power from the control station.

2.10 PAINTING AND PROTECTIVE COATING

A. Surface preparation and protective coating of all exposed ferrous metal surfaces shall be as specified in Section 09900, Painting.

B. Color shall be selected by Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to erection and installation of equipment specified in this Section, the Contractor shall verify dimensions on the Drawings with field conditions at the start of the work and check continuously during construction. Assemblies and components specified in this section shall be installed in strict conformance with the manufacturer's instructions and recommendations.

B. The Contractor shall furnish oil, grease and lubricants required for initial operation. The grades of oil, grease, and lubricants shall be as recommended by the manufacturer.

3.02 FIELD TESTS

A. After installation, equipment described under this Section shall be inspected by the factory representative for proper alignment, quiet operation, proper connection, and satisfactory performance. After inspection by the factory representative, each system shall be given a full load operating test. Hoisting, traveling, and safety features shall be tested. The Contractor shall furnish the labor, test load weights and materials required for such tests and shall, at its own expense, correct defects in the fabrication, erection and operation of the system.

B. All structural welds and bolted connections shall be tested in accordance with applicable standards.

3.03 MANUFACTURER'S SERVICES

A. Furnish the services of a factory representative having complete knowledge of the operational and maintenance requirements and adjustments of the system, for one (1), eight (8) hour day. The factory representative shall instruct the City's personnel in the proper operation and adjustment of the equipment. The day shall be in addition to any installation time and shall be at a time as designated by the Engineer.

+++ END OF SECTION 14600 +++

SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. The work described in this Section and/or indicated on the Drawings shall include, except where otherwise noted, the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all mechanical (HVAC and plumbing) systems.

B. Prior to the ordering or purchase of any equipment or materials or the layout or installation of any work, the Contractor shall visit and examine the site and shall examine and understand the work shown on the Drawings and described in these Specifications. If any work involves existing equipment, ductwork, piping, buildings, etc., the Contractor shall first verify model numbers, electrical characteristics, sizes, dimensions, etc. to be compatible with the work shown on the Drawings.

C. Throughout the course of the Project, the Contractor shall schedule and coordinate work with the Engineer and other trades to optimize space utilization and avoid conflict or interference with the work of other trades, structural elements, doors, windows, lights, conduit and other equipment or systems.

D. Unless otherwise shown on the Electrical Drawings, the mechanical work shall include the following items. These items shall conform with the requirements of Division 16.

1. All motors, motor starters, disconnect switches, relays and other controls and control wiring necessary for the proper operation of all mechanical equipment shall be furnished and installed under Division 15. Power wiring to mechanical equipment and a 120 volt source for control power shall be provided as a part of the electrical work.

2. All controls and control wiring shall be provided and installed under Division 15. Where control power is not available in the vicinity of mechanical equipment, a transformer shall be furnished and installed to convert power voltage to control voltage. The transformer may be an integral part of the starter.

3. Starters complete with "hand-off-automatic" switches, with running indication lights in an approved enclosure, shall be furnished and installed for mechanical equipment automatically started and stopped, or otherwise controlled by thermostats, timers, or other devices under Division 15. Starters for all manually controlled equipment shall include start-stop pushbuttons with running indication lights in an approved enclosure.

E. All electrical items provided under Division 15 of the Specifications shall be provided in

accordance with applicable sections of Division 16. Enclosures shall be the same NEMA type as specified in Division 16 or on the Electrical Drawings.

F. The Contractor will be held responsible for the satisfactory and complete execution of all work included. The Contractor shall produce complete finished operating systems and provide all incidental items required as part of the work, regardless of whether such item is particularly specified or indicated.

1.02 QUALITY ASSURANCE

A. Codes and Standards

1. All mechanical work shall be performed in accordance with all applicable codes, ordinances, rules and regulations of local, state, federal or other authorities having jurisdiction. As a minimum, this shall include: (Verify with City of Atlanta Code Department for latest updates):

   a. International Building Code 2012 with 2015 Georgia Amendments.
   b. International Mechanical Code 2012 with 2015 Georgia Amendments
   c. International Plumbing Code 2012 with 2015 Georgia Amendments
   d. International Fire Code 2012 with 2015 Georgia Amendments
   e. International Fuel Gas Code 2012 with 2015 Georgia Amendments
   f. National Electrical Codes,2011 Edition, with no Georgia Amendments
   g. International Energy Conservation Code, 2009 Edition, with Georgia Supplements and Amendments

   h. Georgia State Energy Code
   i. National Fire Protection Association Codes, 2012 NFPA-101 Life Safety, ADA and UL.
   j. Unless otherwise specified on the Drawings, the latest edition of all codes, ordinances, etc. shall be followed. Where code or other requirements exceed the provisions shown on the Contract Documents, the Contractor shall notify the Engineer. Where provisions of the Contract Documents exceed code or other requirements, the Work shall be performed in accordance with the Contract Documents.
   k. Current Codes as Adopted by DCA- Permissive Codes
   l. Current Local Amendments as Adopted;
      "The requirements in the proposed local amendment cannot be less stringent than the requirements in the state minimum standard code. If the proposed local amendment differs from state minimum standard code than the more stringent requirement shall apply".

2. All equipment, products and materials used in mechanical work shall be listed by Underwriters Laboratories, ARI or AMCA as appropriate.

3. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

B. Allowable Tolerances: Equipment shall be readily adaptable for installation and operation in the structures shown on the Drawings. No responsibility for alteration of a planned structure to accommodate other types of equipment will be assumed by the City. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. Drawings and Specifications:

1. The Drawings are diagrammatic and, unless specifically dimensioned, are intended to show only the general arrangement of equipment and accessories, and the general routing of piping, ductwork, etc. The Drawings do not specifically show every fitting, offset, contour, etc. required to accomplish the intended work or to avoid every interference that may be encountered. It shall be the responsibility of the Contractor to arrange all work to fit within the allowed space without modifying any building structure or property, and to make readily accessible all equipment and accessories requiring servicing or maintenance.

2. Should any changes be deemed necessary by the Contractor in items shown on the Contract Drawings, the Contractor shall submit shop drawings, descriptions, and the reason for the proposed changes to the Engineer for approval.

3. Exceptions and inconsistencies in Drawings and Specifications shall be brought to the Engineer's attention before Bids are submitted.

C. Operation and Maintenance Instructions: Operation and maintenance instructions shall be provided in accordance with the requirements of the General Conditions of the Contract Documents. The Contractor shall instruct the City's personnel during the adjustment and testing period. The Contractor shall also, in the presence of the Engineer, demonstrate the complete operation of each and every piece of apparatus.

1.04 QUALITY STANDARDS

A. All materials shall be furnished by manufacturers fully experienced, reputable and qualified in the manufacture of the particular material to be furnished. All material shall be designed, constructed and installed in accordance with standard practices and methods and shall comply with these Specifications as applicable.

B. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

1.05 TRANSPORTATION AND DELIVERY

A. As part of the mechanical work, the Contractor shall provide and pay for all transportation, delivery and storage required for all equipment and materials.

B. The Contractor shall closely coordinate the ordering and delivery of all mechanical equipment with other trades to assure that equipment will be delivered in time to be installed in the building without requiring special or temporary access or building modifications. Certain equipment may have to be installed prior to the erection of the building walls or roofs.

1.06 STORAGE AND PROTECTION

A. Equipment and materials shall be properly stored to protect against vandalism, theft, the elements and other harm or damage. Any equipment or materials received in a damaged condition, or damaged after receipt, shall not be installed. Only new undamaged equipment in first-class operating condition shall be installed.

B. Provide protection covers, skids, plugs or caps to protect equipment and materials stored or otherwise exposed during construction.

1.07 WARRANTY

A. All mechanical work described in the Contract Documents shall be warranted in accordance with the General Conditions of the Contract Documents.

B. This warranty shall apply to all equipment, materials and workmanship.

C. During the warranty period, all defects in mechanical systems shall be corrected in an acceptable manner, consistent with the quality of materials and workmanship of original construction, at no expense to the City.

PART 2 - PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be new, of the best grade and quality and of current production, unless specified otherwise. Equipment not specified in the Contract Documents shall be suitable for the intended use and shall be subject to approval by the Engineer.

2. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage

or wear.

3. Electric motors shall be as specified in Section 16150, Electric Motors, unless otherwise specified.

B. Piping: See appropriate sections of Division 15 for Specifications on various piping systems. See Part 3 of this Section for general stipulations on installation of piping systems.

C. Valves: See appropriate sections of Division 15 for Specifications and Part 3 of this Section for general stipulations on valve installation.

D. Unions

1. Provide and install unions between each item of equipment and the valve controlling and/or the various piping connections to it.

a. Steel Pipe: Unions 2-1/2-inches and smaller shall have ground joints. Unions 3-inches and larger shall have flanged unions.
b. PVC Pipe: Unions 2-inches and smaller shall be threaded and have Buna O-rings. Unions 2-1/2-inches and larger shall be flanged.

E. Equipment Bases: Each piece of equipment which is motor driven shall be furnished with an approved base, which shall be in addition to the foundation. Each base shall be furnished integral with the equipment or apparatus, or shall be furnished as a separate item, designed to accommodate the equipment or apparatus. Submit shop drawings for all foundations and supports for review.

F. Dielectric Isolation

1. Wherever dissimilar metals are used in piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure and contents of the system involved.

2. Dielectric isolators shall be Watts, Epco, Crane, Maloney, or Equal.

G. Anchor Bolts

1. All anchor bolts shall be ANSI type 316 stainless steel and must conform to requirements of Section 01600 and the material articles in the appropriate Sections in which they are used.

2. All anchor bolts are to be supplied by the manufacturer or fabricator of the specific

material or equipment to be installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be installed according to the manufacturer's recommendations and in accordance with the best practice and standards for the work.

2. All work shall be performed by competent personnel satisfactory to the Engineer. All work requiring particular skill shall be performed by persons that have had special training and past experience in that line of work.

B. Equipment Support

1. Major equipment supports (concrete foundations, framed structural openings, etc.) shall be furnished and installed under other Divisions of the Contract Documents as shown on the Drawings. The mechanical work shall include, however, the furnishing and installation of all miscellaneous equipment supports, housekeeping pads, structural members, rods, clamps and hangers required to provide adequate support of all mechanical equipment.

2. Unless otherwise shown on the Drawings, all mechanical equipment, piping and accessories shall be installed level, square and plumb.

C. Pipe and Ductwork Penetrations

1. Sleeves or wall pipes shall be installed in all masonry or concrete walls, floors, roofs, etc. for pipe and ductwork penetrations. See Section 15060 for pipe sleeve material requirements. Sleeves for ductwork shall be 20 gauge galvanized steel. Sleeves shall be sized to provide a minimum of ¼-inch clearance between the sleeve and pipe or duct. For insulated pipes or ducts, the clearance shall be ¼-inch between the sleeve and the insulation.

2. As far as possible, all pipe and ductwork penetrations shall be made at the time of masonry or concrete construction. Where drilling is required, only core drills shall be used. Star drills shall not be used.

D. Welding

1. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process.

2. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping. The Contractor shall pay for all electrical energy and/or gas used in welding.

E. Cutting and Patching: Where cutting or patching becomes necessary to permit the installation of any work or should it become necessary to repair any defects that may appear in patching, the Contractor shall make the necessary repair at no cost to the City.

F. Large Apparatus and Equipment: All large apparatus and equipment which is specified or shown to be furnished or installed under this Contract, and which may be too large to be moved into its final position through the normal building openings planned, shall be placed by the Contractor in its approximate final position before any obstructing structure is installed. All apparatus shall be cribbed up from the floor and cared for as specified under Paragraph 1.06 or as directed by the Engineer.

G. Cross Connection and Interconnections

1. No plumbing fixture, device or piping shall be installed which will provide a cross connection or interconnection between a distributing supply for drinking or domestic purposes and a polluted supply, such as drainage system or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the water supply system.

2. The Contractor shall verify location of all existing utilities and make all connections to existing facilities as required.

H. Thermal Expansion of Piping

1. The Contractor shall furnish and install all devices required to permit the expansion and contraction of all work installed by the Contractor, particularly in water supply and circulating systems. In the main water and circulating lines, Contractor shall employ expansion joints where required or directed by the Engineer. Swing joints, turns, expansion loops or long offsets shall be provided wherever shown on the Drawings or wherever necessary to allow for the expansion of piping within the building. Broken pipes or fittings broken due to rigid connections must be removed and replaced at the Contractor's expense.

2. Anchor all lines having expansion joints so that expansion and contraction effect is equally distributed. Verify exact locations of anchors with the Engineer prior to making installation. The lines having expansion joints shall be accurately guided on both sides of each joint. These guides shall consist of saddles and "U" clamps properly arranged and supported. Submit complete details for approval.

3. In installing expansion members, exercise care to preserve proper pitch on lines. Furnish and install all special fittings, connectors, etc., as required.

3.02 SURFACE PREPARATION, SHOP AND FIELD PAINTING

A. Unless otherwise specified herein or shown on the Drawings, general painting of mechanical equipment shall be in accordance with Section 09900, Painting.

B. Touch-up painting of mechanical equipment shall be part of the mechanical work. All equipment and materials that are painted or coated by the manufacturer shall be touched-up prior to completion to conceal any and all scratches or other finish irregularities and to maintain the integrity of the paint or coating. All painting and coating shall match the original and shall conform to the requirements detailed in other sections of these specifications.

C. All roof-mounted equipment shall be painted with an exterior paint of a type and color as specified in Section 09900, Painting. The painting shall not impair the performance of the equipment in any manner.

3.03 INSPECTION AND TESTING

A. The mechanical work shall include all materials and labor required to properly test and balance all mechanical systems as required by codes and as described herein.

B. Concealed, underground and insulated piping shall be tested in place before concealing, burying or covering. Tests shall be conducted in the presence of the Engineer or designated representative. Equipment, materials and instruments required for tests shall be furnished without incurring additions to the Contract. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

C. Unless otherwise specified herein, all mechanical piping shall be tested as required by Code to 1-1/2 times the rated system pressure or 100 psig (modify as needed), whichever is greater. Care shall be taken to isolate all equipment not suitable for this test pressure by installing pipe caps or blank flanges at the equipment connections. All valves and fittings shall be tested under pressure.

D. Soil, waste and vent piping shall be tested with water before installing fixtures. Water test shall be applied to the system either in its entirety or in sections. If the test is applied to the entire system, all openings in the piping shall be closed except to highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be plugged and each section shall be filled with water and tested with at least a 10 foot head of water. Each joint or pipe in the building except the uppermost 10 feet of the system shall be submitted to a test with at least a 10 foot head of water. The water shall be kept in the system, or in the portion under test, for at least 1 hour before the inspection starts; no substantial drop in the water level will be acceptable.

E. The services of an independent testing and balancing agency shall be used to balance the air and water distribution systems.

3.04 CLEANING

A. At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the site.

B. After all equipment has been installed, but prior to testing and balancing, all equipment, piping, ductwork, etc. shall be thoroughly cleaned both inside and out.

C. All air moving equipment operated during construction shall have filters in place and changed regularly so as to be clean.

D. After testing and balancing and just prior to Engineer review and acceptance, all systems shall be finally cleaned and shall be left ready for use. Air filters shall be new and piping strainers shall be clean.

E. All water piping shall be cleaned and disinfected in accordance with Section 15060 of these specifications.

+++ **END OF SECTION 15050** +++

SECTION 15100
PROCESS VALVES

PART 1 GENERAL

1.1 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

B. Items included under this Section are:
   1. Gate Valves
   2. Air Valves
   3. Metal Seated Ball Valves

1.2 DESCRIPTION OF SYSTEMS

A. All equipment and materials specified herein are intended to be standard for use in controlling the flow of water.

1.3 QUALITY ASSURANCE

A. Reference Standards: The design, manufacturing and assembly of elements of the products herein specified shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or otherwise specified.

   1. ANSI/AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service
   2. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   3. ANSI/NSF Standard 61 – Drinking Water System Components – Health Effects
   4. ANSI/AWWA C512 – Air-Release, Air/Vacuum and Combination Air Valves for Waterworks service
   5. ASTM A126 – Gray Iron Castings for Valves, Flanges and Pipe Fittings
   6. ASTM A240 – Heat Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
   7. ANSI B16 – Standardization of Valves Flanges, Fittings and Gaskets
   8. National Electrical Code as applicable.

9. American Water Work Association (AWWA):
10. Anti-Friction Bearing Manufacturers Association (AFBMA):

1.04 SUBMITTALS

A. Submittals shall follow the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Complete shop drawings of all valves and appurtenances
2. Manufacturer's certificate certifying that the products meet or exceed the specified requirements.

1.5 TOOLS

A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All valves and appurtenances shall be of the size shown on the Drawings and all equipment of the same type shall be from one manufacturer.

B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

2.2 GATE VALVES (class 150, 24-inches and larger)

A. Gate valves shall be resilient seated type conforming to the requirements of AWWA C509 or AWWA C515.

B. Valves shall have a minimum working pressure of 150 psi.

C. Valve manufacturer shall submit an affidavit to the Engineer indicating valve compliance with all applicable AWWA standards.

D. Valves shall be designed for vertical installation with tracks and rollers, and bevel gear type operator.

E. Valve ends shall be mechanical joint type except where restrained joint ends are shown. Flanged joints shall meet the requirements of ANSI B16.1, Class 125.

F. Valve shall be non-rising stem type with a 2-inch square operating nut and shall open right (clockwise).

G. All internal and external ferrous surfaces shall be coated with epoxy to a minimum thickness of 4 mils. The epoxy shall conform to ANSI/AWWA C550 and shall be applied electrostatically prior to assembly. Epoxy shall be NSF61 approved.

H. Valve shall have a ductile iron body, bonnet and stuffing box. All joints between valve parts, such as body and bonnet, bonnet and bonnet cover, shall be supplied with o-ring seals.

I. Valve wedge shall be symmetrical, made of ductile iron and totally encapsulated in rubber. Rubber shall be permanently bonded to the wedge per ASTM D429.

J. Valves shall be non-rising stem type with a 2-inch square operating nut and shall open right (clockwise).

K. Valves shall be manufactured by American Flow Control, Mueller, M & H Valve, or approved equal.

2.3 AIR VALVES

A. Type

1. Air Release Valves: Air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.

2. Air and Vacuum Valves: Air and vacuum valves (AVV) shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. Size and capacity shall be as specified.

3. Combination Air Valves: Combination air valves (CAV) shall have operating features of both the air and vacuum valve and the air release valve. Combination air valves include both single and dual body construction. Size and capacity shall be as specified.

B. Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

C. Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The set shall be fastened into the valve cover and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shut off into the seat.

D. Combination air valves, unless otherwise specified, shall be single body construction in sizes 1-inch through 6-inches and dual body construction in sizes 8-inches and larger. Single body construction shall be designed to provide all functions within one housing. The body inlet shall be baffled to protect the float and the large and small orifices shall be

designed so that during large orifice closure, the small air release orifice will open to allow small amounts of air to escape. Dual body construction shall combine one air and vacuum valve and one air release valve with interconnecting piping and gate valve.

E. Air valves for vertical turbine pumps (size 4-inches and larger) shall be dual body combination air valves except the inlet shall be fitted with a surge check to prevent water column entering the valve on pump start.

F. Valves shall be suitable for pressures up to 150 psi.

G. Isolation valves and small-diameter piping to local drain or sump shall be provided below each air valve.

H. All air and vacuum release valves installed in pump stations shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors.

I. Manufacturers shall be Vent-Tech, GA Industries, Valmatic, Apco, Ross or Approved Equal.

2.4 METAL SEATED BALL VALVES

A. Type

1. Pump Control Valves: Pump Control Valves (PCVs) shall be operated to minimize hydraulic shock for both pump start and stop operations by gradually opening over an adjustable duration range of 15-90 seconds.

2. Flow Control Valve: Flow Control Valve (FCV) shall be operated to regulate the flow passing through the valve by finely adjusting the opening amount of the valve, affecting the flow coefficient, Cv. To ensure long service life, for minimum Cv, valve shall be no less than 15% open; for maximum Cv, valve shall be no less than 85% open.

B. The ball valve shall be metal to metal seated with flanged ends, drilled to the applicable ANSI B16.1 standard Class 125. Valve shall have a full port equal in size to the adjacent piping, when the valve is in the full open position.

C. The valve shall be drop tight and meet or exceed the AWWA C-507-99 inspection and testing standard. The valve shall be single seated for pump control (double seated available upon request) and rated at 150 psi. The valve shall be manufactured by Pratt, DeZurik, or approved equal.

D. Construction

1. The body shall be constructed of cast ductile iron ASTM A536 GR 65-45-12 or demonstrably similar material, having an inlet and outlet flanged waterway equal to the required valve size. Flanges shall be flat-faced and machined parallel to each other to within .005 inch. Valve body shall have both a drain and vent hole drilled and tapped.

2. The body shall have bronze bearings installed in each half accurately located in the center of the housing to receive the trunnion bearings on the ball and place the ball in the central position. The bearing load shall not exceed 2000 lb/sq. inch at 250psi differential pressure. The body seat shall be monel, electronically fused to the base metal, then accurately machined to form the seating seal, or other C507-99 approved materials. The body seat shall not protrude into the waterway.

3. The ball shall be cast ductile iron ASTM A536 GR 65-45-12 or demonstrably similar material. It shall have integrally cast, trunnions which will be bronze-bushed. One trunnion holds the operating shaft which passes through a packing seal area and connects to the actuator. To prevent leakage around the shaft, the chevron packing is installed to form a seal. The ball seat shall be type 300 series stainless steel. It shall be pressure assisted design and by using an offset on the body and ball, the seats will only be in contact at the actual point of closing. The seat is connected to the ball by means of a stainless steel mounting ring that is securely attached and pinned into position after the correct setting has been attained. Seats threaded directly on to the ball shall not be acceptable.

4. Valve seat assembly shall be fully adjustable and replaceable in the field without removing the valve from the line. The ball seat shall be located at the top, when the valve is in the open position.

5. Bearings for ball and body trunnions shall be bronze of dissimilar hardness as per AWWA C507-99 standard to prevent galling or binding. Self-lubricating teflon reinforced would also be acceptable.

6. Valve shafts shall be: ASTM A564 Type 630, H1150 (17-4PH) stainless steel, or other C507-99 approved materials.

E. All ball valves shall be subjected to hydrostatic, shop leakage and performance tests as specified in AWWA Standard C507-99. Maximum seat leakage allowance 1fl. oz. per diameter inch per hour as per AWWA C507-99.

F. Valve Painting: all internal ductile iron surfaces, except finished or bearing surfaces, shall be shop painted with heat-cured epoxy coating conforming to Federal Specification TT-C-494, and AWWA C550. All exterior steel or cast or ductile iron surfaces of each valve, except finished or bearing surfaces, shall be shop painted with one or more coats of Alkyd primer. For buried service valves, two coats of asphalt varnish per Federal Specification TT-C-494.

2.5 ACTUATORS

A. Each actuator shall include electric motor, reduction gearing, reversing starters, thermal overloads, controls transformer, limit controls, non-intrusive local controls and hardwired status and control points as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

1. Provide actuators capable of setting of torque, turns, and configuration of indication contacts without the necessity to remove any electrical compartment covers.
   a. Enclosure: Watertight to IP68, BASEEFA classification. Enclosure must be certified NEMA 6 by FM (Factory Mutual), for all units except those in classified areas.
2. Provide an internal watertight compartment to protect switches, contacts, motor and internal electronics from ingress of moisture and dust when the external terminal cover is removed.
3. Breathers and drains are not permitted, enclosure must be totally sealed.
4. Provide each actuator with a handwheel for manual operation. Provide a hammerblow device which permits motor to come up to speed before picking up load and unseating valve.

B. Motors:

1. Open/Close applications: Motors, Class F with 15-minute duty rating.
2. Modulating applications: Motors, Class H with a 30-minute duty rating.
3. Motor: Low inertia, high torque type to prevent over travel.

C. Provide internal clutch that cannot engage handwheel operating mechanism and motor-operating mechanism at the same time. Friction type declutching is not acceptable.

1. Provide handwheel with arrow and the word CLOSE or SHUT cast on handwheel to indicate turning direction to close.
2. Handwheel must not rotate during power operation.
3. Provide handwheel and low gear ratio combined to give maximum rate of movement possible with 80lb (36 kg) rim pull.

D. Reduction Unit:

1. Metal worm wheel and worm shaft type.
2. Provide an oil filled gear box. Grease lubrication is not acceptable.
3. Worm shaft to operate in ball or roller bearings and be machine cut, ground, and highly polished, hot rolled steel, hardness 50-60 Rockwell Scale C bronze worm wheel with large contact area. Provide mating surfaces of dissimilar metals to prevent galling. Cast metals or gears manufactured from non-metallic materials are not acceptable.
4. Worm and shafts: Heat-treated steel and accurately machined. Output or driving shaft to operate in bronze bearing or in ball or roller bearings.
5. Make provisions to take thrust in both directions.
6. Gearing to be oil lubricated at all times.

7. Gear case: Cast iron or aluminum depending on size of actuator offered, all thrust or torque bearing components shall be ductile iron.
8. Provide drive bushing as part of a detachable thrust base making for easy retrofit.

E. Fully wire electric motor operators at factory and furnish complete with terminal strips for external power and control connections. Wiring: copper with tropical grade PVC cover. Internal wiring to remain in a watertight compartment with external cover removed.

F. Provide manual or automatic control as indicated and specified.

G. Manual Control: Provide the following Control, Status, Alarm and Diagnostic capabilities locally, at the actuator:
   1. Control:

      a. Open/Stop/Close.
      b. Desired Valve Position Control 0-100%.

   2. Status:

      a. Motor Running Open Direction.
      b. Motor Running Close Direction.
      c. Fully Open.
      d. Fully Closed.
      e. Percentage Open 0-100% in 1% increments.
      f. Percentage Output Torque 0-100% in 1% increments.

   3. Alarms:
      a. Remote Control Communications Failure.
      b. Actuator Alarm.
      c. Valve Alarm.
      d. Battery Low Alarm.

I. Each actuator shall be fitted with hard-wired dry contacts. Each Contact shall be rated at 5A, 250VAC, 30VDC and provide the following features:

      1. REMOTE status.
      2. OPEN status.
      3. CLOSED status.
      4. OPEN command.
      5. CLOSE command.
      6. VALVE POSITION command (modulating actuator only).
      7. VALVE POSITION status (modulating actuator only).
      8. FAULT status.
      9. IN TRANSITION status.

J. Provide contacts and operating parts made of non-corrodible metal and suitable for a sea

atmosphere and for contact with H_2S.

K. Control Station:

1. Provide for each actuator.
2. Enclosure:
   a. NEMA 6 cast aluminum for all areas not classified.
   b. Provide red, green, and yellow indicating lights on operator. Green light on when valve, gate or equipment is completely closed, red light on when valve, gate or equipment is completely opened, and yellow light when valve, gate or equipment is in mid travel.
   c. Control circuits: 110VAC or 24VDC.
   d. LOCAL/STOP/REMOTE switch: Padlock-able in all positions.
   e. OPEN/CLOSE switch.

L. Starters/transformers: Consists of two relay contactors, 3-pole, mechanically interlocked, reversing, with suitable arc suppressors.

1. Provide inverse time element overload relays.
2. Provide a control transformer capable of generating either 110VAC (220VAC) or 24VDC.
3. Provide electromechanical starter capable of OPEN/CLOSE sixty starts per hour. Size solid-state starter for modulating service at 1200 starts per hour.
4. Provide replaceable fuses to protect wiring, fuses must be locally available.
5. Provide automatic phase correction.

M. For actuators located higher than 5 feet (1.5 m) above the operating level or below finished floor level (in pits, etc.), provide a separate pushbutton enclosure. Mount on a pedestal, or on adjacent structure.

1. Provide actuator capable of accepting indication input from separate pushbutton station, that pushbutton station has been selected for remote control.
2. Provide each actuator with an unfused disconnect switch.
3. Enclosure Type: Refer to 2.5L.

N. For actuators located in chemical containment areas, provide extension stems to raise actuators above containment walk levels.

O. Limit Controls:
1. Type: Positive in action ensuring tight seating and full openings.

2. Position Setting Range: 2.5 to 100,000 turns, with resolution of 7.5 degrees of one actuator output revolution.

3. Provide mechanism designed to minimize drift or overtravel and to open or close

valve, gate or equipment to fixed, predetermined limits of opening and closing travel.

4. Provide controls that disconnect driving mechanism from stem. Geared limit or torque type as required capable of predetermined limits of opening and closing travel. Potentiometers for position transmission are not acceptable.

5. Provide torque switches for both directions of travel.
   a. Sensing to be independent of voltage fluctuation. Mechanical torque springs are not acceptable.
   b. Provide torque protection to prevent repeated starting in the same direction.
   c. The initial unseating hammer blow shall not cause over-torque.
   d. Provide torque switch settings independent of OPEN/CLOSE position switches.

P. Provide output shaft to accept rising stem for rising spindle valves and include roller and ball type thrust bearings.

Q. Provide actuator sized to close valve, gate or equipment against required differential. Size actuator motor to seat and unseat valve gate or equipment and ensure torque switch trip at maximum valve torque when supply voltage is 10% below normal. Size motor to open or close valve, gate or equipment to satisfy the process dynamics.

R. All fasteners and hardware: Type 316 stainless steel.

S. Supply each actuator with a start-up kit comprising installation instructions, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning.

T. Manufacturer: Limitorque, Rotork, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

B. Buried flanged or mechanical joints shall be made with cadmium plated bolts.

C. Prior to installation, valves shall be inspected for direction of opening clockwise, number of turns to open, freedom of operation, tightness of pressure containing bolting and test plugs, cleanliness of valve ports and especially seating surfaces, handling damage and cracks. Defective valves shall be corrected or held for inspection by the Engineer. Valves shall be closed before being installed.

3.2 LAYING AND JOINTING VALVES AND APPURTENANCES

A. Valves, fittings, plugs, and caps shall be set and joined to the pipe in accordance with the manufacturer's recommendations for cleaning, laying and joining pipe.

B. In no case shall valves be used to bring misaligned pipe into alignment during installation. Pipe shall be supported in such a manner as to prevent stress on the valve.

C. A valve box shall be provided on each buried valve. The valve box shall be set over the center of the valve operating nut and plumbed. The box shall not transmit shock or stress to the valve. The bottom portion of the lower belled portion of the box shall be placed below the valve operating nut. The flange shall be set on brick, so arranged that the weight of the valve box and superimposed loads will bear on the base and not on the valve or pipe. The valve box cover shall be flush with the surrounding surface or such other level as directed by the Engineer.

D. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service engineer, conduct running test for each actuator in presence of Engineer to determine its ability to operate without vibration or jamming and to operate at the speeds specified. During tests, observe and record, motor inputs. Promptly correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the City, and repeat tests until specified results and results acceptable to the Engineer are obtained. Contractor to provide all labor, equipment, and materials necessary for conducting tests.

3.3 BLOW-OFFS

A. Blow-offs shall be installed in locations as directed by the Engineer and as shown on the Drawings. Blow-offs shall not be connected to any sewer, submerged in any stream or creek, or be installed in any manner that will permit back siphonage into the water distribution system.

3.4 TESTING

A. After installation, all valves and appurtenances shall be tested at least 1 hour at 125 psi, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

VALVE SCHEDULES

Table 1: Gate Valve Schedule

Tag ID	Size	Operation	Actuator
10-V2-001	60	Open/Close	Electric
10-V2-002	48	Open/Close	Electric
10-V2-003	48	Open/Close	Electric
10-V2-004	48	Open/Close	Electric
11-V2-001	36	Open/Close	Electric
11-V2-002	36	Open/Close	Electric
11-V2-003	36	Open/Close	Electric
11-V2-007	60	Open/Close	Electric
11-V2-008	48	Open/Close	Electric
11-V2-009	48	Open/Close	Electric

Table 2: Air Valve Schedule

Site	Tag ID	Type	Orifice Diameter (inches)	Operation
CWTP	10-V9-001	Dual body combination	16	Self-Regulated
	10-V9-002	Air Release	8	Self-Regulated
	10-V9-003	Air release	8	Self-Regulated
RIPS	11-V9-001	Well service	8	Self-Regulated
	11-V9-002	Well service	8	Self-Regulated
	11-V9-003	Well service	8	Self-Regulated
	11-V9-007	Air release	2	Self-Regulated
	11-V9-008	Air release	2	Self-Regulated

Table 3: Pump Control Valve Schedule

Tag ID	Type	Size (inches)	Operation	Actuator
11-V8-001	Metal Seated Ball Valve	36	Modulating	Electric
11-V8-002	Metal Seated Ball Valve	36	Modulating	Electric
11-V8-003	Metal Seated Ball Valve	36	Modulating	Electric

Table 4: Flow Control Valve

Tag ID	Type	Size	Operation	Actuator	Min. Cv	Max. Cv
11-V1-001	Metal Seated Ball Valve	48	Modulating	Electric	5,500	32,000

+ + + END OF SECTION 15100 + + +

SECTION 15101
FLEXIBLE RAKE BAR SCREENS

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment and incidentals required for a complete operational screening system with necessary items specified and as shown on the Contract Drawings. The system contains front-cleaning, front-return link driven mechanically cleaned bar screen assemblies, belt conveyor, controls, spare parts, and all accessories as required for proper use in a river raw water intake application.

B. The screen manufacturer is required to coordinate with the Owner for SCADA system integration as required to insure a complete and operational system when designing the controls described herein.

C. **The mechanically cleaned bar screens are sole sourced and will be provided by Duperon. Duperon's scope of supply for this project is contained in Volume 4.** The Contractor shall be responsible for any work specifically excluded or identified as assigned to Contractor as identified in the attached Duperon Proposal and scope of supply.

1.2 RELATED WORK

A. Cast-in-place concrete, grout, and horizontal surface reconditioning is included in Section 03300.

B. Instrumentation work is shown on the drawings.

C. Electrical work, except as otherwise specified herein, is included in Division 13.

D. Belt conveyor, including controls and accessories, specified herein.

1.3 SUBMITTALS

A. Submit in accordance with the General Conditions and Section 01730, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all details of construction, dimensions and anchor bolt locations.

i. Descriptive literature, bulletins, and/or catalogs of the equipment.

ii. The total operational weight of the equipment including the single largest component.

iii. Complete bill of materials of all equipment

B. Test Reports to be submitted:

1. Description of test procedures and equipment.

2. Copies of all test results, as specified in Parts 2 and 3 of this Section.

C. Submit electrical and instrumentation control schematics and details.

D. Complete operating and maintenance instructions shall be submitted in accordance with the requirements of these specifications.

E. Manufacturer's Certification per Specification 15101.3.5.A.

1.4 QUALITY ASSURANCE

A. Qualifications

1. All equipment and appurtenances furnished under this Section shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished.

2. The equipment shall be designed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings.

B. All equipment furnished under this Section shall be new and unused and shall be the standard products of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with the manufacturer's recommendations and with Section 01600 and 01610.

B. Equipment shall be protected against damage during delivery and storage at the site. The General Contractor shall unload all equipment and provide the necessary storage space as required.

C. The screen equipment furnished and installed under this Specificaiton shall not be delivered to the site more 30 calendar days prior to scheduled installation.

1.6 WARRANTY

A. The Contractor and Manufacturer shall warrant all equipment supplied under this Section for a period of one (1) year. All rotating parts shall be warranted for a period of five (5) years. Warranty period shall commence as outlined in the General Conditions and Division 1.

B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and restored to service at no expense to the Owner.

C. The Manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The equipment manufacturer has been pre-selected for this project per Paragraph 1.1.C of this Specification. The price and scope of supply by the named manufacturer is included in the specification section.

2.2 SCREEN DESIGN CRITERIA

A. General

1. The mechanically cleaned bar screen shall be a stainless-steel link drive, front-cleaning, front-return type mechanically cleaned bar screen.

2. The mechanically cleaned bar screen shall have a head sprocket only, with no sprockets, bearings, or similar drive components under water.

3. The mechanically cleaned bar screen shall clean continuously, from bottom to top, the entire width of the scraper.

4. The mechanically cleaned bar screen shall run continuously.

5. The link system shall be such that it bends in one direction only, which allows it to become its own lower sprocket and frame. The link system shall also have the ability to flex around a large object such as a drum, tire, log, etc. to avoid shutting down the unit.

6. All non-corrosive materials shall be used in components traveling underwater. The scrapers shall be of UHMW/304 stainless steel and the links and pins shall be of 316 stainless steel

B. Design Criteria.

1. Presented below is the design criterion for each screen.

Description	**Flexible Rake Bar Screens**
Quantity	**2**
Capacity of each, mgd (+/- 10%)	**70**
Head loss at rated capacity, inches	**0.76" 50% blockage @ NLWL**
Nominal rake width, feet	**8**
Normal low water level, elevation	**746**
Normal high water level, elevation	**751**
Max flood water level, elevation	**773**
Channel bottom invert, elevation	**730**
Unit angle from vertical, degrees	**15**
Bar Sizing	**0.25 in x 0.75 in**
Bar clear opening, inches	**0.25**
Clear opening velocity at rated capacity, fps	**1.74**
Bar screen material of construction	**304 S.S.**
Scraper material	**UHMW/304SS**
Scraper Penetration	**3 sides**
Drive motor horsepower	**1/2**
VFD motor horsepower	**1**
Screenings conveyance	**Belt Conveyor (included)**
Enclosure for Screening Equipment	**Full Enclosure**
Equipment No.	**11-FS-001, 11-FS-002, 11-BC-001**

2.3 SCRAPER

A. Scrapers shall be spaced 21 inches apart. The scraper shall move at no greater than 28 inches per minute at standard operating speed of 0.87 rpm allowing for approximately 1 debris discharge per minute. Staging Scrapers and Thru Bar Scrapers shall be a maximum ratio of 3:1 per manufacturer recommendations. At least one scraper every 84 inches shall fully penetrate the bar screen, cleaning all three sides of

the bars as well as through to the cross members in openings of 0.25, 0.375 and 0.50 inches.

2.4 DRIVE UNIT

A. The drive unit motor shall be inverter duty, 2 horsepower and explosion proof, non-ventilated. The unit shall be provided with a safety guard and rated 208V, 3Phase.

B. The unit shall be supplied with a speed reducer with torque output sufficient to meet the design conditions.

C. The drive sprockets shall be cast iron. The drive shaft shall be 1018 steel. Bearings shall be ball bearing type, non-self aligning, sealed and lubricated.

2.5 LINK SYSTEM

A. The link system shall be manufactured of all 316 stainless steel and 302/4 stainless steel pins. The lifting capacity of the link system shall be a minimum of 1000 pounds.

2.6 CHAIN SLIDES

A. Chain slides shall be provided to support the link system. The chain slides shall be manufactured of UHMW and 304 stainless steel.

B. Return guides shall be provided to guide the mechanically cleaned bar screen in proper tracking as recommended by the manufacturer. The return guides shall be manufactured of 304 stainless steel.

2.7 CONTROL SYSTEM

A. Control Package shall be Package as manufactured by Duperon Corporation, Saginaw, Michigan, or approved equal. VFD shall be 1 HP AC Tech (208V, 3Phase) with 3% line reactor, main control breaker with thru door handle, high/low speed selector, HOA where Hand enables remote station and Auto uses discrete start/stop input from SCADA and a cycle timer. HOA switch shall include auxiliary contacts for remote “Hand” and “Auto” indication at the SCADA panel. The VFD package shall include provisions for remote push button stations. The push button stations shall be standard NEMA 4X remote push button stations and include operators for Forward / Reverse (Jog) / E-Stop /. All three push buttons shall be combined into a single stainless steel enclosure.

The motor will be located approximately 100’ from the VFD. Provide filters as required to address any dv/dt issues that may arise from excessive distance.

The Control Panel shall be rated for 208V, 3Phase and shall include an integral 20A, 208V,3P circuit breaker.

The belt conveyor component shall have an independent LCP.

B. Each screen shall be monitored by the SCADA system for "Run", "VFD fault", "Motor overload", "In Auto" status", "In Hand" status, "Start/Stop".

C. Control of each of the screens will be performed through the SCADA system or locally at the local control panels.

D. Provide a stainless steel NEMA 4x rated enclosure. Each screen control panel shall be provided with a disconnect switch for interrupting the power to the motor. All lights, pushbuttons, switches, disconnects, ETMs, etc shall be mounted on the face of the panel. Do not mount devices on the side of the panel.

1. Each screen control panel shall be equipped as a minimum with the following devices:

a. E-Stop pushbutton
b. VFD fault light
c. Forward indicating light
d. Reverse indication light
e. Power on light
f. Forward pushbutton
g. Jog/Reverse pushbutton
h. H-O-A selector switch
i. Elapsed time meter
j. AC, VFS
k. Dual cycle timers
l. Accept the following signals from a remote location
    i. E-Stop
ii. Start/Stop in the auto mode
iii. Forward when in hand mode
iv. Analog input for speed

m. Digital outputs from the control panel shall include:

i. Run
ii. VFD fault
iii. Motor overtemp
iv. In "auto" mode status
v. In "hand' mode status
vi. start/stop

E. Description of Screen Operation

1. "Local" Mode:

Each screen can be operated in the "HAND" position. The local control panel shall be provided with an H-O-A selector switch. Place the selector switch in the "HAND" position. To start the screen, in a forward direction, depress the forward pushbutton (latching the system in for operation). The screen will continue to operate until the HOA selector switch is placed into the "off" position.

The screen may also be operated in the reverse direction using the HOA selector switch in combination with the jog/reverse pushbutton. To start the screen in a reverse, place the HOA in hand and depress the reverse/jog pushbutton (momentary operation). This function requires the operator to stand at the control panel.

The local control panel shall be provided with an emergency mushroom-head pushbutton to stop the screen.

A remote pushbutton station located at each screen is to be provided by the General Contractor. The pushbutton station will be used to remotely start/stop the equipment (forward, reverse/jog). The General Contractor shall wire the remote pushbutton to the Bar Screen control panel.

2. "Automatic" Mode:

Place the screen H-O-A selector switch in the "AUTO" position at the control panel. In this mode, the system operation can be controlled from ANY of the following:

a. Internal control panel cycle timer operation AND
b. SCADA system control at the pumping station AND

Internal control panel cycle timer operation:

Using the internal cycle timers the operation is as follows:

a. The internal control panel timers can be set to start and stop the screen operation. The cycle timers are repeat adjustable to provide multiple start/stops (0-6 hours) and also duration of run time (0-60 minutes). During any operational cycle, once the duration cycle timer has expired, the screen will automatically stop until such times as the cycle timer call for the screen to automatically start again.

b. Speed adjustment for the screen is performed at the screen control panel by manually adjusting the speed pot.

SCADA system control at the pumping station:

Using the SCADA system programming the operation is as follows:

a. The SCADA system shall be programmed to control the operation of the screens. The programming of the SCADA system through PLC 100 to control the screens shall duplicate that as described earlier using the control panel internal cycle timers. The SCADA system programming shall utilize its own cycle timers to achieve the controls for cycle start/stop and duration. The control panel adjustable repeat cycle timers require the operational staff to zero-out the internal cycle timers to allow for the SCADA start/stop control.

b. Adjustment of the screen operational speed shall be provided through the SCADA system to the VFD using an analog input.

During automatic or manual operation of the screen each screen drive shall be monitored by the run status, motor overload, and VFD fault.

F. Belt Conveyor Operation

1. Screenings collected shall be deposited on the belt conveyor system to be deposited in a roll-off container (by others).
2. Conveyor to be driven by a 5 HP, 3 ph., 60 Hz, 230/460 vac NEMA Design B, Class F insulation, 1.15 s.f., 40° C, energy efficient motor.
3. Reducer to be AGMA, Class II, helical gear shaft mount reducer assembly with V-belt and sheave reducer input drive to provide required belt speed. Complete with FRP OSHA style V-belt guard.
4. Pulleys & Bearings to be 16” dia. minimum with tapered "QD" compression type hubs mounted on cold rolled steel shafting supported by 2 7/16” dia. minimum self-aligning roller bearings. The head pulley will have 1/2" thick vulcanized neoprene lagging to prevent a belt slip. The tail pulley will be supported by protected screw take-ups with 12” take-up length minimum. The take-ups will include stainless steel adjusting rods with brass bearing capture nuts.
5. Belting & Splice to incorporate a 2-ply nylon carcass belt, 36” wide with 1/8" x 1/16" oil resistant nitrile covers and rated tension of 220 P.I.W. The belt will be spliced with a stainless steel mechanical hinged fastener, drawn and recessed into the belt cover.

6. Belt will be supported on the carrying run by CEMA, 20 degrees troughed idlers on 4'-0" centers except at the load points on 2'-0" centers, and return runs on CEMA idlers at maximum spacing of 10'-0". Idlers are to be covered with corrosion and wear resistant 1/8" thick molded urethane and supported from the frame by 304 st steel brackets. Idlers will include 3/4" diameter shafts and tapered roller bearings with sealed bearings. Shaft seals will be multi-passage labyrinth with a positive wiper and an outer shield constructed as established by CEMA.
7. Belt conveyor frames and supports will be constructed of 304 st steel structural members with spreaders, sized as required to limit deflection to 1/250 at the longest support span. Top of channel frames will be covered with #12 ga 304 st steel return belt cover to prevent product spillage onto the return run of the belt.
8. Conveyor will be provided with continuous #10 ga 304 st steel skirt at load area with an adjustable neoprene seal strip at the belt to guide and control the product and splash plates at load areas.
9. Return run of the belt will be provided with a #12 ga 304 st steel drip pan 6" wider than overall belt width with water tight flanged connections in 10'-0" maximum lengths. Drains will be located as shown on the drawings. The drip pan will be installed to serve as a guard for the return run of belting.
10. Conveyor will be provided with OSHA style guards at all "nip points" and motor driven rotating components, specifically including motor drive and tail pulley and head pulley guards. Guards will be constructed of FRP.
11. The conveyor will be provided with a cable operated OSHA safety stop switch with continuous cable run on both sides and a zero speed switch mounted at the conveyor tail shaft. Switches will be SPDT, 120 vac.
12. The product will be scraped from the belt surface by a spring tensioned adjustable neoprene scraper blade. The blade will be tensioned by (2) adjustable 304 stainless steel springs.
13. Discharge Chute to be fabricated from minimum of #12 ga 304SSTL, approximately 20ft long with SSTL supports to wall.
14. Interlock to be provided that screens cannot run if belt conveyor is not running.
15. Coating: Component hardware will have one shop coat epoxy over Manufacturer’s standard finish. Stainless steel fabrications will be shop acid passivated or glass brush blasted to remove heat tint scale and provide a uniform finish. Nonferrous items will remain unfinished. Shafting will be coated with a rust inhibitive compound
16. Fasteners: Component assembly will be achieved with 304 stainless steel, bolts, flat and lock washers prepared with anti-seize compound prior to engagement.

2.8 SPARE PARTS

A. Spare parts shall be provided in accordance with the Scope of Supply as indicated in Duperon's proposal.

B. Conveyor belt system spare parts as follows:
1. drive shaft pillow block bearing
2. tail shaft take up bearing
3. trough carry idlers
4. return idler
5. 20' of conveyor belting
6. (1) st steel mechanical belt splice kit with tools and templet
7. (1) wiper blade of each size and type
8. (1) set vee belts

PART 3 EXECUTION

3.1 Equipment Supply Contract

A. The awarded bidder will enter into an equipment supply contract with Duperon Inc., the main equipment supplier for this section. The Contractor shall be responsible for the timetable and schedule of the equipment in relationship with the remainder of the project.

3.2 Factory Test

A. The system supplier shall factory test each screen prior to shipment. Each screen shall be operated for a minimum of 4 hours, continuous operation, at the angle specified for the application to assure proper alignment and operation.

B. The supplier shall provide Factory Certification of testing performed with three (3) copies furnished to the Engineer. Failure to submit the Factory Certification will result in its non-acceptance by the Owner.

C. The control panels shall also be tested and testing certification of proper operation shall be submitted to the Engineer. Failure to submit factory testing will result in non-acceptance by the Owner

D. The Contractor shall submit to the Engineer three copies of full and complete test reports for all tests describing the units tested, the type of test, test setups, and procedures and instrumentation; and test flow rates, pressures, levels and all other data and results as required to demonstrate that all items tested meet specified requirements.

3.3 INSTALLATION

A. The Contractor shall inspect all equipment prior to erection. Repair or replace damaged items as directed by the Engineer, at no additional increase in contract time or cost to the Owner

B. The Contractor shall install the screens, screenings sluiceway and controls as show on the Contract Drawings and in accordance with the manufacturer's recommendations.

C. All grease or oil lubricants will be provided by the system supplier and installed by the Contractor in accordance with the manufacturer's recommendations.

3.4 SERVICES OF THE MANUFACTURER'S REPRESENTATIVE

A. The equipment manufacturer shall furnish the services of a competent and experienced factory representative who has complete knowledge of proper installation, operation and maintenance of the equipment. Provide two site visits, each a minimum of eight (8) hours on site.

B. The first visit shall be to provide the Contractor with installation guidance, the second visit shall be to inspect the installed equipment, perform an initial test run, and provide operating and maintenances instruction to the Owner's personnel. The second visit to the site, conduct final performance testing and provide certification stating the equipment is properly installed and is operating within the design parameters and will be warranted as required by these Specifications. In the event of improper installation or improper operation, all defects shall be corrected by the Contractor at no expense to the Owner, and at no increase in Contract time until the equipment operates to the satisfaction of the Engineer with certification from the system supplier.

C. The factory representative shall inspect the installation and verify the installation is in accordance with the manufacturer's recommendations and the Drawings.

D. The factory representative will start-up the equipment, make all necessary adjustments as required and field verify the equipment is functioning properly including the controls. The Contractor shall continuously operate the equipment for a period of seven (7) days. The equipment must operate without failure or fault for seven (7) continuous days before the Owner shall accept operation.

E. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or Contractor's installation, corrections shall be made by the General Contractor and the system supplier at no charge in Contract Price or Time. The system shall be re-tested until the testing requirements are satisfied.

F. The equipment manufacturer shall include a video of a standard training session to be provided to the client for training purposes.

3.5 CERTICFICATION

A. The manufacturer representative shall prepare written certifications stating the equipment is installed properly, is operating within the design parameters, and will be warranted as required by the Specifications. The system shall be retested. The cycle of repairs or adjustments shall be made until the testing requirement is satisfied.

+++END OF SECTION 15101+++

SECTION 15102
DEHUMIDIFIERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of packaged dehumidification units. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Contractor's recommendations and as shown on the drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Equipment specified in this Section includes the following:
   1. Dehumidification units.

D. Related Work Specified Elsewhere:
   1. Section 15050, Basic Mechanical Materials and Methods.
   2. Section 15950, HVAC Controls.
   3. Division 16, Electrical.

E. The following wiring shall be furnished under Division 16, Electrical:
   1. Provide control wiring between unit-mounted control panel and thermostats, remote control panels and any other control device furnished as Work in this Section.
   2. Provide factory-mounted and wired controls and electrical devices as specified in this Section.
   3. Additional electrical work including motor starter, disconnects, wire/cables, raceways and other required electrical devices; not Work of this Section.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; and installation and start-up instructions.
   2. Maintenance data and parts list for each dehumidification unit, control and

accessory; including trouble-shooting maintenance guide.

3. Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances and methods of assembly of components.
4. Submit manufacturer's electrical requirements for power supply wiring for dehumidification units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of dehumidification units and associated controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of dehumidification units, of types and in similar service for not less than 5 years.

B. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
   1. ASTM, American Society for Testing Materials.
   2. ASME, American Society of Mechanical Engineers.
   3. OSHA, Occupational Safety and Health Act.
   4. ANSI, American National Standards Institute.
   5. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers.
   6. ARI, Air Conditioning and Refrigeration Institute.
   7. NFPA, National Fire Protection Association.
   8. FM, Factory Mutual Engineering Corporation.
   9. UL, Underwriters Laboratories, Inc.

1.04 QUALITY STANDARDS

A. Manufacturer's offering products that comply with these specifications include:
   1. Munters
   2. Or equal.

1.05 STORAGE AND HANDLING

A. Handle dehumidification units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

B. Store dehumidification units and components in a clean and dry environment. Protect from weather, dirt, fumes, water, construction debris and physical damage. Storage area location shall be approved by the Engineer.

C. Comply with manufacturer's rigging and installation instructions for unloading dehumidification units and moving them to final location for installation.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.
    1. Provide written warranty on motors, fans and drive unit, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/fans/drive units with inadequate and defective materials and workmanship. Replacement is limited to component replacement only and does not include labor for removal and reinstallation. Warranty period shall be 5 years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 DEHUMIDIFICATION UNIT

A. Dehumidification unit shall be Munters model GC-150 or equal.

B. Dehumidifier shall be of a type proven in satisfactory operation for a minimum of ten years.

C. Dehumidifier shall be of the non-cycling sorption type with a single desiccant rotary structure.

D. Unit casing shall be fabricated as a unitized body with welded aluminum construction for maximum strength and durability. Suitable access panel shall allow access for inspection or servicing without disconnecting ducting or electrical wiring.

E. Airflow balancing dampers shall be furnished with dehumidification units.

F. Dehumidifier rotary structure shall be a monolithic fabricated extended surface consisting of inert silicates reinforced with uniform diameter glass fibers for maximum strength. The fabricated structure shall be smooth and continuous in the direction of airflow without interruptions or sandwich layers which restrict airflow or create a leakage path at joining surfaces.

G. Desiccant shall not channel, cake or fracture due to repeated temperature and moisture cycling.

H. The materials of construction shall be non-toxic and NFPA 225-ASTM E84 compliant.

I. Full face contact pressure seals shall be provided to separate the process and reactivation air streams and eliminate detrimental leakage of air or moisture with static pressure differentials of up to 3″ of water gauge.

J. Dehumidifier shall be factory assembled. fully automatic, complete with desiccant wheel,

reactivation heaters, reactivation energy control system, roughing filters, motors, fans, non-racheting desiccant drive unit, automatic controller and all components' auxiliaries.

K. Reactivation energy modulation shall be stepless solid state proportioning type.

L. Dehumidifier shall be functionally tested at the manufacturer's factory and shipped complete with all components necessary to maintain normal operation.

M. The standard unit shall operate on a 60 Hz power supply, three phase for 480V as specified with a total connected load not to exceed 10 amps.

N. Dehumidification units shall operate at process flow rates of 125-150 SCFM at 2" ESP with a nominal moisture removal capability of 2-4 lbs/hr and be capable of processing saturated, conditioned or outside air.

O. Dehumidification filters shall be of "permanent" design and be washable.

P. Dehumidification units' electrical control shall allow for continuous automatic operation and include motor starters, control relays and overload protection devices.

Q. Unit drive system shall have a simple drive belt arrangement with as few moving parts as possible.

R. Process and reactivation air shall be separate with air seals to provide minimum leakage and with a 5-year minimum life expectancy.

S. All unit fans shall be of a centrifugal, direct drive design and be totally enclosed and non-ventilated.

T. Dehumidifier housing shall be of welded aluminum construction. Housing shall be constructed such that controls are insulated.

U. Unit cabinet finish shall be light gray enamel MIL-E-15090 paint.

2.04 SPARE PARTS

A. Furnish to the Engineer with receipt, the manufacturer-recommended spare parts for each packaged unit:

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which units are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to

Installer.

3.02 INSTALLATION OF DEHUMIDIFIER UNITS

A. General

Install dehumidification units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

B. Electrical Wiring

Install and connect electrical devices furnished by manufacturer but not specified to be factory- mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

C. Piping Connections

Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

D. Field Quality Control

Start dehumidification units in accordance with manufacturer's startup instructions. Test controls and gauges and demonstrate compliance with requirements. The system shall be designed to maintain humidity conditions in the vaults. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements.

3.03 FIELD QUALITY CONTROL

A. Start-up dehumidification units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Provide services of manufacturer's technical representative for 1-half day to instruct City's personnel in operation and maintenance of dehumidification units.

1. Schedule training with the Engineer, provide at least a 7-day notice to Contractor and Engineer of the training date.

+++END OF SECTION 15102+++

SECTION 15250
MECHANICAL INSULATION
AND HEAT TRACING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of mechanical insulation. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Contractor's recommendations and as shown on thedrawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Then types of mechanical insulation specified in this Section include the following:
   1. Piping System Insulation – Flexible Unicellular and Pre-molded Cellular Glass.
   2. Ductwork System Insulation - Fiberglass.

D. Related Work Specified Elsewhere:
   1. Section 15050, Basic Mechanical Materials and Methods.
   2. Section 15891, Ductwork.
   3. Section 15910, Ductwork Accessories.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Manufacturer's technical product data and installation instructions for each type of mechanical insulation:
      a) Manufacturer's product number.
      b) k-Value and thickness.
      c) Accessories included for each mechanical system requiring insulation.

2. Maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
3. Submit catalog cuts performance data, sealing tape, mastic and all other information required to demonstrate compliance with the contract documents
4. Submit conduit plan drawings for the heat tracing systems. Show proposed conduit routing between heat trace panels and heat tracing connections and thermostats. Show contents of each conduit.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84, NFPA 255 method. Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150. Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

C. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
1. ASTM, American SocietyforTestingMaterials.
2. ASME, American SocietyofMechanical Engineers.
3. OSHA, Occupational Safetyand Health Act.
4. ANSI, American National Standards Institute.
5. AWWA, American WaterWorks Association.
6. NFPA, National FireProtection Association.
7. FM, FactoryMutual EngineeringCorporation.
8. UL, Underwriters Laboratories, Inc.

D. Heat tracing products shall be manufactured by Raychem, Thermon, or Chromalox.

1.04 STORAGE AND PROTECTION

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 GENERAL

A. Flexible unicellular piping insulation: ASTM CI 534, Type 1.B. Rigid fiberglass ductwork insulation: ASTM C612, Class 1.

B. Ductwork Insulation Accessories:
1. Provide staple, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

C. Ductwork Insulation Compounds:
1. Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.02 HEAT TRACED PIPING INSULATION

A. Materials

1. Pre-molded cellular glass thermal insulation shall be furnished in accordance with ASTM C 552 and C 585 fabricated for standard pipe sizes, fittings and valves
2. Maximum thermal conductivity of 0.32 BTU in/hr/Ft^2/°F at 70 degrees F mean temperature in accordance with ASTM C 177 and C 518
3. Maximum water vapor permeability of 0.00 perm-in when tested in accordance with ASTM E 96
4. Average density of 8.0 pounds per cubic foot
5. Maximum Flame Spread Rating of 5 and Smoke-Developed Rating of 0 when tested in accordance with NFPA 255
6. Utilize installation adhesives and joint sealants as recommended by the insulation manufacturer.
7. Furnish 30-gauge smooth Type 304 stainless steel jacketing over insulation retained by stainless steel bands. All jacketing seams shall be sealed weathertight with sealant suitable for outdoor installation.
8. Insulation products shall be equal to Pittsburgh Corning FOAMGLAS

B. Description:
1. Piping insulation thickness shall be 1-inch for pipes up to 2-inches, 1-1/2 inches for pipes over 2-inches and up to 4-inches, and 2-inches for pipes over 4-inches.

2.3 ELECTRIC HEAT TRACING FOR PIPING

A. Provide self-limiting heat trace cable where shown on the Drawings or described in these Specifications

B. Cable shall have 16 AWG copper bus wire with self-regulating, semi-conductive core and tinned copper braided shield over bus wire and core. Over jacket shall be modified polyolefin or fluoropolymer over shield.

C. Cable shall provide temperature maintenance up to 150 degrees F and Intermittent Temperature up to 185 degrees F

D. Provide all required electrical accessories, including power connection kits, splice kits, tee kits, thermostats, aluminum or glass tape, and other components required for a complete operating system for each heat trace service as scheduled herein. Cable and accessories shall be FM approved for installation in NEC classified areas where indicated on the Heat Trace Schedule. Unless heat trace enclosures for electrical accessories shall be NEMA 4X rated. All components shall be UL-listed. The connection system shall be of NEMA 250, Type 4 and Factory Mutual approved rating with an operating monitor light to indicate when heat tracing is energized.

E. Securing tape for plastic piping systems shall be of aluminum foil coated adhesive tape type equal to product AT-180 as manufactured by Raychem. Securing tape for metallic piping systems shall be of glass or polyester cloth pressure sensitive tape type equal to products GS54 or GT66 as manufactured by Raychem.

F. Thermostats shall be the bulb type. Line sensing thermostats shall have a minimum of 9-foot capillary tube. Temperature range shall be adjustable from 25 to 150 degrees F. Line sensing thermostats shall be equal to Model AMC-F5 as manufactured by Raychem.

G. Ambient-sensing thermostats shall be equal to Model AMC-1A as manufactured by Raychem. Line-sensing thermostats shall be equal to Model AMC-1B as manufactured by Raychem.

H. Lines of similar configuration and operating at the same temperature may be grouped together and controlled by one thermostat.

I. Splice or Tee connection kit shall be equal to Raychem Model T-100

J. Outdoor design temperatures shall be 0 degrees F

K. Coordinate circuit sizing with available electrical circuits shown on the

electrical drawings. All wiring and conduit from the junction boxes (shown on the electrical drawings) to the heat trace power connection kits shall be provided under this Division and installed in accordance with Division 16.

L. All heat traced piping shall be provided with premolded cellular glass insulation and 304 SS jacketing per Section 2.3. The insulation thickness shall be per Section 2.3.

M. Provide pipe markers cautioning "ELECTRICAL HEAT TRACING – SHOCK HAZARD".

N. Provide pipe heat tracing with a nominal cable capacity of 5 Watts/Ft.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which mechanical insulation is to be installed. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 HVAC PIPING SYSTEM INSULATION

A. Insulate sub-freezing HVAC piping systems with flexible unicellular, 1" thick for pipe sizes up to 1-1/2"aboveground.

B. Insulate sub-freezing HVAC piping systems with cellular glass, 1-1/2" thick for pipes underground.

C. Insulate the following sub-freezing HVAC piping systems:
1. Refrigerant suction lines between evaporators and compressors.

3.03 DUCTWORK SYSTEM INSULATION

A. Do not insulate fibrous glass ductwork, or lined ductwork. Ductwork in the Environmental room to be lined.

B. Insulate the following cold ductwork:
1. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
2. HVAC supply ductwork between fan discharge or HVAC unit discharge and room terminal outlet.
3. Insulate neck and bells of supply diffusers.
4. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet; except omit insulation on return ductwork located in

return air ceiling plenums.

5. HVAC plenums and unit housings not pre-insulated at factory or lined.

C. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:

1. Rigid fiberglass,1-1/2" thick, increase thickness to 2" in machine, fan and equipment rooms with vapor barrier.
2. Flexible fiberglass, 1-1/2" thick, application limited to concealed locations with vapor barrier.

3.04 EQUIPMENT INSULATION

A. Insulate the following cold equipment with fiberglass insulation, 2" thick for surfaces 35^{O}F and 3"thick for surfaces 35^{O}F and lower:

1. Drip pans under chilled equipment.

3.05 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure insulation serves its intended purpose.

1. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, pre-cut or job fabricated units (at Installer's option) except where specific form or type is indicated.
2. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.
5. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
6. Maintain integrity of vapor-barrier jackets on pipe insulation and protect to prevent puncture or other damage.
7. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3"wide vapor barrier tape or band.

3.06 INSTALLATION OF DUCTWORK INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
   1. Install insulation materials with smooth and even surfaces.
   2. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit oversurfaces to be covered.
   3. Maintain integrity of vapor-barrier jackets on ductwork insulation and protect to prevent puncture and other damage.
   4. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
   5. Omit insulation on lined ductwork where internal insulation or sound absorbing linings have been installed, except as otherwise indicated.

B. Protect outdoor insulation exposed to weather by installing outdoor protective finish or jacketing as recommended by manufacturer.

C. Install corner angles on external corners of insulation on ductwork in exposed finished spaces before coveringwith jacketing.

3.07 INSTALLATION OFEQUIPMENT INSULATION

A. Install equipment thermal insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
   1. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
   2. Maintain integrity of vapor-barrier on equipment insulation and protect to prevent puncture and other damage.
   3. Do not applyinsulation to equipment, breechings or stacks while hot.
   4. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
   5. Coat insulated surfaces with layer of insulated cement, troweled in workman-like manner, leaving smooth continuous surface. Fill in scored block, seam, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
   6. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable.
   7. Do not insulate manholes, handholes, cleanouts, ASME stamp, or manufacturer's nameplate. Provide neatly beveled edge at interruptions

of insulation.

8. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

B. Protect outdoor insulation exposed to weather by installing weather-barrier mastic protective finish or jacketing as recommended by manufacturer.

3.8 PIPE HEAT TRACING INSTALLATION

A. General
1. Install in accordance with the manufacturer's instructions and recommended practices
2. Provide insulation as specified in Section 2.3 over all pipe heat tracing
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping

B. Electrical Heating Tape:
1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. De-rate heating tape capacity when installed on plastic piping
4. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than following:

ITEM	HEATING TAPE LENGTH (min. ft.)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four time valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:
1. Install in accordance with manufacturer's instructions and as approved by Engineer.

2. For each group of heat traced circuit, install one ambient thermostat.

3.9 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground
   1. Insulation Resistance: Minimum 1,000 megaohms per 1,000 feet.

+++END OF SECTION 15250 +++

SECTION 15700
ELECTRICAL UNIT HEATERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all electrical unit heaters and controls. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Manufacturer's Certification.
   2. Manufacturer's data.
   3. Operation and maintenance manuals.
   4. Complete wiring and control diagrams.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

   1. NEC, National Electric Code.
   2. NEMA, Standards of National Electrical Manufacturers Association.
   3. OSHA, Occupational Safety and Health Act.
   4. ANSI, American National Standards Institute.
   5. ASTM, American Society for Testing Materials.
   6. AISI, American Iron and Steel Institute.
   7. AGMA, American Gear Manufacturer's Association.
   8. AFBMA, Anti-Friction Bearing Manufacturer's Association.
   9. NFPA, National Fire Protection Association.

B. Experience. Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation. Provide a list of such installations complete with installation description contact names, addresses, telephone numbers. This reference list shall be submitted with the shop drawings.

1.04 QUALITY STANDARDS

A. The electrical unit heaters shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

C. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the electrical unit heater manufacturer shall not be accepted.

D. Manufacturer's offering products that comply with these specifications include:

1. Unit Heaters-Chromalox, Model HD3D
2. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 ELECTRICAL UNIT HEATER

A. Provide and install electrical unit heater as described herein and as indicated on the Drawings.

1. Unit heater shall be horizontal and wall mounted.
2. Furnish electrical heater with mounting brackets.
3. Unit heater heat bank shall consist of patented chromalox spiral metal sheath fintube electric heating elements with built-in overheat protection.
4. Furnish heavy duty magnetic control contactor.
5. Unit heater shall be hose-down corrosion resistant blower type.

2.02 CONTROLS

A. Unit heaters shall be energized by their respective 2-stage thermostats set at 48^0. The unit heater shall de-energize when room temperature is 50^0 F.

PART 3 - EXECUTION:

3.01 INSTALLATION

A. The equipment shall be installed in strict conformance with the approved shop drawings and manufacturer's installation instructions.

3.02 EQUIPMENT TESTING

A. After completion of the work, test and regulate heating coils, and unit heaters, to conform to conditions indicated on the Drawings. Contractor shall adjust apparatus for securing proper volumes and conditions.

+++ END OF SECTION 15700 +++

SECTION 15775
PACKAGED AIR CONDITIONING UNITS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Vertical wall-mount air conditioning units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 390-2003 – Vertical Air-Conditioners.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.03 SUBMITTALS

A. Product Data: Submit data indicating capacity, dimensions, rough-in connections, and electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

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

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALITY ASSURANCE

A. Test and rate vertical wall mounted air conditioners in accordance with ARI 390-2003.

B. Performance Requirements: Conform to minimum cooling mode efficiency prescribed by ASHRAE 90.1 when tested in accordance with ARI 390-2003.

1.06 QUALIFICATIONS

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

B. Installer: Company specializing in performing work of this section with minimum three years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept units on site in factory packaging. Inspect for damage.

B. Protect units from damage by providing temporary covers until construction is complete.

C. Protect items shipped loose with units in original packaging and store in secured area.

1.08 FIELD MEASUREMENTS

A. Verify by field measurements size and configuration are compatible with wall construction and layout.

1.09 COORDINATION

A. Coordinate wall openings, and electrical rough-in locations to accommodate work of this Section.

1.010 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

B. Provide five-year manufacturer's warranty for compressors.

PART 2 - PRODUCTS

2.01 VERTICAL WALL MOUNTED AIR CONDITIONING UNITS

A. Manufacturers: Marvair or approved equal.

B. Product Description: Vertical wall mounted air conditioning units, with electric refrigeration system, remote temperature controls and a factory installed full flow economizer with enthalpy controller.

C. Cabinet: Construction shall be a single, enclosed, weatherproof casing constructed of 20-gauge galvanized steel. Unit base shall be constructed of 16-gauge galvanized steel. Each exterior casing panel shall be bonderized and finished with baked-on exterior polyester enamel paint prior to assembly. The baked-on cured paint finish shall pass the industry rub test with a minimum of 72 rubs MEK (Methyl Ethyl Ketone) or standard rub test of a minimum of 100 rubs using Toluene. Cooling section shall be fully insulated with 1-inch fiberglass to prevent sweating and to muffle sounds. Openings shall be provided for power connections. Access openings shall be appropriate for outside structure to all fan motors and compressor for making repairs and for removing internal components without removing unit from its permanent installation. Fresh air intake and outdoor coil shall be protected from intrusions by a sturdy metal grating with less than 1/4-inch openings. Separate filter service door shall provide easy access for filter change.

D. Drain Pan: Drain pan shall be constructed of 20-gauge galvanized steel, bonderized and finished with baked-on exterior polyester enamel paint.

E. Insulation: Insulation shall be foil-faced for ease of cleaning.

F. Mounting Brackets: Full-length side mounting brackets shall be an integral part of the cabinet.

G. Refrigeration System: All models shall use a high efficiency scroll compressor. The compressor shall be covered by a 5-year parts warranty. The refrigeration circuit shall be equipped with factory installed high and low pressure controls and liquid line filter dryer. Compressor shall be mounted on rubber grommets. Unit shall be provided with R-410A (HFC) non-ozone depleting refrigerant.

H. Condenser Fan Motor: The condenser fan, motor and shroud shall be of slide out configuration for easy access.

I. Indoor Blower Motor: The indoor blower motor shall be high efficiency ECM motor providing low sound levels with soft start capability and high efficiency operation. Motor will automatically respond to higher static ducted applications without user adjustment or wiring changes.

J. Electric Heat: The unit shall have a factory installed electric resistance heater. Heater shall include automatic limit safety controls.

K. Economizer: The built-in economizer system shall be internally mounted and shall allow outside air to be introduced through the air inlet openings. The amount of outdoor air shall vary in response to the system controls and settings. The economizer module shall be factory installed in the ventilation section. The economizer module shall be easily removed for service. The economizer shall have the following features:
   1. Exhaust air damper control for positive closed position. Damper shall be furnished and installed with building louver by Contractor.
   2. Unit controls shall interface with an actuator motor (furnished and installed by Contractor) that shall be 24-volt with power to open, spring return actuator and built-in torque limiting switch
   3. Proportioning type control algorithm
   4. Moisture eliminator & pre-filter with permanent, washable aluminum construction
   5. Enthalpy control with outdoor temperature and humidity monitoring for precise control of economizer operation
   6. Minimum position potentiometer to control minimum damper blade position for ventilation purposes
   7. Mixed air sensor to monitor outside and return air to automatically modulate damper position

L. Filters shall be 2” fiberglass, pleated, MERV 11 that are changeable from the outside.

M. Controls
   1. Lead/Lag Microprocess Controller with capability to run both units upon demand.
   2. Low Ambient Control: Unit shall have low ambient temperature controls for operation down to 0^0F.

N. Capacity:
   1. See schedule on drawing.

2.02 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: see schedule on drawing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify wall opening is ready for wall sleeve installation.

B. Verify wall construction is ready for unit installation.

C. Verify electrical rough-in is at correct location.

3.02 PREPARATION

A. Coordinate to assure correct opening size for wall sleeve.

3.03 INSTALLATION

A. Install units level.

B. Install unit with wall sleeve, and outside air louver.

C. Connect controls.

D. Install condensate drain piping to grade.

3.04 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units.

B. Vacuum clean coils and inside of cabinets.

C. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.

D. Install new throwaway filters in units after Substantial Completion.

3.05 DEMONSTRATION

A. Demonstrate unit operation and maintenance.

3.06 PROTECTION OF FINISHED WORK

A. Protect finished surfaces of cabinets with protective covers during remainder of construction.

+ + + END OF SECTION 15775 + + +

SECTION 15830
HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Roof mounted exhaust fans

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 99 Standards Handbook
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 Laboratory Methods of Testing Fans for Rating Purposes
4. AMCA 300 Test Code for Sound Rating Air Moving Devices

B. International Mechanical Code

C. Underwriter's Laboratories (UL) Standards

1. UL 705 Power Ventilators

D. National Fire Protection Association (NFPA) Standards

1. NFPA 70 National Electrical Code
2. NFPA 90A Installation of Air Conditioning and Ventilating Systems

1.03 SUBMITTALS

A. Shop Drawings: Indicate size and configuration of fan assembly, materials of construction, mountings, weights, ductwork and accessory connections.

B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, AMCA certification, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and disconnects where specified or shown.

C. Roof curbs and fan accessories

D. Manufacturer's Installation Instructions: Submit fan manufacturer’s instructions.

E. Spare parts list

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

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.07 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.08 WARRANTY

A. Furnish one-year manufacturer's warranty for fans.

PART 2 - PRODUCTS

2.01 ROOF MOUNTED CENTRIFUGAL EXHAUST FANS

A. Manufacturers: Fan shall be manufactured by Greenheck, Loren Cook, or Acme.

B. Fan Unit: Downblast or upblast type and V-belt or direct drive as indicated on the Fan Schedule on the Drawings, with spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Self-flashing curb: Roof Curb: minimum 12-inch high self-flashing of aluminum construction with continuously welded seams, built-in cant strips, 1-inch insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, ventilated double wall, and factory installed nailer strip.

E. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 250 Type 3R enclosure.

F. Accessories:

1. Gravity Backdraft Damper.

2. Variable speed controller where indicated on the Fan Schedule on the Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify roof curbs installations dimensions are coordinated between existing and/or proposed structures and the rooftop equipment supplier.

3.02 INSTALLATION

A. Secure wall, roof and structure mounted fans with stainless steel screws/anchors to structure.

B. Install backdraft dampers on inlet to roof and wall exhaust fans and gravity ventilators used in relief air applications.

3.03 CLEANING

A. Vacuum clean inside of fan cabinet.

3.04 PROTECTION OF FINISHED WORK

A. Do not operate fans until ductwork is clean, and fans have been test run under observation.

+ + + END OF SECTION 15830 + + +

SECTION 15891
DUCTWORK

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of rectangular, round and flat-oval ducts and plenums. The ducts shall be supplied for heating, ventilating and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage. All systems shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Fabricator's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:
   1. Section 15050, Basic Mechanical Materials and Methods.
   2. Section 15250, Mechanical Insulation.
   3. Section 15910, Ductwork Accessories.
   4. Section 15990, Testing, Adjusting and Balancing of HVAC Systems.

D. Definitions:
   1. Sealing Requirements: For the purposes of duct system sealing requirements specified in this Section the following definitions apply:
      a. A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
      b. Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to duct; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Product data including details of construction relative to material, dimensions of individual components, profiles, and finishes for the following items:
      a. Duct liner.

b. Sealing materials.
c. Fire-stopping materials.

2. Shop drawings from duct fabrication shop, drawn to scale not smaller than ¼ inch equals 1 foot, on drawing sheets same size as the Contract Drawings detailing:
   a. Fabrication, assembly and installation details for metal and glass fiber ducts, including plans, elevations, section, details of components and attachments to other Work.
   b. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled.
   c. Fittings.
   d. Reinforcing details and spacing.
   e. Seam and joint construction details.
   f. Penetrations through fire-rated and other partitions.
   g. Terminal unit, coil and humidifier installations.
   h. Hangers and supports, including methods for building attachment, vibration isolation and duct attachment.
3. Coordination drawings for ductwork installation shall show the following:
   a. Coordination with ceiling suspension members.
   b. Spatial coordination with other systems installed in the same space with the duct systems.
   c. Coordination of ceiling and wall mounted access doors and panels required to provide access to dampers and other operating devices.
   d. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
4. Record drawings including duct systems routing, fittings, details, reinforcing, support and installed accessories and devices.
5. Maintenance data for volume control devices, fire dampers and smoke dampers.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
   1. ASTM, American Society for Testing Materials.
   2. ASME, American Society of Mechanical Engineers.
   3. OSHA, Occupational Safety and Health Act.
   4. ANSI, American National Standards Institute.
   5. NFPA, National Fire Protection Association.
   6. UL, Underwriters Laboratories, Inc.
   7. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers.
   8. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association.
   9. TIMA, Thermal Insulation Manufacturer's Association.
   10. ICBO, International Conference of Building Officials.

1.04 QUALITY STANDARDS

A. The duct system design, as indicated, has been used to select and size air moving and

distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been designed in accordance with these specifications and is suitable for these service conditions.

1.05 STORAGE AND HANDLING

A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

B. Store and handle sealant fire-stopping materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperature, contaminants or other causes.

C. Deliver and store stainless steel sheet with mill-applied adhesive protective paper, maintained through fabrication and installation.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 METAL DUCT MATERIALS

A. Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.
   1. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
   2. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
   3. Stainless Steel: ASTM A 480, Type 316, sheet form, with No. 4 finish on exposed surface for ducts exposed to views; Type 304, sheet form, with No. 1 finish for concealed ducts.

B. Reinforced shapes and plates, unless otherwise indicated, shall be galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

C. Tie-rods shall be galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer that 36 inches.

2.02 DUCT LINER FOR METAL DUCT

A. Metal duct liners shall comply with NFPA Standard 90A and TIMA Standard AHC-101.
   1. Materials: ASTM C 1071, Type II, with coated surface exposed to air stream to prevent erosion of glass fibers.
   2. Thickness: 1- inch.
   3. Density: 3 pounds.
   4. Thermal Performance: K-Factor shall be equal to 0.28 or better, at a mean temperature of 75^{o}F.
   5. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM C 411.
   6. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.
   7. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
      a. Fastener pin length shall be as required for thickness of insulation and without projecting more than 1/8-inch into the air stream.
      b. Adhesive for attachment of mechanical fasteners shall comply with Fire Hazard Classification of duct liner system.

2.03 FIBERGLASS DUCTWORK

A. Indoor installed FRP duct shall have a maximum flame spread rating of 25 and a maximum smoke development rating of 50, and shall meet UL and ICBO approval. All outdoor, above grade FRP duct shall have UV-inhibitor and fire retardant for maximum flame spread of 25.

B. The ductwork shall conform to NBS-PS-15-69 and ASTM C 582 for the foul air collection and shall be fabricated of reinforced fiberglass pipe ducts and FRP transition sections and fittings as described herein.
   1. The resin shall be of a commercial grade and shall be evaluated as described in the NBS Voluntary Product Standard PS 15-69 published by the U.S. Department of Commerce or equivalent standard.
   2. Resins shall not contain fillers except as required for viscosity control or fire retardance. Up to 5 percent by weight to thixotropic agent which will not interfere with visual inspection may be added to the resin for viscosity control.

C. Acceptable manufacturers include Skillcraft Fiberglass; Fiberdyne, Inc.; Harrington Industrial Plastics, ATS Products; or equal. All FRP ductwork shall be provided by a single manufacturer.

D. Fabricator shall be responsible for the basic design of FRP duct, in accordance with these

specifications and the Drawings. The product shall be corrosion resistant to hydrogen sulfides, ozone and other gases generated from raw sewage.

1. The reinforcing material shall be a commercial grade of glass fiber having a coupling agent which will provide a suitable bond between the glass reinforcement and the resin.
2. The laminate shall consist of an inner surface, and interior layer and an exterior layer of laminate body. The compositions specified for the inner surface and interior layer are intended to achieve optimum chemical resistance. The inner surface shall be free of cracks and crazing with a smooth finish. Some waviness is permissible as long as the surface is smooth and free of pits. A minimum of 0.100 inch of the laminate next to the inner surface shall be reinforced with not less than 20 percent nor more than 30 percent by weight of non-continuous glass strands. The exterior layer or body of the laminate shall be of chemically resistant construction suitable for the intended service and providing the necessary strength to meet tensile and flexural requirements.
3. When separate layers such as mat, cloth or woven roving are used, all layers shall be lapped a minimum of 1 inch. Laps shall be staggered as much as possible.
4. Finished joints shall be built up in successive layers and be as strong as the piece being joined and as crevice free as is commercially practicable. The width of the first layer shall be 2 inches minimum. Successive layers shall increase uniformly to provide the necessary minimum total width of overlay which shall be centered on the joint. Crevices between jointed pieces shall be filled with resin or thixotropic resin paste, leaving smooth inner surfaces. The interior joints may also be sealed by covering with not less than 0.100 inch of reinforced resin-rich surface. The minimum wall thickness in no case shall be less than 1/8 inch regardless of operating conditions.
5. The laminate shall have a Barcol hardness of at least 90 percent of the resin manufacturer's minimum specified hardness for the cured resin. The finished laminate shall be as free as commercially practicable form visual defects such as foreign inclusions, dry spots, air bubbles, pinholes or pimples.

E. Duct and fittings shall be shop spooled as much as possible. Use of flanges shall be kept to a minimum, with field welded bell and spigot joints where required for installation. Use butt joints for shop welded joints only, unless approved by the Engineer.

1. Fittings shall conform to radius requirements of standard fittings.
2. Jointing, sealing, and adapting of round pipe to flat FRP ducting and supports shall be per FRP ductwork manufacturer's installation instructions.
3. Gaskets shall be full-faced, 1/8-inch thick, fabricated from ethylene propylene rubber (EPR).

F. The sizes of rectangular ducting shall be determined by the inside dimensions. Unless otherwise specified, the tolerances shall be +3/16 inch for dimensions of 18 inches and under and +1 percent for dimensions of over 18 inches. Rectangular ducting minimum thickness shall not be less than NBS-PS15-69 standards, substituting the longer side for the diameter.

1. Ends shall be square within +1/8 inch for round ducting through 24-inch diameter and rectangular ducting through 72-inch perimeter.

2. Wall thickness of fittings shall at least equal the thickness of ducting of the same size.
3. Minimum thickness of ducting shall be per FRP duct manufacturer's standards; internally reinforced and externally supported per manufacturer's instructions.

G. Standard bends shall have a centerline radius of one and one-half times the duct diameter. Maximum deflection of a side on a rectangular duct shall not exceed 1 percent of the width of the side under operating conditions. Ribs or other special constructions shall be used, as required, to meet the deflection requirements.

H. Elbow turns shall be FRP airfoil with non-sparking accessories of the same manufacturer as the FRP ducting and installed per manufacturer's instructions.

I. Fabricator shall provide all information details and requirements for installation and support of duct and torque values for flange bolting.

J. Use manufacturer's currently recommended cure system unless otherwise agreed upon by the fabricator and Engineer.

K. Expansion joints shall be isobutylene isoprene, single-arch sleeve-type with inside diameter of capped sleeve ends equal to the ductwork outside diameter. Expansion joints shall be Mercer Rubber Co., or equal.

2.04 SEALING MATERIALS

A. Joint and Seam Sealants: The term sealant used in this Section is not limited to material of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
1. Joint and Seam Tape: 2-inch wide, glass-fiber-fabric reinforced.
2. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant; formulated with a minimum of 75 percent solids.
3. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
4. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.

2.05 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4-inch thick.

B. Hangers: Galvanized sheet steel or round, uncoated steel, threaded rod.

C. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

D. Straps and Rod Sizes: Conform with Table 4-1 SMACNA HVAC Duct Construction Standards for sheet steel width and gage and steel rod diameters.

E. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger.

F. Sleeves:
   1. Sleeves for round ductwork: Form with galvanized steel.
   2. Sleeves for rectangular ductwork: Form with wood or galvanized steel.
   3. Size sleeves large enough to allow for movement due to expansion and contraction.

G. For galvanized steel ducts provide hot-dipped galvanized steel support materials. For stainless steel provide stainless steel support materials. For aluminum provide aluminum support materials, except where materials are electrolytically separated form ductwork.

2.05 RECTANGULAR DUCT FABRICATION

A. Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA HVAC Duct Construction Standards. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications and joint types and intervals.

B. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains and discoloration.

D. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
   1. Supply Ducts: 3 inches water gage.
   2. Return Ducts: 2 inches water gage, negative pressure.
   3. Exhaust Ducts: 2 inches water gage, negative pressure.

E. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA HVAC Duct Construction Standards, unless they are lined or are externally insulated.

2.05 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections and other duct construction in accordance with SMACNA HVAC Duct Construction Standard.

2.06 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve necessary thickness is prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
   1. Butt transverse joints without gaps and coat joint with adhesive.
   2. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

C. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

D. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

E. Secure transversely oriented liner edges facing the air stream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:
   1. Fan discharge.
   2. Intervals of lined duct preceding unlined duct.

2.07 ROUND AND FLAT OVAL DUCT FABRICATION

A. Basic round diameter as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given size of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.
   1. Round Ducts: Fabricate round supply ducts with spiral lock seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater that 72 inches with longitudinal butt-welded seams. Comply with SMACNA HVAC Duct Construction Standards for galvanized steel gages.

B. Double-Wall (Insulated) Ducts: Fabricate double-wall insulated ducts with an outer shell, insulation and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.
   1. Thermal Conductivity: 0.27 Btu/sq. ft./F/inch thickness at 75^{o}F mean temperature.
   2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation and in gages specified above for single-wall duct.

C. Insulation: Unless otherwise indicated, provide 1-inch thick fiberglass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or

non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the inner liner diameter.

D. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gages listed below. For flat oval ducts, the diameter indicated in the table below is the basic round diameter.

2.08 ROUND AND FLAT OVAL SUPPLY AND EXHAUST FITTINGS FABRICATION

A. 90-Degree Tees and Lateral and Conical Tees: Fabricate to conform to SMACNA HVAC Duct Construction Standards with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting form the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated or mitered construction with bend radius of 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:
   1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.
   2. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA HVAC Duct Construction Standards Table 3-1.
   3. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
      a. 3 to 26 inches: 24 gage.
      b. 27 to 36 inches: 22 gage.
      c. 37 to 50 inches: 20 gage.
      d. 52 to 60 inches: 18 gage.
   4. Round Mitered Elbows: Solid welded and with metal thickness listed for pressure classes from 2 inches to 10 inches:
      a. 3 to 14 inches: 24 gage.
      b. 15 to 66 inches: 22 gage.
      c. 27 to 50 inches: 20 gage.
      d. 52 to 60 inches: 18 gage.
      e. 62 to 84 inches: 16 gage.
   5. Round Elbows - 8 inches and smaller: Die-formed elbows for 45^{o} and 90^{o} elbows and pleated elbows for 30,45,60 and 90 degrees only. Fabricate non-standard bend angle configurations or 1/2-inch diameter (e.g. 3-1/2 and 4-1/2 inch) elbows with gored construction.
   6. Round Elbows- 9 through 14 inches: Gored or pleated elbows for 30, 45, 60 and 90 degrees, except where space restrictions require a mitered elbow. Fabricate non-standard bend angle configurations or 1/2-inch diameter (e.g. 9-1/2 and 10-1/2 inch) elbows with gored construction.
   7. Round Elbows- Larger than 14 inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

8. Die-Formed Elbows for Sizes Through 8 inches and All Pressures: 20 gage with 2-piece welded construction.
9. Round Gored Elbows Gages: Same as non-elbow fittings specified above.
10. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.
11. Pleated Elbows Sizes Through 14 inches and Pressures Through 10 inches:26 gage.

D. Double-Wall (Insulated) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.
1. Thermal Conductivity: 0.27 Btu/sq. ft./F/inch thickness at 75^{o}F mean temperature.
2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation and in gages as specified above for uninsulated fittings.

C. Insulation: Unless otherwise indicated, provide 1-inch thick fiberglass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.

D. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gages listed below. For flat oval ducts, the diameter indicated in the table below is the basic round diameter.
1. 3 to 34 inches: 24 gage.
2. 35 to 58 inches: 22 gage.
3. 60 to 88 inches: 20 gage.
4. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation form dislocation by mechanical means.

E. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:
1. Round Elbows 4 to 8 inches: 2-piece, die stamped, with longitudinal seams spot welded, bonded and painted with a PVC aerosol spray.
2. Round Elbows 9 to 26 inches: Standard seam construction.
3. Round Elbows 28 to 60 inches: Standard gore construction, riveted and bonded.
4. Other Fittings: Riveted and bonded joints.
5. Couplings: Slop-joint construction with a minimum of 2-inch insertion length.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Construct and install each duct system for the specific duct pressure classification indicated. Provide openings in ductwork where required to accommodate thermometers and controllers.

B. Install ducts with fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building line; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment.
   1. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partition, except as specifically shown.
   2. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
   3. Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1-inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

3.02 SEAM AND JOINT SEALANT

A. Seal duct seams and joints as follows:
   1. Pressure Classifications Greater than 3 Inches Water Gage: All transverse joints, longitudinal seams and duct penetrations.
   2. Pressure Classification 2 and 3 Inches Water Gage: All transverse joints and longitudinal seams.
   3. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.
   4. Seal externally insulated ducts prior to insulation installation.

3.03 HANGING AND SUPPORTING

A. Install rigid, round, rectangular and flat oval duct with support systems indicated in SMACNA HVAC Duct Construction Standards.
   1. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

2. Support vertical ducts at a maximum interval of 16 feet and at each floor.

B. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

C. Install concrete insert prior to placing concrete.

D. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.04 CONNECTIONS

A. Connect equipment with flexible connectors in accordance with Section 15910 Ductwork Accessories.

B. All duct connections shall comply with SMACNA HVAC Duct Construction Standards.

3.05 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Adjustments shall be in accordance with Section 15990 Testing, adjusting and balancing air systems.

B. Vacuum ducts systems prior to final acceptance to remove dust and debris.

+++END OF SECTION 15891+++

SECTION 15950
HVAC CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work consists of providing controls for the HVAC system as shown on the Drawings or indicated in these specifications. Controls shall be electric or DDC.

B. The Contractor shall provide all engineering, installation, supervision, hardware, labor, materials and checkout to provide a fully functioning system. The Contractor shall furnish and install all items normally included on systems of this type which, while not mentioned directly herein, are essential to the installation and operation of the system.

1.02 SCOPE

A. Extent of electric control systems work required by this Section is indicated on drawings and schedules, and by requirements of this Section. Control sequences are specified both in this Section and on drawings.

B. Refer to other Division-15 Sections for installation of manual volume dampers in mechanical systems.

C. All work shall be in compliance with the National Electrical Code.

D. Refer to Division-16 Sections for the following work:
   1. Power supply wiring for power source to control panels, starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

E. Furnish control and interlock wiring under this section between field installed controls, indicating devices, motorized damper operators and unit control panels in compliance with the requirements of Division 16.

F. Control panel enclosures, starters, and disconnect switches shall be furnished under this section in accordance with the requirements specified under Division 16.

1.03 SUBMITTALS.

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Product Data. Manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-

up instructions.
2. Schematic flow diagram of system showing fans, dampers, and control devices.
3. Label each control device with setting or adjustable range of control.
4. Control interlock wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Details of faces of control panels, including controls, instruments, and labeling.
6. Written description of sequence of operation.
7. Wiring diagrams.
8. Operation and maintenance manuals.

1.04 GUARANTEE

A. All materials and equipment shall be fully guaranteed by the Contractor to be free of defects. Contractor shall keep his entire portion of the work in repair without additional cost to the Owner, so far as defects in workmanship, apparatus, material or construction are concerned for one year from the date of final acceptance. Any equipment which fails to meet the ratings specified shall be removed and replaced without cost to the Owner.

1.05 QUALITY ASSURANCE.

A. Manufacturer's Qualifications. Only firms regularly engaged in the manufacture of electric control equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years shall be eligible to provide and install the equipment specified herein.

B. Codes and Standards.
1. Electrical Standards. Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.
2. NEMA Compliance. Comply with NEMA standards pertaining to components and devices for electric control systems.
3. NFPA Compliance. Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.06 QUALITY STANDARDS

A. Manufacturer. Subject to compliance with requirements, provide electric control systems from one of the following manufacturers.
1. Honeywell, Inc.
2. Johnson Controls, Inc.
3. Siemens.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage,

and to protect equipment from dirt and moisture. Store equipment and materials inside and in original shipping packaging.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT.

A. DDC Control System: shall include an operator interface for display, adjustment and override. The equipment shall be appropriately protected from power surges or overload. Controller memory shall be protected from power failure for a minimum of 48 hours.

B. DDC controller: Controller shall be provided for all major equipment scheduled and accept analog or digital inputs, as required and provide digital outputs. Standard functions shall include: time-of-day scheduling, power failure/auto restart, override control and schedule adjustment. System memory and cock time shall not be erased by a power failure. Controller shall have an alphanumeric keypad to change schedules and to display output status. Controller shall be equipped with lightning arrestor and power surge protection.

C. Room Thermostats. Provide room thermostats with locking covers, and with concealed or readily-accessible adjustment devices and dead band, as indicated.

1. Except where unit mounted, thermostats shall be installed five feet above the finished floor in administrative areas. In warehouse and maintenance areas, thermostats and switches shall be mounted 6'-6" A.F.F. with heavy duty steel cages to prevent damage. This Contractor shall install and wire thermostats and control switches for all infrared heaters, rooftop units, heat pumps, HV units and makeup air units. Baseboard heaters and air rotation units shall have unit mounted thermostats.
2. Electronic space temperature sensors shall be located in warehouse areas as shown on Drawings, eight feet above finished floor. The outside air sensors shall be located a minimum of five feet above the roofline.
3. Provide thermostats with spiral bimetallic thermometers.
4. Thermostats. Provide 24 VAC thermostats of the bimetal actuated open contact, or bellows actuated enclosed snap-switch type, or equivalent solid-state type. Thermostat shall be UL-listed at electrical rating comparable with application. Provide bimetal thermostats which employ heat anticipation.
5. Thermostat for air-conditioning units shall be by the unit manufacturer.

D. Electric Contactors. Provide contactors for operating or limit control of electric heating loads which are UL-listed for 100,000 cycles of resistive loads. Equip with replaceable molded coils and replaceable silver cadmium oxide contacts. Coat core laminations with heat-resistant inorganic film to reduce core losses. Provide line and load terminals on contactors with higher-than-35-amp rating, or provide one-piece formed-and-welded pressure type. Provide screw-type contactors for 35-amp-or-lower rating. Equip field-mounted contactors with suitable steel enclosures; and provide open-type mounting for those installed in factory-fabricated panels.

E. Fan Switches: Provide fan switches where indicated on the Drawings. Switches shall be factory sealed, shall be rated 600 VAC heavy duty and shall have indicating lights. Selector switches shall be two or three position as indicated on the Drawings:
   1. START/STOP
   2. HAND/OFF/AUTO

F. Control Wiring: All control, interlock and starting circuit wiring, except where otherwise specified or noted on the plans, is to be furnished under this Section.
   1. Line voltage wiring shall not be smaller than #14, 600 volt wire. All wire shall be run in conduit with outlet boxes and fittings in compliance with the requirements of Division 16, Electrical.
   2. 24 volt wiring shall be not less than #18 gauge, with 600 volt insulation. Wiring run in partitions or above ceilings shall be run in plenum rated cable.
   3. Control voltage shall not exceed 120 volts. Provide transformers and relays to comply with this requirement.

2.02 TIMECLOCKS

A. Timeclocks shall be 7-day, 24-hour electronic type as manufactured by Paragon or equal. Clock and programmed start-stop schedules shall be fully protected from power failure. Contact rating shall be adequate for equipment served, or 3 Amp minimum. LEDs will indicate run status.

B. A DDC controller may be installed in lieu of timeclocks with a separate digital output for each timeclock grouping. Controller shall accept analog or digital inputs, as required and provide digital outputs. Standard functions shall include: time-of-day scheduling, power failure/auto restart, override control and schedule adjustment. System memory and cock time shall not be erased by a power failure. Controller shall have an alphanumeric keypad to change schedules and to display output status. Controller shall be equipped with lightning arrestor and power surge protection.

PART 3 – EXECUTION

3.01 WORKMANSHIP

A. All work shall be executed in a workmanlike manner and shall present a neat appearance when completed. All material and equipment shall be installed in accordance with the manufacturer's recommendations and applicable codes.

3.02 INSTRUCTIONS

A. Upon complete installation, provide a minimum of 4 hours of training for operating personnel. Provide copies of as-built drawings indicating all terminations. Provide also written operating instructions and equipment manufacturers cut-sheets.

3.03 INSPECTION

A. Examine areas and conditions under which electric control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.04 INSTALLATION OF ELECTRIC CONTROL SYSTEMS

A. General. Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division-16 Sections of these specifications. Mount controllers at convenient locations and heights.

B. Control Wiring. The term "control wiring" is defined to include provision of wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices.

C. Wiring System. Install complete control wiring system for electric control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

D. Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system.

3.05 ADJUSTING AND CLEANING.

A. Start-Up. Start-up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment. After completion of installation, adjust thermostats, damper operators, motors and similar equipment provided as work of this Section. Final adjustment shall be performed by specially trained personnel in direct employ of the manufacturer of primary temperature control system.

3.06 CLOSEOUT PROCEDURES

A. City's Instructions. Provide services of manufacturer's technical representative for four hours to instruct City's personnel in operation and maintenance of electric control systems. Schedule instruction with Engineer, provide at least 7-days of notice to Contractor and

Engineer for training date.

3.07 SEQUENCE OF OPERATION

A. Wall Mounted AC units (Electric Building):
   1. When the unit's ON/OFF switch is in OFF position, the units shall be off.
   2. When the switch is in ON position, the unit shall be controlled by factory furnished lead/lag controller to maintain space temperature and humidity.
   3. The units shall operate simultaneously as needed to meet the space loads.
   4. The units shall operate in economizer mode with factory furnished enthalpy controls.
   4. When the space temperature rises above the space high temperature set point, a high temperature alarm shall be activated for remote reporting at the HMI. See P&ID drawings.
   5. When the fire alarm is activated, the AC units shall be shut-off.

B. Desiccant Dehumidification units (Metering and Valve Vaults):
   1. When the unit's ON/OFF switch is in OFF position, the unit shall be off.
   2. When the switch is in ON position, the unit shall be controlled by factory furnished controls with in-built hygrometer and humidistat for space humidity control.

C. Exhaust Fans (Metering and Valve Vaults):
   1. When the fan's ON/OFF switch (with timer) located at the entrance of the vault is in OFF position, the fan shall be off.
   2. When the switch is in ON position, the fan shall run till the timer setpoint.

D. Electric Unit Heaters (Metering and Valve Vaults):
   1. The electric unit heaters shall be controlled by their own factory furnished thermostats.

3.08 FIRE ALARM INTERFACE

A. This Contractor shall install wiring, associated conduit, fittings and pilot relays to shut down and start fans when initiated from the fire alarm panel. Division 16 Contractor shall provide a dry contact initiation signal near the fire alarm panel for use by this Contractor. There shall be one shutdown and one start signal provided for each fire compartment. The fire alarm panel start signal shall have the highest priority, the fire alarm panel shutdown signal shall have the next highest priority, followed by the starter hand-off-auto switch, and finally the normally sequenced start-stop command.

B. Outside air ventilation damper control shall be overridden by the fire alarm panel. When a fire compartment is shutdown by the panel, all ventilation dampers within the compartment shall close. When a start signal is initiated by the alarm panel, all ventilation dampers within the compartment shall open.

C. Each fire zone, Fire Alarm Riser and Schedule, constitutes a fire compartment.

D. Wiring shall meet Factory Mutual approval. Control shall not be through DDC system but shall be hard wired.

3.09 GENERAL

A. Install end switches, relays, contactors, wiring, etc., to make a complete and operable system in accordance with the intent of this specification

+++ END OF SECTION 15950 +++

SECTION 15990
TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section specifies the requirements and procedures for HVAC systems testing, adjusting and balancing. Requirements include measurement and establishment of the fluid quantities of the HVAC systems as required to meet design specifications, and recording and reporting the results.

B. The Contractor shall procure the services of an independent air balance and testing agency, who is a current member in good standing of the Associated Air Balance Council (AABC), approved by the Engineer and who specializes in the testing, balancing and adjusting of heating, ventilating and air conditioning systems. The agency shall be certified by the National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project and having at least one Professional Engineer registered in the State in which the services are to be performed and certified by NEBB as a Test and Balance Engineer.

C. Test and balance all HVAC systems including the following:
   1. Supply air systems, all pressure ranges; including variable volume and double duct systems.
   2. Return air systems.
   3. Exhaust air systems.
   4. Verify temperature control system operation.

D. Test systems for proper sound and vibration levels.

E. Related work specified elsewhere:
   1. Section 15950, HVAC Controls.

F. Definitions:
   1. Systems testing, adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
      a. The balance of air distribution.
      b. Adjustment of total system to provide design quantities.
      c. Electrical measurement.
      d. Verification of performance of all equipment and automatic controls.
      e. Sound and vibration measurement.
   2. Test: To determine quantitative performance of equipment.
   3. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment.
   4. Balance: To proportion flows within the distribution system (submains,

branches and terminals) according to specified design quantities.

5. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
6. Report forms: Test data sheets arranged for collecting data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.
7. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply outlets on air terminals and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers and hoods.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Condition of the Contract Documents. In addition, the following specific information shall be provided:
   1. Submit testing agency's name for approval; include resume of at least ten similar projects including testing dates, project name, system description and contractor.
   2. Name of certified Test and Balance Engineer assigned to supervise the procedure and the technicians proposed to perform the procedures.
   3. Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed for the project.
   4. Maintenance and operating data that includes how to test, adjust and balance the building systems.
   5. Copies of test reports intended for use.

B. Preconstruction Plan Check and Construction Review.
   1. The Contractor is to ensure that the testing agency is provided with up-to-date Contract Documents and all Contractor submittals related to the Work required by this Section.
   2. Provide a preconstruction plan check in accordance with the procedure specified in the referenced standards. Submit a written report of the plan check to the Engineer for review prior to commencement of HVAC Systems installation.
   3. Provide periodic construction review during the progress of related HVAC systems installation in accordance with the procedures specified in the referenced National Standards.

C. Pre-TAB Checklist
   1. Prior to the Testing, Adjusting and Balancing (TAB) Work for any HVAC system, submit a completed AABC "Systems Ready to Balance Checklist" to the Engineer for records. The Contractor is to ensure that all work is complete and ready for TAB.

D. Certified Reports: Submit testing, adjusting and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted and balanced in accordance with referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing,

adjusting and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Draft Reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Organize and format draft reports in the same manner specified for the final reports (drafts may be hand written). Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
2. Final Reports: Upon verification and approval of draft reports, prepare final reports, type written and organized and formatted as specified in paragraph 2.01. Submit 2 complete sets of final reports.
3. Calibration reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
   1. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers- Fundamental Handbook, Ch. 13; System and Application Handbook, Ch. 57.
   2. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association- Testing, Balancing and Adjusting of Environmental Systems; HVAC Systems.
   3. AABC, Associated Air Balance Council- National Standards for Total System Balance.
   4. NEBB, National Environmental Balancing Bureau- Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

B. The testing agency shall be the single source of responsibility to test, adjust and balance the HVAC systems and produce the design objectives.

1.04 SEQUENCING AND SCHEDULING

A. Test, adjust and balance air conditioning systems before refrigerant systems.

B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5^{o} F wet bulb temperature of maximum summer design condition, and within 10^{o}F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide all necessary TAB devices, instrumentation, test equipment, electricity, HVAC system accessories and specialties required to accomplish the Work specified in this Section. The Contractor is responsible for the proper placement of such items in the HVAC system.

B. Certified TAB Report.
   1. Report forms shall be standard forms as prepared by the referenced standard for each respective item and system to be tested, adjusted and balanced. Bind report forms, complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the following divisions:
      a. General Information and Summary
      b. Air Systems
      c. Temperature Control Systems
      d. Sound and Vibration Systems

   2. Certification Form shall include most current date on Contract Documents.

   3. The certified test report shall include, but not be limited to, the following Forms and Test Reports:
      a. Instrument list form.
      b. Air moving equipment test report shall include the additional information:
         1) Design and operating motor brake-horsepower.
         2) Manufacturer's fan curve with design and operating points plotted.
         3) Operating voltage and amperage.
         4) Motor starter heater element sizes.
      c. Static pressure profile form.
      d. Air terminal test forms.
      e. Rectangular duct traverse report.
      f. Round duct traverse report.

PART 3 - EXECUTION

3.01 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system perform the following steps:
   1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
   2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return and exhaust) and temperature control diagrams.
   3. Compare design to installed equipment and field installations.
   4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.

5. Check filter for cleanliness.
6. Check dampers (both volume and fire) for correct and locked position and temperature control for completeness of installation before starting fans.
7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.
8. Determine best locations in main and branch ductwork for most accurate duct traverses. Place outlet dampers in the full open position.
9. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.02 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage. Take all measurements in the system where best suited to the task.
   1. Instruments shall meet the specifications of the referenced standards.
   2. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
   3. Apply instrument as recommended by the manufacturer.

B. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

C. Take all readings with the eye at the level of the indicated value to prevent parallax.

D. Use pulsation dampeners where necessary to eliminate error involved in estimating averages of rapidly fluctuating readings.

3.03 TESTING, ADJUSTING AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
   1. Cut insulation, ductwork and piping for installation of test probes to the minimum extent possible to allow adequate performance of procedures.
   2. Patch insulation, ductwork and housings using materials identical to those removed.
   3. Seal ducts and piping, and test for and repair leaks. Seal insulation to re-establish integrity of the vapor barrier.
   4. Mark equipment settings, including damper control position, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
   5. Retest, adjust and balance systems subsequent to significant system

modifications and resubmit test results.

B. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.

C. Adjust all HVAC systems to deliver the specified air quantities within the following tolerances:
   1. Equipment (fans, heat transfer equipment, and air terminal units). ±10%.
   2. Air outlets. ±10%.

3.04 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
B. Prepare report of recommendations for correcting unsatisfactory performances when system cannot be successfully balanced.

3.05 DEMONSTRATION

A. Submit the final TAB report for review along with Contractor's completed checklist of recommendations for correcting unsatisfactory areas identified by testing agency.

B. Pre-test all systems prior to inspection and acceptance tests required by referenced standards. Provide detailed documentation of the referenced standard inspection tests by the Contractor and include test procedures, participants, dates and times, instruments used, test data and a summation of test results. Submit test reports prior to system commissioning tests conducted by the City.

C. System Commissioning Tests.
   1. Tests shall demonstrate that capacities and general performance of air systems comply with Contract requirements.
   2. At the time of system commissioning, recheck, in the presence of the Engineer, random selections of data (air quantities and air motion) recorded in the certified TAB test report.
   3. Selections for checks in general will not exceed 25 percent of the total number tabulated in the report.

D. Train the City's maintenance personnel on troubleshooting procedures and testing, adjusting and balancing procedures. Review with the City personnel the information contained in the Operating and Maintenance Manual.

E. Schedule training with City with at least 7 days prior notice.

3.06 SERVICES

A. Retests. If random tests elicit a measured flow deviation exceeding the specified tolerances, the TAB report will automatically be rejected. In the event the report is rejected, readjust and test all systems, record new data, submit new certified Reports and perform new rechecks at no additional cost to the City; including time required by the Engineer.

B. Re-inspection. TAB Agency shall make 2 return inspection trips to the project, one during heating design conditions and one during air conditioning design conditions for the purpose of checking out the entire system or group of systems.

C. Re-adjustments. Balancing agency shall make additional adjustments required during the re-inspection.

+++ END OF SECTION 15990 +++

SECTION 16000
ELECTRICAL POWER AND SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all electrical power and systems. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 DEFINITIONS

A. Provide: Furnish, install, and connect
B. Product Data: Catalog cuts and descriptive literature
C. Shop Drawings: Factory prepared specific to the installation
D. Indicated: Shown on the Contract Drawings
E. Noted: Indicated or specified elsewhere
F. Control Diagram: A control diagram shows by means of graphic symbols, the electric connections and functions of a specific circuit arrangement. The control diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
G. One-Line Diagram: A one-line diagram shows by means of single lines and graphic symbols the course of an electric circuit or system of circuits and the components, devices, or parts used therein. Physical relationships are usually disregarded.
H. Block Diagram: A block diagram is a diagram of a system, instrument, computer, or program which selected portions are represented by annotated boxes and interconnecting lines.
I. Wiring Diagram: A wiring or connection diagram includes all the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or b) a panel layout drawing showing the physical location of devices plus the control diagram.
J. Interconnection Diagram: Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams which interface to the interconnection diagram. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the

individual wires clearly shown. Wireless diagrams and wire lists are not acceptable. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified. All jumpers, shielding and grounding terminations not shown elsewhere shall be shown here. Signal and DC circuit polarities shall be shown. Spare wires shall be shown.

K. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements or the location to which connections are to be made.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Information required "for reference" such as product samples, similar unit test reports, and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned and stamped approval is not required prior to installation.

2. Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.

3. Interconnecting diagrams depicting all cable requirements together with actual terminations as specified under paragraph 1600-1.02J.

1.04 QUALITY ASSURANCE

A. Provide complete electrical installation in accordance with the National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.

B. All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable, products shall be labeled or listed by third party certification agencies.

C. Industry Standards: Standards organizations and their abbreviations, as used herein, are as follows. Applicable date for industry standards is that in effect on the date of advertisement of the project.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Federal Specifications (FS).
4. Institute of Electrical and Electronics Engineers (IEEE).

5. Insulated Cable Engineers Association (ICEA).
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA).
8. Underwriters Laboratories, Inc. (UL).
9. National Electrical Testing Association (NETA).

1.05 WORK PROVIDED OUTSIDE THIS CONTRACT

A. New power service from Georgia Power Company.

1.06 WORK INCLUDED IN DIVISION 16, ELECTRICAL

A. Electrical power and systems.
B. Basic materials and methods.
C. Conduit.
D. Conductors.
E. Boxes.
F. Wiring devices.
G. Electric motors.
H. Cabinets and enclosure.
I. Instrument transformers and meters.
J. Dry type transformers.
K. Panelboards.
L. Acceptance testing and calibration.

1.07 MATERIALS AND EQUIPMENT FURNISHED AND INSTALLED UNDER OTHER DIVISIONS WITH RACEWAY AND ELECTRICAL CONDUCTORS FURNISHED, INSTALLED, AND CONNECTED UNDER DIVISION 16, ELECTRICAL

A. Equipment, Instrumentation and control system components indicated on the Drawings by filled circumscribed diamond symbol.

1.08 INTENT OF DRAWINGS

A. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for proper routing of raceway, subject to the approval of Engineer.

1.09 ELECTRICAL NUMBERING SYSTEM

A. Raceway Numbers:
   1. Raceways shall be tagged at all terminations. Where raceway numbers have not been assigned, Contractor shall assign raceway numbers in accordance with the following system:

Raceway Prefix	Type of Function
C	Control and/or 120V or less power
H	Power above 600V
N	Pneumatic tubing
P	Power 208V to 600V
S	Low level signal (less than 90 volt communication or less than 30 volt instrumentation)
X	Spare

2. Prefixes shall be followed by a 5-digit equipment number. Where there is more than one raceway to a particular equipment, a letter suffix is added to distinguish the raceways.

3. Example:

Raceway number = P31109A
31109 = unique 5-digit equipment number
A = Letter to distinguish from other raceways to same equipment

B. Conductor Numbers:

1. Conductors shall be identified with numbers at both ends. Conductor tag numbers shall consist of the 5-digit equipment number followed by a dash followed by the conductor number specified on the control diagram.

2. Example:

Tag number = 19000-L1
Where:
19000 = Cable number
L1 = Conductor number

3. Conductors which are in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall have the same conductor number. Wherever possible, the conductor shall be the same as the terminal to which it connects.

4. When factory-wired equipment has terminal numbers different than the conductor number shown on the control diagram, both shall be shown on the interconnection diagram, and a copy of the interconnection diagram shall be fastened to the inside of the equipment cabinet.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.

B. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide only new products of the manufacturer's latest design.

B. Equipment shall be applied only within its rating. Equipment ratings shown are minimums. Voltage and current ratings shall be as required to adequately power the connected equipment. Fault current ratings shall be as shown for the particular item or for the next upstream device that has a fault current rating shown.

C. The following areas are classified hazardous:

1. Head works.
2. All sump pits.

D. The following areas are classified as corrosive:

1. Primary sludge pumping stations.
2. Mixed liquor channel.
3. Mixed liquor pumping station.
4. Aerated tanks.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Maintain continuity of electric service to all portions of the process or buildings at all times. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with Engineer and the electric utility company providing service to the facility. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work.

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is

mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

C. Unless otherwise indicated, all material required to be removed and salvaged shall become the property of the City.

D. Carefully modify existing electrical equipment, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

3.02 CERTIFICATION AND TESTS

A. Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.

B. At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.

C. After final review and acceptance, turn over to the Engineer all keys for electrical equipment locks. Present to the City's designated representatives, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

+++END OF SECTION 16000+++

SECTION 16050
BASIC ELECTRICAL MATERIAL AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. This Section covers basic materials and methods not included in other Sections of Division 16.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 INDIVIDUAL MOTOR STARTERS

A. Manual Starters: NEMA ICS-2; general purpose type; trip-free mechanism; with overload relays. Provide pushbutton operation for integral horsepower sizes, and toggle switch for fractional sizes.

B. Magnetic Starters: NEMA ICS-2 Type A; NEMA size 1 minimum; magnetically held contactor with field replaceable coil and contacts; bimetallic or melting alloy overload relay, manually reset. Starters shall be rated and sized in accordance with NEMA size designations; fractional sizes and ratings per IEC recommendations are not acceptable.

C. Magnetic Starter Controls: All controls, unless otherwise noted or shown, shall be 120 volts. Equip each starter with a control power transformer fused on the primary and secondary. Provide starter and overload relay auxiliary contacts for red run light, green stop light and amber overload light on the enclosure door. Provide one (1) spare normally open starter auxiliary contact, and door mounted start-stop pushbuttons or hand-off-auto selector switch and other controls as indicated.

D. Combination Starters: Molded case circuit breaker rated 42,000 amps.

E. Acceptable Manufacturers: General Electric, Square D, Allen Bradley, Siemens, Westinghouse or equal.

2.02 FUSES

A. Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class RK-5 for motors and transformers for ratings 600 amp and below and Class L for feeders rated 601 amp and above.

B. Acceptable Manufacturers: Bussmann, Brush, Littelfuse or equal.

2.03 TERMINAL JUNCTION BOXES (TJB)

A. Provide hinged-cover terminal junction boxes of the required type and size where indicated. Utilize enclosures as required in 16000-2.01. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide metal back plate for mounted terminal blocks. Provide 20 percent spare terminal points. Paint interior surfaces with white enamel or lacquer.

2.04 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. For nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, provide heavy-duty, oiltight type pushbuttons, indicating lights, selector switches, and stations for these devices. Utilize General Electric Type CR 104P, or equivalent by Square D, Cutler-Hammer, or equal.

B. For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy-duty corrosion resistant, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4X stainless steel (316) enclosures. Provide special gasketing required to make complete station watertight. Utilize Square D Type SK, General Electric, Cutler-Hammer, or equal.

C. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide pushbutton stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600.

D. Utilize selector switches having standard operating levers. Make all indicating lights push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.05 TERMINAL BLOCKS 0 TO 600 VOLTS

A. Provide 600-volt terminal blocks for termination of all control circuits entering or leaving equipment, panels, or boxes. Provide screw clamp compression, dead front barrier type terminal blocks with current bar providing direct contact with wire between the compression screw and yoke. Provide yoke, current bar, and clamping screws constructed of high strength and high conductivity metal. Utilize yoke that guides all strands of wire into the terminal. Utilize current bar providing dependable vibration-proof connection. Supply terminals constructed to allow connection of wire without any special preparation other than stripping. Rail mount individual terminals to create a complete assembly and provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

B. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags. Supply CSA certified and UL approved terminal blocks manufactured by Weidmuller, Ideal, Electrovert, or equal.

2.06 CONTROL RELAYS

A. Provide magnetic control relays, NEMA Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control type with field convertible contacts, and meeting the requirements of NEMA ICS 2. Provide General Electric Type CR120B, Cutler-Hammer Type M-600, or equal.

B. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a timer attachment adjustable from 0.2 to 60 seconds (minimum) and field convertible from ON delay to OFF delay and vice-versa.

C. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts. Utilize an attachment allowing 01 easy manual latching and unlatching.

2.07 ELAPSED TIME METERS

A. Provide synchronous-motor-driven, elapsed time meters, to 99,999.9 hours range, nonreset type, suitable for semiflush, panel mounting. Provide General Electric Type 240, 2-½-inch Big Look unit, Eagle Signal Bulletin 705 unit, or equal.

2.08 CIRCUIT BREAKERS, INDIVIDUAL, 0 TO 600 VOLTS:

A. Mount individual circuit breakers complying with requirements for circuit breakers in this section in enclosure required for the location, unless otherwise indicated. Provide circuit breakers with handles that can be locked in the OFF position. Interlock enclosure and circuit breaker to prevent opening the cover with the circuit breaker in the ON position.

2.09 CIRCUIT BREAKERS, 0 TO 600 VOLTS

A. General: Provide circuit breakers of the indicating type showing ON/OFF and TRIPPED positions of the operating handle. Do not use single-pole circuit breakers with handle ties where multipole circuit breakers are indicated. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting the requirements of NEMA AB 1. Circuit breakers shall have a minimum interrupting rating equal to the maximum fault current available at the point of application or they shall be part of an assembly with an integrated equipment short circuit rating at least as great as the fault current available at the point of application. Where circuit breakers are used as service entrance equipment, provide units UL labeled for that use. Provide circuit breakers suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

B. Inverse Time Type:

1. Provide thermal-magnetic circuit breaker, unless otherwise shown, for one- and two-pole breakers, breakers operating- at 240V or less, and three-pole branch circuit breakers operating at 480V.
2. Provide solid state trip circuit breakers with an adjustable short-time function, unless another type breaker is required for coordination, or otherwise indicated on the Drawings, for three-pole, 480V feeder circuit breakers with not more than

one downstream, 480V, overcurrent protective device, excluding protective devices provided as part of a process equipment package. Such breakers shall be Westinghouse Seltronic Circuit Breakers, Square D, Type ME or PE Circuit Breakers, or equal.

3. Provide solid-state trip circuit breakers with at least the following adjustment: long time pickup, long time delay, short time pickup, short time delay, I-squared t, for circuit breakers not covered by either of the above cases. Such breakers shall be General Electrical Circuit Breakers with Microversatrip; Westinghouse Circuit Breakers with Digitrip; or equal.

C. Instantaneous Only Type: Instantaneous only circuit breakers shall have only an instantaneous trip element. The breakers shall be used only as part of a listed combination motor starter. Instantaneous only breakers shall be sized with a continuous rating of at least 115 percent of the full-load current of the motor served. The trip setting shall be continuously adjustable from a lowest setting of not more than 700 percent to a highest setting of not less than 1,300 percent of the motor full-load current. Instantaneous only breakers shall be General Electric Mag-Break; Westinghouse MCP; Square D Mag-Guard; or equal.

2.10 SUPPORTING DEVICES

A. Support Channel: Fiberglass, according to 16000-2.01

B. Hardware: Stainless steel, according to 16000-2.01.

2.12 ELECTRICAL IDENTIFICATION

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Wire and Cable Markers: Plastic, split sleeve or tubing type.

2.13 PLYWOOD BACKBOARDS

A. Backboards: Grade BC plywood, ¾-inch thick. Paint with two coats of flat black paint.

PART 3 - EXECUTION

3.01 INDIVIDUAL MOTOR STARTERS

A. Select and install heater elements in motor starters to match installed motor characteristics. Do not use NEC motor full load ampere data for heater selection.

B. Provide a typed label inside each motor starter enclosure door identifying the motor served and listing the motor nameplate data. Provide an engraved nameplate on the exterior of the enclosure door identifying the motor served, the horsepower, voltage, and phase rating.

C. Enclosure type, unless otherwise indicated, enclosures shall be according to Section 16000-2.01.

D. Install starters so they are rigidly supported and readily accessible. Where mounted on stud walls, provide a non-flammable backboard secured to the studs with the starter secured to the backboard. Provide stainless steel mounting channel or phenolic spacers to give nominal ½ inch separation from concrete walls in wet or damp locations.

3.02 FUSES

A. Equip all fusible devices with fuses. Replace all blown fuses up to final acceptance of the Project. At the completion of the Project, turn over to the Owner spare fuses for each type and size installed; six each for ratings 60 amps and below, and three each for ratings above 60 amps.

3.03 TERMINAL JUNCTION BOXES (TJB)

A. Install in accordance with all the requirements detailed under Section 16130, BOXES. Label each block and terminal with a permanently attached, nondestructible tag.

3.04 SUPPORTING DEVICES

A. Fasten hanger rods, support stands, conduit clamps, etc. to building structure using approved material.

B. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Do not use powder actuated fastening devices. Do not drill structural steel members.

3.05 ELECTRICAL IDENTIFICATION

A. Provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters, and other items of electrical distribution equipment. Engrave with the equipment identification as indicated, and the voltage rating. Attach nameplates with screws or rivets; adhesives are not acceptable.

+++ END OF SECTION 16050 +++

SECTION 16060
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Documents and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. Related Sections include but are not limited to:
   1. Section 01300 – Submittals.
   2. Section 02222 – Excavation, Trenching and Backfill.
   3. Section 16120 – Wire and Cable (600V).

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. American Society for Testing and Materials (ASTM).
      a. ASTM B3 – Specification for Soft or Annealed Copper Wire.
      b. ASTM B8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      c. ASTM B33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
   2. National Electrical Code (NEC).
      a. NEC – National Electrical Code.
   3. Underwriters Laboratories Inc. (UL).
      a. UL 467 – Standard Grounding and Bonding Equipment.
      b. UL 486A and UL 486B – Standard Wire Connectors.
   4. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the requirements of Section 01300 - Submittals.

B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.

C. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the international Electrical Testing Association (NETA).
   1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3 of this Section.

B. Comply with NFPA 70.

C. Comply with UL 467.

D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. See Also Spec 16010 – General Electrical Requirements, Part 1 for listing of applicable reference standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Apache Grounding; Nashville Wire Products.
   2. Chance: A. B. Chance Co.
   3. Erico Products- Cadweld.
   4. Burndy Co.
   5. Fushi Int.- Copperweld
   6. Continental Industries – Thermoweld.

7. Heary Brothers Lightning Protection Co.
8. Ideal Industries, Inc.
9. Kearney.
10. Lightning Master Corp.
11. O-Z/Gedney Co.
12. Thomas & Betts, Electrical.
13. Or approved equal.

2.02 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirement and the greater size, rating, and quantity indications shown shall be adhered.

2.03 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Section 16120 - Wire and Cable (600V). Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Grounding-Electrode Conductors: Stranded copper cable.

D. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:
   1. Solid Conductors: ASTM B 3.
   2. Assembly of Stranded conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

2.04 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.

C. Bonding straps: Soft copper, 0.05-inch thick and 2-inches wide, except as indicated.

2.05 GROUNDING PRODUCTS

A. Pressure connectors: High-conductivity-plated units.

B. Bolted Clamps: Heavy-duty type.

C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combination of conductors and connected items.

2.06 GROUNDING ELECTRODES AND TEST WELLS

A. Grounding Rods: Copper-clad steel.
   1. Size: 3/4-inch by 120-inches.

B. Test Wells: Grounding rod, as above, driven through drilled hole in bottom of handhole. Handhole minimum size 12-inch x 1-inch x12-inch with cover. See 3.02 below.

PART 3 - EXECUTION

3.01 APPLICATION

A. Equipment grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
   1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
      a. Feeders and branch circuits.
      b. Lighting circuits.
      c. Receptacle circuits.
      d. Single-phase motor or appliance branch circuits.
      e. Three-phase motor or appliance branch circuits.
      f. Flexible raceway runs.
   2. Metallic Raceways: Raceways, conduits and cable trays, etc. shall be made electrically and mechanically continuous, and shall be bonded/ grounded to earth. Utilize jumpers, clamps, etc. as necessary to meet requirements for NEC. Install a grounding conductor in each metallic raceway, conduit and cable tray.
   3. Nonmetallic Raceways: Install a grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
   4. Air-Duct Equipment Circuits: Install a grounding conductor to duct mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
   5. Water Heater, Heat-Tracing, and Antifrost Heater Circuits: Install a separate grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, backboard, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and wiring Closets: Terminate grounding conductor on a 1/4-inch x 2-inch x 12-inch grounding.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC.

D. Metal Poles Supporting Exterior Lighting Fixtures: Ground pole to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.

E. Grounding and Bonding for Piping and Metallic Parts:
1. Ground and bond piping to meet NEC and requirement of local Authority Having Jurisdiction.
2. Ground and bond metallic structures, supports, fences, handrails, misc. metallic parts and similar items which are in proximity to electrical equipment, conduit and wiring and which are likely to become electrified upon fault or short of the electrical equipment, conduit or wiring.

F. Grounding and Bonding Metal Air Ducts: Ground and Bond metal air ducts to equipment grounding conductors of associated fans, blowers, heaters and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.02 INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Grounding Electrode System: Where available on the premises, at each building or structure served, a metal underground water pipe, the metal frame of the building or structure, concrete encased electrodes, any ground ring encircling the building or structure and all made electrodes (ground rods, etc.) shall be bonded together to form the grounding electrode system. The main bonding jumper and the grounding electrode conductor shall be installed and sized per NEC except where larger sizes than required by NEC are indicated.

C. Electrical Room Grounding Bus: Space 1-inch from wall and support from wall 6-inches above finished floor, except as otherwise indicated.

D. Grounding Rods: A minimum of two (2) ground rods shall be installed where the ground rod serves as the grounding electrode per NEC. Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
1. Drive until tops are 2-inches below finished floor or final grade, except as otherwise indicated.
2. Interconnect with grounding-electrode conductors. Except at test wells and as otherwise indicated, use exothermic welds. Make these connections without damaging copper coating or exposing steel.

E. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

F. Underground Grounding Conductors: Use bare, soft-drawn copper wire: Bury at least 30-inches below ground.

G. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit at each end.

H. Test Wells: Minimum of two at each building/ structure ground loop, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1-inch maximum-size crushed stone or gravel.

3.03 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Non-contact metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor

to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both entrances and exits with the grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: 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 a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven grounding rod close to wall and set rod depth so 4-inches will extend above finished floor. Where necessary, install grounding rod before manhole is placed and provide a No. 1/0 AWG bare copper conductor from grounding rod in to manhole through a waterproof sleeve in manhole wall. Protect grounding rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2-inches above to 6-inches below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire. Train conductors plumb or level around corners and support to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Grounding System: Ground Pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage an electrical testing organization to perform tests described below.

B. Test: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means

of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81

C. Maximum grounding to resistance values are as follows:
   1. Equipment rated 500 KVA and Less: 10 ohms.
   2. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
   3. Manhole Grounds: 10 ohms.

D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

E. Report: Prepare test reports, certified by the testing organization, or 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.

3.06 ADJUSTING AND CLEANING

A. Restore surface features, including vegetation, at areas disturbed by work in this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoil, fertilizer, lime, seed, sod, sprigs, and mulch. Comply with Section 02222 – Excavation, Trenching and Backfill. Maintain restored surface. Restore disturbed paving to the original condition.

+++ END OF SECTION 16060 +++

SECTION 16110
RACEWAYS, BOXES, AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE

This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, manholes, handholes, cable trays, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI	Rigid Steel Conduit-Zinc Coated
ANSI	Electrical Metallic Tubing-Zinc Coated
ASTM	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC	Conduit and Conduit Fittings, Plastic, Rigid
NEMA	Industrial Control and Systems Enclosures
NEMA	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA	Cable Tray Systems

NEMA	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electrical Code (NEC)
UL	Flexible Metal Electrical Conduit
UL	Rigid Metal Electrical Conduit
UL	Liquid Tight Flexible Electrical Conduit
UL	Rigid Nonmetal Electrical Conduit
UL	Electrical Metallic Tubing

1.03 SUBMITTALS

The following information shall be provided in accordance with the General Conditions:

1. Manufacturer's descriptive literature for all materials.

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (□) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

PART 2 - PRODUCTS

2.01 BOXES AND FITTINGS

A. PULL BOXES AND WIRING GUTTERS:

Indoor boxes larger than FD boxes shall be constructed of sheet steel and galvanized after fabrication. Similar enclosures outdoors shall be provided with neoprene gaskets

on the hinged doors or removable covers. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle. Covers larger than 3 by 4 feet shall be split.

B. TERMINAL CABINETS:

Terminal cabinets located indoors shall be NEMA 12. Cabinets located outdoors and in corrosive areas shall be NEMA 4X. Cabinets shall be provided with hinged doors. Adjustable terminal strip mounting accessories shall be provided. Cabinets shall be provided with channel mounted terminal blocks.

C. MANHOLES:

Unless otherwise specified, manholes shall be precast concrete, 3000 psi strength at 28 days, with reinforcing and cover designed for H-20 bridge loading. Manhole dimensions shall be as indicated on the drawings. Necking and shaft shall have 36-inch minimum clear opening.

Manhole cover and frame shall be Class 30B grey cast iron per ASTM A48 with machine finished flat bearing surfaces. Manholes shall be watertight. Exterior walls of manholes shall be provided with 6 mils of waterproof membrane, Sonneborn HLM 5000 Series, or equal.

Duct entrees shall be no less than 14 inches above floor and below ceiling. Cables supports, clamps or racks shall be provided to support the cable at minimum 2-foot intervals. Concrete inserts shall be embedded in walls and ceiling. Floor shall slope 2 percent in all directions to a sump. Sump shall be a minimum of 18 by 18 by 12 inches deep.

Manhole walls shall be provided with boxouts with waterstops on all sides of each boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section. Boxouts shall be sized to accommodate the penetrating underground duct banks.

D. HANDHOLES:

Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H-20 loading. Dimensions shall be as specified on the drawings. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be constructed of 3000 psi reinforced concrete. Handhole cover shall be engraved "ELECTRICAL" or "SIGNAL" as applicable.

Handhole walls shall be provided with boxouts, as specified for manholes.

2.02 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS:

Hot-dip galvanized framing channel with end caps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. Conduit supports for PVC coated rigid steel and PVC conduit systems shall be one-hole PVC coated rigid steel or clamps conduit wall hangers.

B. CEILING HANGERS:

Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise specified, hanger rods shall be 1/2 inch all-thread rod and shall meet ASTM A193. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

C. SUSPENDED RACEWAY SUPPORTS (RACKS):

Suspended raceway supports shall consist of concrete inserts, galvanized carbon steel rod hangers, and jamb nuts supporting hot-dip galvanized framing channel or lay-in pipe hangers as required. Hanger rods shall be 1/2 inch all-thread rod and shall meet ASTM A193, unless otherwise specified. All suspended raceway supports shall be braced at 30-foot intervals (alternating from one side to the other) to meet specified seismic requirements.

2.03 CONCRETE ENCASED DUCT BANKS

Concrete used for duct banks shall be Class E with red oxide added as specified in the Cast-in-Place Concrete section.

2.04 UNDERGROUND MARKING TAPE

Underground marking tape shall be for early warning protection of digging around reinforced concrete duct banks. Tape shall be low density polyethylene plastic, nominally 6 inches wide and 4-mil thickness. The plastic color shall be red. A warning shall be imprinted continuously along the length, with message reading similar to "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW." Tape shall be Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

Underground marking tape for directly buried cables and conduits shall be 6-inch-wide metallic lined tape with red polyethylene film on top and clear polyethylene

film on the bottom. The message shall be clearly printed with black over red tape and shall read "CAUTION ELECTRIC LINE BURIED BELOW".

2.05 NAMEPLATES

Nameplates shall be provided for all boxes in accordance with the requirements of Section 16000. Nameplate wording shall be as indicated on the drawings. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate.

2.06 FIRESTOPS

Firestops and seals shall be Flamemastic 77, Vimasco No. 1-A, or equal, and shall be applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

2.07 RACEWAY IDENTIFICATION

Raceway number tags shall conform to the requirements of raceway markers, Section 16000.

PART 3 - EXECUTION

3.01 CONDUIT

A. GENERAL:

The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

Conduit runs shall be limited to a maximum of 400 feet between pull boxes, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

B. INDOOR AND OUTDOOR CONDUIT SYSTEMS:

In general, conduit inside structures shall be concealed unless otherwise specified or indicated on the drawings. No conduit shall be exposed in water chambers unless so indicated on the drawings.

Unless otherwise indicated on the drawings, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.

Conduit installation shall conform to the following:

1. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

2. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.

3. Exposed conduit shall be run on supports spaced not more than 10 feet apart.

4. Where three or more conduits are located in parallel run, they shall be spaced out from the wall using framing channel.

5. Conduits support systems shall comply with the requirements of Section 16000.

6. Conduit rack supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.

7. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.

8. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement.

9. Conduit shall be routed clear of structural openings and indicated future openings.

10. Conduits through roofs or metal walls shall be flashed and sealed watertight.

11. Conduit shall be neatly grouted into any openings cut into concrete and masonry structures.

12. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

13. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

14. Concealed conduit stub-up locations shall be determined from the manufacturer's shop drawings.

15. Concealed conduit for future use shall be terminated in equipment or by galvanized couplings plugged flush with structural surfaces.

16. Where the drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

17. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.

18. All conduits that enter enclosures shall be terminated by fittings which ensure that the NEMA rating of the enclosure is not affected or changed.

19. Underground metallic or nonmetallic conduit which turns out of concrete, masonry or earth shall be connected to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.

20. Conduit across structural joints where structural movement is allowed shall have an O-Z "Type DX" or Crouse-Hinds "Type XD," bonded, weathertight expansion and deflection fitting of that conduit size.

C. UNDERGROUND CONDUIT SYSTEM:

All excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:

1. All underground conduits not indicated otherwise on the drawings shall be concrete encased. All concrete encasement shall be reinforced.

2. Concrete encased conduit shall have minimum concrete thicknesses of 3 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches over reinforcing.

3. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

4. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere.

5. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads shall be protected. All steel surfaces shall be given two coats of thixotropic coal tar paint.

6. Underground conduits and conduit banks shall have 2 feet minimum earth cover except where indicated otherwise.

7. Underground conduit banks through building walls shall be cast in place or concreted into boxouts with waterstops on all sides of the boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section.

8. Conduits not encased in concrete and passing through walls which have one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

9. Conduits shall be thoroughly swabbed on the inside, immediately upon completion of pouring concrete. After the concrete has set, and before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

10. All spare raceways shall be provided with a nylon pull rope.

D. SEALING OF CONDUIT:

Conduits passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area, or between Class 1, Division 1 area and Class 1, Division 2 area shall be provided with a sealing fitting which shall be located at the boundary in accordance with NEC.

Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type, UL listed for explosion proof sealing fittings. Sealing compound shall be nonhardening type for corrosive areas. Seal fitting and sealing compound shall be as manufactured by Appleton, Crouse-Hinds, or equal.

3.02 MANHOLES AND HANDHOLES

Unless otherwise specified, manhole and handhole installation shall be as follows:

1. Manholes and handholes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

2. Manholes and handholes shall be set plumb, so that water shall drain properly to the sump.

3. Manhole covers, unless otherwise specified, shall be set at 1 to 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

4. All metallic hardware inside manholes and handholes shall be grounded by connection to the ground plate. Connections shall be made using bolted connections, bonding jumpers and grounding bushings.

3.03 CABLE TRAY

Unless otherwise specified, cable tray installation shall be as follows:

1. Cable trays shall be supported at intervals not to exceed 5 feet.

2. Corners shall be supported by two supports installed as close as possible to the corner, with one support on each side of the corner.

3. All field cuts shall be treated with zinc rich paint.

4. Expansion joint splice plates shall be used to allow 1 1/2-inch free movement between adjacent trays when crossing building expansion joint.

5. Cable tray shall have minimum clearance of 3/4 inch from concrete surfaces and minimum spacing of 12 inches from other trays. The top of the tray shall be minimum 9 inches from the ceiling.

6. Signal cable trays shall be provided with covers. Covers shall be solid or louvered type.

7. Each cable tray shall be provided with No. 2/0 AWG minimum bare copper equipment ground conductor. The ground conductor shall be attached to the outside of each tray section using UL Listed bolted bronze or brass ground clamp.

8. Power cables shall be placed in cable trays not more than two layers deep.

9. Cables shall be arranged in trays so as to provide minimum cross-over.

3.04 RACEWAY NUMBERING

Each conduit shall be provided with a number tag at each end and in each manhole and/or pull box. Trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end.

3.05 RACEWAY SCHEDULE

A. GENERAL:

The Raceway Schedule is on the drawings.

B. UNSCHEDULED RACEWAY:

With the exception of lighting, communication, paging, fire alarm, security and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules. Lighting and receptacle raceway are unscheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

The number and size of communication, paging, fire alarm, and security raceways shall be as required for the particular equipment provided subject to the minimum sizes specified above.

+++END OF SECTION 16110+++

SECTION 16111
CONDUIT

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of conduit, including rigid metal conduit and fittings, flexible metal conduit and fittings, liquidtight flexible metal conduit and fittings, non-metallic conduit and fittings, explosion proof flexible steel conduit, manholes, handholes and ductbanks. All conduit shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Equipment data specified in this Section.
2. Catalog cuts.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI C80.1
2. ASTM F 512
3. Fed Spec WW-C-581E
4. Fed Spec WW-C-1094A
5. NEMA TC2
6. NEMA TC6
7. NFPA 70
8. UL 1
9. UL 6

10. UL 360
11. UL 651

1.04 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with NEMA standards, and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:

1. Conduit: Allied, Republic, Triangle, Wheatland or equal.
2. PVC Coated Conduit: Permacote, Robroy or equal.
3. PVC Conduit: Amoco, Carlon, Certainteed or equal.
4. Flexible Conduit: Anamet, Columbia, Electrilex or equal.
5. Fittings: Appleton, Crouse-Hinds, Thomas & Betts or equal.

PART 2 - PRODUCTS

2.01 GENERAL

A. The type and size of raceway shall be as specified on the Drawings or schedules. Lighting and receptacle raceways are not scheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be ¾-inch for exposed and 1-inch for embedded raceway. The number and size of communication and security raceways shall be as required for the particular equipment provided, subject to the minimum sizes specified above.

2.02 RIGID METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit: UL 6; ANSI C80.1; hot dip galvanized. Minimum size 3/4-inch, exposed, 1-inch embedded or inaccessible.

B. PVC Coated Conduit: NEMA RN-1; galvanized rigid steel conduit with factory applied external 40 mil PVC coating and 2 mil urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. Minimum size ¾-inch.

C. Fittings and Conduit Bodies: NEMA FBI; zinc coated; taper-threaded type, material to match conduit. Where PVC coated conduits are indicated all couplings, fittings, conduit bodies, pipe straps, U bolts, beam clamps, and other accessories are to be PVC coated.

2.03 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: UL 1; FS WW-C-566; single steel continuous strip with galvanized coating. Minimum size ½-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; malleable iron squeeze type.

2.04 LIQUIDTIGHT FLEXIBLE CONDUIT AND FITTINGS

A. Conduit: UL listed liquidtight consisting of an extruded thermoplastic cover over a galvanized steel core. Minimum size ¾-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; galvanized steel compression type with 0-ring.

2.05 RIGID NONMETALLIC CONDUIT AND FITTINGS

A. Use rigid PVC Schedule 40 conduit, UL listed for concrete-encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90 degrees C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL, NEC, and ASTM specified tests for the intended use. Use only conduit with a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable. Minimum size ¾-inch exposed, 1-inch embedded or encased.

B. Fittings for PVC conduit shall comply with Standard for PVC Fittings for use with Rigid Conduit and Tubing, NEMA TC3, and shall be NEMA Type IV.

2.06 PRECAST HANDHOLES AND MANHOLES

A. Install handholes and manholes with 28-day, 2,500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions for handholes and manholes are shown on the Drawings. Increase these as required by use of extension sections to accommodate the several raceway entrances at their required elevations.

B. Slope floors toward drain points, leaving no pockets or other nondraining areas. Provide a drainage outlet at the low point of the floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

C. Provide raceway entrances on all four sides. For raceways installed under this Contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this Contract, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.

D. For manholes, utilize heavy-duty type frames and covers made of stainless steel, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each. On the upper side of each cover, cast or burn by welder, in integral letters not less than 2 inches high appropriate titles, ELECTRIC HV (for above 600 volts), ELECTRIC LV (for 600 volts and below), or COMMUNICATION. Field stamp covers with handhole and manhole numbers indicated on the Drawings.

E. For handholes, frames and covers shall conform to ASTM A48-83 and shall be slab type with letters as indicated above.

F. Provide heavy weight cable racks with adjustable arms and acceptable insulators for all cables in each handhole and manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation. Provide racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the handhole, including spares.

G. Provide pulling irons. Utilize ¾-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.

H. Utilize handhole and manhole hardware of steel, hot-dip galvanized after fabrication.

I. Manufacturers: Brooks Products, Inc.; Penn-Cast Products, Inc.; Concrete Conduit Company; Associated Concrete Products, Inc.; or equal.

2.08 WARNING TAPE

A. Provide heavy-gauge, yellow plastic tape of 6-inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: ITT Blackburn Type YT or RT; Griffolyn Co. Terra-Tape; or equal.

2.09 RACEWAY IDENTIFICATION

A. Raceways number tags shall be brass with stainless steel attachment wire. Raceway number shall be embossed on to the tag with ¼-inch letters.

PART 3 - EXECUTION

3.01 CONDUIT SCHEDULE

A. Use rigid steel conduits for indoor clean area.

B. Use liquidtight flexible steel conduit for connections to motors, transformers, and other vibrating equipment.

C. Non-jacketed flexible steel conduit may be used for connections to lighting fixtures in suspended ceilings.

D. Use PVC coated conduits where conduits are in direct contact with earth or where conduits are installed in corrosive areas.

E. Use PVC conduits where conduits are embedded in concrete structures, encased in concrete duct bank or concealed in concrete block CMU.

F. Where PVC conduit is indicated, make a transition to PVC coated rigid steel below grade or slab and continue above with PVC coated rigid steel conduit.
Exception: PVC may enter switchboards, motor control centers or other floor standing electrical equipment enclosures.

3.02 CONDUIT ARRANGEMENT AND SUPPORT

A. Arrange conduit to maintain headroom and present a neat appearance. Run exposed conduits parallel or perpendicular to building surfaces and adjacent piping. Group conduit in parallel runs where practical and provide rack space for 25 percent additional conduits.

B. Avoid sources of heat when possible. Where unavoidable, maintain 6-inch clearance when crossing hot pipes and 12-inch clearance between parallel hot pipes, flues, heating appliances, and other heat sources.

C. Support conduits to prevent distortion of alignment by wire pulling operations. Fasten single conduits with one hole malleable iron straps. For multiple runs use galvanized steel channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.

D. Support conduit at a maximum of 7 feet on center and within 3 feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 3/8-inch diameter. Remove all temporary supports prior to pulling conductors.

3.03 CONDUIT INSTALLATION

A. Cut conduit square using a saw or pipecutter and de-burr and ream cut ends. Paint threads with zinc compound. Bring conduit to the shoulder of fittings and couplings and fasten securely. All connections are to be wrench tightened and electrically continuous. No running threads are permitted.

B. Use conduit hubs for fastening conduit to boxes. Use conduit bodies to make sharp changes in direction. For sizes 2-inches and larger, use "LD" or similar fittings to permit a straight pull from either direction.

C. The maximum length between pull points is 400 feet. This length shall be reduced by 100 foot for each 90 degree of bend.

D. Use hydraulic one-shot shoe bender or factory elbows for bends in conduit larger than 2-inch size. Crushed or deformed conduits may not be installed.

E. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

F. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Install threaded PVC end caps on conduits stubbed up for future use.

G. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box.

H. Provide a 200 pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.

I. Install expansion joints where conduit crosses building expansions joints and for straight runs in excess of 100 feet.

J. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.

K. Provide watertight seals, equal to OZ type WSK or FSK, where conduit penetrates exterior walls and where conduit passes between spaces normally at different temperatures.

L. Provide clamp backs for conduits on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.

M. Route conduits in slabs above the bottom reinforcing and below the top reinforcing. Maximum size for conduits in slabs above grade is 1-inch. Route so conduits in slabs above grade do not cross.

N. PVC conduit bends: Use PVC-coated rigid steel factory elbows.

O. PVC coated conduit: Exercise care not to damage the coating during cutting, threading, bending, and assembly. Follow the manufacturer's installation instructions. Use vise jaws, bending equipment, strap wrenches, and other tools which are specifically designed for coated conduits. Do not use chain vise, pipe wrench, channel locks or the like.

P. Provide sealing compound equal to Chico A or Chico B where conduit passes from hazardous or corrosive area in to a nonclasified area.

Q. Each conduit shall be provided with a number tag at each end.

3.04 UNDERGROUND DUCT BANK INSTALLATION

A. Install top of duct bank minimum 24-inches below finished grade with plastic warning tape 12-inches below finished grade.

B. Install conduit with minimum grade of 4-inches per 100 feet.

C. Terminate conduit in end bell at manhole entries.

D. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank. Use suitable separators and chairs installed not greater than 4 feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during concrete placement. Stagger conduit joints in concrete encasement 6-inches minimum.

E. Construct duct banks with 3,000 psi concrete. Provide reinforcing bars as indicated. Each 50 lb. bag of concrete shall include 3 lbs of red oxide.

F. Where duct bank passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the ductbank and the structure.

G. Thoroughly swab inside of conduits upon completion of pouring concrete. Before backfilling, a mandrel, ½-inch smaller than the conduit diameter, shall be pulled through each conduit.

3.05 HANDHOLES AND MANHOLES

A. Install handholes and manholes where shown on the Drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified in Division 2 of these Contract Documents.

B. Do not install handholes or manholes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.

C. Install one ground rod in each handhole and/or manhole. Connect all noncurrent-carrying metal parts in the manhole or handhole and any metallic raceway grounding bushings to this ground rod with No. 6 AWG (minimum) copper conductor.

+++END OF SECTION 16111+++

SECTION 16119
UNDERGROUND DUCTS AND UTILITY STRUCTURES

1. GENERAL

1.01 SCOPE

A. This Section includes underground conduits and ducts, duct banks, pull boxes and handholes, manholes, and other underground utility structures.
B. Products furnished and installed under this Section include pulling eyes, cable stanchions, cable arms, and insulators.
C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
D. Related Sections include but are not limited to:

1. Section 01300 – Submittals.
2. Section 02225 – Excavation, Trenching, and Backfill for general requirements for excavation, backfill and related items for ducts, manholes, and handholes.
3. Section 03200 – Concrete Reinforcement and Dowelling.
4. Section 03300 – Cast-In-Place Concrete for cast-in-place concrete requirements.
5. Section 16195 – Electrical Identification.

1.02 REFERENCES

A. Publication listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.

1. Industry Standards:

a. American National Standards Institute, Inc. (ANSI).

i. ANSI C2 – National Electrical Safety Code
ii. ANSI C80 – Rigid Steel Conduit

b. National Electrical Manufacturers Association, Inc. (NEMA).

i. NEMA TC-2 – Rigid Nonmetallic Conduit
ii. NEMA TC-3 – PVC Conduit and Tubing Fittings

c. National Fire Protection Association (NFPA):

i. NFPA 70 – National Electrical Code (NEC)

2. Government Standards:

a. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA). Code of Federal Regulations, Title 29, Chapter XVII

i. 1910 – Part 1910, Subpart S, Electrical, Revised by CFR 4056, January 16, 1981.
ii. 1926 – Part 1926, Subpart K, Electrical, Revised by 51 CFR 25318, July 11, 1986.

1.03 SUBMITTALS

A. General: Submit the following according to the requirements of Section 01300 - Submittals.
B. Product data for metal accessories for manholes and handholes, conduit and duct, duct bank materials, and miscellaneous components.
C. Field test reports indication and interpreting test results relative to compliance with performance requirements of Paragraph 3.06, "Field Quality Control" Article in Part 3 of this Section.
D. Record Documents: Show dimensioned locations of underground ducts.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70, and ANSI C2 for components and installation.
B. Listing and Labeling: Provide products that are UL listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.

C. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities as determined in the field.
D. Coordinate elevations of duct and duct bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to manholes and handholes, and as approved by the Engineer.

1.05 DEFINITIONS

A. Duct: PVC conduit used underground, embedded in concrete.

B. Duct Bank: 2 or more PVC conduits installed underground in the same concrete envelope.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

2. PRODUCTS

2.01 CONDUIT AND DUCT MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the Work include:

1. Nonmetallic Ducts:

a. CANTEX, Inc.
b. Carlon; Lamson & Sessions Company.
c. Pipe & Plastic Group; Certainteed Products Corp.
d. Or approved equal.

2.02 CONDUIT AND DUCT

A. Rigid Steel Conduit: ANSI C80.1, galvanized.
B. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, rated for use with 105ºC conductors under all installation conditions. Suitable for above ground, direct burial, concrete encased, and direct sunlight applications, ASTM class DB (suitable for direct burial without concrete encasement). Use Schedule 80 PVC for locations subject to damage.
C. PVC Conduit and Tubing Fittings: NEMA TC3.

2.03 CONDUIT AND DUCT ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacing and concrete cover depths indicated, while supporting ducts during covering.
B. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35ºF, withstands temperature of 300ºF without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheathes, cable jackets, insulation materials, and the common metals.

2.04 CONDUIT AND DUCT CONSTRUCTION MATERIALS

A. Concrete: Conform to Section 03300 - Cast-In-Place Concrete for concrete and Section 03300 – Concrete Reinforcement and Dowelling, for reinforcing steel.
   1. Strength: Class D 3000 psi (20.7 Mpa) minimum 28-day compressive strength.
   2. Aggregate for Duct Encasement: 3/8-inch maximum size.

2.05 MANHOLE AND HANDHOLE MANUFACTURERS

A. Acceptable Manufacturers:

   1. Old Castle precast, Inc.
   2. Brooks Products Co.
   3. Jensen Precast Products.
   4. Or approved equal.

2.06 MANHOLE AND HANDHOLE CONSTRUCTION MATERIALS

A. Concrete: Where applicable, conform to Section 03300 - Cast-In-Place Concrete, for concrete and reinforcing.

   1. Strength: 3000 psi (20.7 Mpa) minimum 28 day compressive strength.
   2. Aggregate for Duct Encasement: 3/8-inch maximum size.

B. Concrete Reinforcement: All underground structures, including duct banks, shall utilize concrete reinforced with rebar. Intent is for rebar details to be in accordance with the requirements of Section 03200 – Concrete Reinforcement and Dowelling, and / or electrical details as shown on the Contract Drawings. In the details in Contract Drawings, structure and duct bank rebar shall be #4 steel rebar. Install rebar continuously near all the structure's or duct bank's top and bottom edges and corners, with additional #4 rebar spaced such that maximum spacing between rebars is 18-inches. Additionally, duct banks shall have #4 rebar placed across the top and bottom of the bank, every 18-inches, for the entire length of the duct bank.

2.07 MANHOLES AND HANDHOLES

A. Cable racks, supports, pulling-in-irons, manhole steps and hardware shall be hot dipped galvanized steel as manufactured by Line Materials Co. or approved equal.

B. Precast concrete manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Old Castle Precast, Inc., or approved equal.

C. Manhole frames and covers shall be cast iron heavy duty type for class H-20 wheel loading, and shall be as manufactured by Neenah, or equal. Manhole

covers shall be marked Electrical Medium Voltage or Electric Low Voltage as applicable, in addition stamp the manhole covers with minimum 1-1/2-inch high letters and numbers for manhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

D. Handhole covers and frames shall be hot dipped galvanized and designed for a Class H-20 wheel load. Handhole covers and hatches shall have Type 316 stainless steel security bolts. Handhole covers shall be marked Electric Medium Voltage or Electric Low Voltage as applicable, in addition stamp the handhole covers with minimum 1-1/2-inch high letters and numbers for handhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

E. Bell ends and plastic duct spacers shall be as manufactured by Carlon or approved equal.

F. Manholes and Handholes shall be installed to permit passive drainage of infiltration seepage as detailed on the Drawings. In the absence of such detail, provide 3-inch diameter PVC sleeve at low point of structure extending to a depth approximately 12-inches below the bottom surface of the structure. Provide a finely crushed and packed stone base below the structure to a total depth approximately 24-inches below the structure bottom to permit drainage. Provide drain cover at pipe termination in structure.

3. EXECUTION

3.01 APPLICATION

A. Underground Ducts for Electrical Utility Service: Plastic conduit encased in concrete.

B. Underground Ducts for Electrical Feeders: Plastic conduit encased in concrete.

C. Underground Ducts for Telephone Utility Service: Plastic conduit encased in concrete.

D. Underground Ducts for Communication Circuits: Plastic conduit encased in concrete.

3.02 EXAMINATION

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 EARTHWORK

A. Excavation and Backfill: Conform to Section 02225 – Trench Excavation and Backfill, but do not use heavy-duty, hydraulic-operated compaction equipment.

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing or dirt, cable lay, and other work. Restore vegetation and include necessary topsoil, fertilizing, liming, seeding, sod, sprigging, or mulching.

C. Restore disturbed paving to the original condition.

3.04 CONDUIT AND DUCT INSTALLATION

A. Install Non-metallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of 4-inches per 100-feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and require duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18-inches into the concrete on both sides of joint near the corners of the envelope.
3. Reinforcing: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.

5. Minimum Clearances Between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
6. Depth: Except as otherwise indicated, install top of duct bank at minimum of 18-inches below finished grade in general areas and at maximum of 30-inches below finished grade in vehicular traffic areas.
7. Install identification marker tape in accordance with Section 16195 – Electrical Identification.
8. Run #1/0 bare copper grounding conductor in all concrete encased duct banks.

F. Pulling Cord: Install 100-pound-test nylon cord in ducts, including spares.

G. Building Entrances: Transition from underground duct to conduit 10-feet minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcing in duct banks. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight

H. Overall underground electrical ductbanks are shown on the electrical site plans. Final stub-up locations (entry/exit) into equipment inside electrical rooms and at each site area shall be field coordinated and determined by contractor.

I. Equipment drawings shall be used to determine where embedded conduits may be stubbed-up at or beneath equipment. For all embedded conduits contractor shall determine routing of conduit based on site conditions.

J. Conduits embedded in concrete slab shall not interfere with equipment or building structures. Interferences with embedded conduits stubbed-up at or beneath equipment shall also consider accessibility at such equipment. Interferences with embedded conduits shall be the contractor's responsibility and cost to remedy.

K. Spare empty conduits shall be installed embedded in slabs as required, and as part of underground ductbanks.

3.05 MANHOLE AND HANDHOLE INSTALLATION

A. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2-inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

B. Install pulling-in irons opposite all raceway entrances to manholes. Pulling irons shall be cast into the walls and floor. Bolt on style pulling irons are not acceptable.

C. Cables shall be completely looped and trained in manholes and supported on racks and hoods at intervals not greater than 3-feet 0-inches and supports shall be installed on each side of all splices.

D. Furnish cast in place inserts on all manhole walls for mounting future racks as well as racks required for present installation.

E. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish 3-inches above crown adjacent roadway.

F. Floor elevations of manholes shall be so set that the center line of the lowest conduit entering will be not less than 1-foot below the roof slab or top.

G. A 3/4-inch by 10-foot copperclad ground rod shall be driven in the bottom of each manhole. All bond wires, galvanized conduits and metal cable racks shall be bonded to the ground rod.

H. Polyethylene warning tape shall be provided for all underground raceways, duct banks, etc.

I. Install a bare copper cable in the concrete encased duct bank. Size shall be as shown on the Drawings. In the absence of cable size being shown on the Drawings, it shall be #1/0. It shall be continuous from one end to the other for the entire length of the ductwork and shall be bonded to building steel on each end and to all manhole-handhole ground loops and associated manhole-handhole ground rods.

J. Install expansion deflection fittings as required by the NEC and duct bank raceway manufacturer.

K. Record drawings shall be furnished showing each conduit termination, elevations, locations, manholes, etc.

3.06 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
2. Duct Integrity: Rod ducts with a mandrel 1/4-inch smaller in diameter than internal diameter of ducts. Where rod indicates obstructions in ducts, remove the obstructions and retest.

B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.07 CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2-inch greater than internal diameter or duct.

+++ END OF SECTION 16119 +++

SECTION 16120
600 VOLT CONDUCTORS, WIRE, AND CABLE

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to document shall mean the documents in effect at the time of Advertisement for bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electrical Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.03 SUBMITTALS

A. The following information shall be provided in accordance with the General Conditions.

1. Submittals specified in Section 16000.

2. Complete catalog cuts for all conductors, wire, and cable.

PART 2 – PRODUCTS

2.01 GENERAL

A. Unscheduled Conductors and Cables:

1. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein.

2. Unscheduled conductor with insulation shall be provided in accordance with the following:
   a. CABLESPEC "MEPR/CPE" multi-conductor power and control cable
   b. CABLESPEC “RHW” for single conductors
   c. CABLESPEC “XHHW or THWN” for indoor lighting and receptacles

B. Cable Specification Sheets (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in paragraph 16120-3.06.

2.02 COLOR CODING

A. Control Conductors: Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (DC)	Blue/White
Foreign Voltage (AC)	Yellow
Power (DC)	Blue

Control (DC)	Violet

B. Power Conductors:

1. Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

2. Cables may be black with colored 3/4 inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

C. Signal Conductors: Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. Single Conductor: Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 AWG for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

B. Multiconductor Cable: Provide multiconductor power cable and multiconductor control cable where identified on the drawings. Provide stranded conductors for all cable or wires.

2.04 SIGNAL CABLES

A. General:

1. Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.

2. Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) and multiple-circuit instrument cable (MIC) shall be provided in accordance with the following examples:

   a. CABLESPEC “SIC”:
   Cable designation: 1PR#16S shielded twisted pair (STP)
   Cable designation: 1TR#16S triad (STT)

   b. CABLESPEC “MIC":
   Cable designation example: 4PR#16S with individual shields for each of the four pair and an overall shield and jacket for the multiconductor instrument cable.

B. Communication, Paging, and Security System Cables: Voice communication, paging, and security system cables shall be specified in their respective specification sections.

2.05 PORTABLE CORD

A. Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.06 SPLICING AND TERMINATING MATERIALS

A. Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Wire nuts for a splice is prohibited.

B. Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals as specified in paragraph 16175.

C. Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Construction Manager.

D. Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or approved equal. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

E. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

F. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances. Refer to the electric motor specification Section 16150.

2.07 CORD GRIPS

A. Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

PART 3–EXECUTION

3.01 GENERAL

A. Conductors shall be identified at each connection terminal and at splice points. The identification marking system shall comply with Section 16000.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

D. Provide tin-plated bus bar. Scratch-brush the contact areas and tin plate the connection where flat bus bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600 VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on unistrut in manholes and handholes.

D. Raceway fill limitations shall be as defined by NEC and the following:

1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.

2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.

3. Slices and terminations are subject to inspection by the Construction Manager prior to and after insulating.

4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.

5. In-line splices and tees, where approved by the Construction Manager, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.

6. Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors within the termination box.

7. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single wire control conductors and analog cable (SIC or MIC) then installed in flexible conduit to the actuator control and signal termination compartments.

3.03 SIGNAL CABLE

A. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3 wire circuits are required.

C. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground return conductors for two or more circuits are not acceptable.

D. Shields shall be bonded to the signal ground bus at the control panel only and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

F. Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with label as specified in Section 16000.

G. Cable for paging, security, voice communication, and telephone systems shall be installed and terminated in compliance with the manufacturers and the Utilities recommendations.

3.04 PORTABLE CORD

A. Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to relieve the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with dedicated boxes and terminals blocks.

3.05 TESTING

A. The Contractor shall test conductors, wire, and cable in accordance with Section 16999.

3.06 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. General: Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC SHEETS.

B. Cablespec Sheets: The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
MIC	600	SP-OS: Multiple Pair PR#18 or 16SH With Overall Shield and Jacket	Cable Tray Rated Instrument Cable

Type	Volt	Product	Purpose
SIC	600	P-OS: 1-PR#18 or 16SH or 1-TR#18 or 16SH	Cable Tray Rated Instrument Cable
THWN	600	PVC-insulated with nylon jacket building-grade conductor	Lights & receptacles
XHHW-2	600	XLP-insulated industrial-grade conductor	Power, control, lighting, & receptacles
MEPR / [XLP] [CPE]	600	Multi-conductor rubber insulated cable with jacket Examples: Power cable: 3/c #500 kcmil with factory ground conductor within cable Control cable: 19/C #14	Cable tray rated power & control
MXLPE / S / PVC	1000	Multiconductor shielded motor cable with PVC jacket	Flexible 3/C cable with NEC ground conductor. motor feeder range:16 AWG - 500KCMIL
CORD	600	Heavy Duty Cable: SJOOW	Portable Items

3.06 CABLE SPECIFICATION SHEET - CABLESPEC

Cable System Identification:	MIC
Description:	Multiple twisted, shielded pairs, 18 or 16 AWG, with overall shield instrumentation cable; Number of pairs as shown; UL listed, Cable Tray rated.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; Class-B stranded per ASTM B-8
Insulation:	15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum/polyester or mylar tape with 7-strand tinned copper drain wire
Overall Shield:	2.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire
Jacket:	Flame-retardant, moisture and sunlight resistant 45 mil Polyvinyl Chloride (PVC)
Flame Resistance:	UL 1277 and UL 1581 vertical tray flame test
Manufacturer(s):	Okonite, Okoseal-N type SP-OS (Shielded Pairs with Overall Shield); or Cooper Industries-Belden; General Cable or approved equal
Execution:	
Installation:	Install in accordance with paragraph 16120-3.03.
Testing:	Test in accordance with paragraph 16999.

3.06 CABLE SPECIFICATION SHEET - CABLESPEC

Cable System Identification:	SIC
Description:	Single twisted, shielded pair or triad, 18 or 16 AWG, instrumentation and signal cable; UL listed; Cable Tray rated
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90 degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire
Jacket:	45 mil Polyvinyl Chloride (PVC)
Flame Resistance:	UL 1277
Manufacturer(s):	Okonite, Okoseal-N Type P-OS (Pair(s) Overall Shield) and Type TOS (Triad(s) Overall Shield); or Cooper Industries-Belden; General Cable or approved equal
Execution:	
Use:	Analog signal cable and RTD device Triad extension cable.
Installation:	Install in accordance with paragraph 16120-3.03.
Testing:	Test in accordance with paragraph 16999.

3.06 CABLE SPECIFICATION SHEET - CABLESPEC

Cable System Identification:	THWN
Description:	Single conductor lighting and receptacle type; Indoor branch circuit conductor.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	THWN/THHN, 90 degree C dry, 75 degree C wet, Polyvinyl Chloride (PVC) per UL 83.
Jacket:	Nylon
Flame Resistance:	UL 83
Manufacturer(s):	Okonite, Okoseal-N, series 116-67-XXXX; or approved equal.
Uses Permitted:	Lighting, receptacle and appliance circuits
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16999.

3.06 CABLE SPECIFICATION SHEET - CABLESPEC

Cable System Identification:	XHHW-2
Description:	Industrial grade single conductor Sizes: 14 AWG through 750 kcmil as shown
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	NEC Type XHHW-2; 90 degree C dry and C wet; Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44; Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue
Jacket:	None
Flame Resistance:	UL 83
Manufacturer(s):	Okonite, X-Olene; Cablec, Durasheath XLP; or approved equal.
Uses Permitted:	Power, control, lighting and outlet circuits.
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16999.

3.06 CABLE SPECIFICATION SHEET - CABLESPEC

Cable System Identification:	MEPR / CPE
Description:	Multiconductor Power Cable and Multiconductor Control Cable: 14 AWG stranded conductors; Cable tray rated.
Power Cable:	Insulated green grounding conductor sized per the NEC.
Ground Conductor Size:	Multiple sets of multiconductor power cable: Oversize the grounding conductor per NEC 250.
Control Cable Type:	ICEA Method 1, E-2, without white neutral conductor or green ground conductor
Control Cable Identification:	Conductors color coded per ICEA and conductors numbered
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8, coated per ASTM B33
Insulation:	RHW/RHH, 90 degree C dry, 75 degree C wet, ethylene propylene rubber (EPR) per ICEA 2-68-516 and UL 44.
Jacket:	Cross-linked Polyethylene (XLP)
Flame Resistance:	IEEE 383
Manufacturer(s):	Okonite, Okonite-Okolon-Okoseal series 202-11-3XXX; Cablec, Durasheath EP; or approved equal.
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16999.

+++END OF SECTION 16120+++

SECTION 16124 – MEDIUM VOLTAGE CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.

C. Qualification Data: For Installer and testing agency.

D. Material Certificates: For each cable and accessory type, signed by manufacturers.

E. Source quality-control test reports.

F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NFPA 70.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than fourteen (14) days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cables:

a. American Insulated Wire Corp.; a Leviton Company.
b. General Cable Technologies Corporation.
c. Kerite Co. (The); Hubbell Incorporated.
d. Okonite Company (The).
e. Pirelli Cables & Systems NA.
f. Rome Cable Corporation.
g. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

a. Engineered Products Company.
b. G&W Electric Company.
c. MPHusky.
d. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.

e. RTE Components; Cooper Power Systems, Inc.
f. Scott Fetzer Co. (The); Adalet.
g. Thomas & Betts Corporation.
h. Thomas & Betts Corporation/Elastimold.
i. 3M; Electrical Products Division.

2.2 CABLES

A. Cable Type: MV105.

C. Comply with UL 1072, AEIC CS 8**,** ICEA S-93-639, and ICEA S-97-682.

D. Conductor: Copper.

E. Conductor Stranding: Compact round, concentric lay, Class B.

G. Strand Filling: Conductor interstices are filled with impermeable compound.

I. Conductor Insulation: Crosslinked polyethylene.

K. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 5 or 15kV as indicated in construction drawings.
2. Insulation Thickness: 133 percent insulation level.

L. Shielding: Solid copper wires, helically applied over semiconducting insulation shield.

M. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

N. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.

O. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

P. Delete paragraph below except where single or multiconductor cable construction requires armor outer finish (Type MC).

Q. Cable Armor: Interlocked galvanized steel applied over cable where indicated in construction drawings.

R. Jackets can be applied over insulation or armor.

S. Cable Jacket: Sunlight-resistant PVC where exposed to exterior, Chlorosulfonated polyethylene, CPE where installed in raceway.

T. Submersible Pump Use Cables: cables attached to the submersible pump shall be evaluated for use in wiring of submersible pumps. Product name shall identify this use

"SUBMERSIBLE PUMP CABLE." Cable shall extend from pump to junction point above water level as indicated in the construction drawings.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.4 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
6. Class 3 Terminations: Kit with stress cone and compression-type connector.

C. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.7 FAULT INDICATORS

A. Indicators: Manually reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

E. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches (305 mm) above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits.

I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

J. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: Three.
3. Standoff Insulator: Three.

K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

L. Seal around cables passing through fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

M. Install fault indicators on each phase where indicated.

N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

O. Identify cables according to Division 16 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

+++ END OF SECTION 16124 +++

SECTION 16141
WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of wall switches, receptacles, device plates and box covers. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Catalog cuts.

1.03 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with NEMA standards and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:

   1. Arrow Hart.
   2. Bryant.
   3. GE.
   4. Hubbell.
   5. Leviton Specmaster.
   6. Pass and Seymour.
   7. Sierra.
   8. Crouse Hinds.
   9. Appleton.
   10. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 SWITCHES

A. General Purpose: NEMA WD-1; FS W-S-896; 20 amp, 120/277 volt, specification grade; horsepower rated; quiet type; back and side wiring provisions; toggle handle.

B. Hazardous Areas: Switches shall consist of a factory assembled and sealed combination general purpose switch in an explosion proof housing. The external operating mechanism shall consist of a wing-type handle having the on-off positions visible from front. The switch shall be rated in accordance with NEC for the area.

C. Corrosive and Outdoor Areas: Switches shall be 20 Amp pressure switch type with weatherproof/corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

D. Ground Fault Interrupter (GFI) Receptacles: Provide duplex specification grade GFI receptacles tripping at 5 milliamps; rated 20 amps, 120 volts, NEMA Configuration 5-20R. Use units meeting NEMA WD 1, fitting standard sized outlet boxes having provision for testing, and ivory in color. Use standard model where ground fault protection is needed. Do not use feed-thru model. Acceptable manufacturers: Square D, General Electric, or equal.

E. Specific Use Receptacles: NEMA WD-1 or WD-5; type as indicated. For branch circuits serving a single device, match device rating to branch circuit rating.

F. Device Colors: Brown or black for specific use devices, otherwise as selected by the Engineer.

G. Plug Caps: Male plug caps for receptacles shall be of the cord grip armored type with heavy phenolic housing of the same manufacturer as the receptacle.

H. Three Phase Receptacles and Plugs: Receptacles shall be suitable for 480V, 3 phase, 4 wire service with ampere rating as specified. The grounding pole shall be permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, a gasketed screw-type, weathertight cap with chain fastener and one plug.

2.02 RECEPTACLES

A. General Purpose: Receptacles shall be NEMA WD-1; FS W-C-596, 20 AMP, 125 Volt,

specification grade; impact resistant nylon face; back and side wiring provision; grounding screws; duplex.

B. Hazardous Areas: Receptacles shall be rated in accordance with NEC for the area and shall be factory sealed. Receptacle shall be designed so the plug must be inserted and turned before load is energized. Provide mounting box, sealing chamber and compatible plug.

C. Corrosive Areas: Receptacles shall be duplex; 20 Amp, NEMA 5-20R. Receptacle and plug shall be corrosion resistance; marine duty; polycarbonate with weatherproof lift cover.

2.03 WALL PLATES

A. Decorative Cover Plates: Unbreakable nylon, Lexan, or noryl, smooth finish, color to match devices.

B. Unfinished Area Device Plates: Type 302 stainless steel, 0.030 inch thick minimum, satin finish.

C. Weatherproof Cover Plate: Gasketed cast metal with hinged, gasketed, spring loaded device covers.

2.04 PLUG STRIP

A. Plug strip shall be manufactured of sheet steel with the receptacles mounted on front cover. The front cover shall be removable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Secure devices to outlet boxes without depending on device plates to pull them tight. Install a bonding jumper between all devices and outlet boxes.

B. Install switches with off position down; and receptacles with grounding pole on bottom.

C. For cord and plug connected equipment, coordinate receptacle configuration with equipment supplied.

D. Install device plates on switch, receptacle, and blank outlets. Use jumbo size plates for devices installed in masonry walls.

+++END OF SECTION 16141+++

SECTION 16265
REDUCED VOLTAGE SOLID STATE STARTERS

PART 1 INTRODUCTION

A. This specification describes the performance, functional specifications and fabrication details for a digital, reduced voltage, step-less, solid state medium voltage motor starter that can provide a selectable voltage ramp, current limit or current ramp (all standard) method of soft starting 3-phase AC induction motors.

B. Each motor starter(s) shall be complete self-contained Combination Starters and house the fused disconnect switch, in-line isolation contactor, solid-state controller, motor overload protection and bypass contactor.

PART 2 CODES AND STANDARDS

A. Unit(s) must be manufactured to the codes listed below:

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronic Engineers
UL	Underwriters Laboratories Inc.
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health

B. Unit(s) must be approved and/or certified by, and carry the label(s) of Underwriters Laboratories (UL). Units shall be UL listed as a complete assembly, including all necessary sub-assemblies and components in the same package.

PART 3 PRODUCT FEATURES

A. Solid state reduced voltage motor starters shall be provided by Schneider Electric, Eaton, Rockwell Automation, or approved equal modified to meet all the requirements of this specification and design Drawings. The starter shall be complete with the following standard features and adjustments.

1. Motor and Load Protection shall be integral to the starter assembly. Motor protection shall be based upon modeling of the thermal characteristics of the motor as programmed by the user and measured by the starter. All current referenced protection features shall be calculated from the motor nameplate FLA, and automatically adjusted for the Service Factor, NEMA Design, Insulation Class, Line Voltage and Line Frequency as entered by the user. All time based protection features shall be based on a Real Time Clock, remaining active through any power loss. Starter shall provide the following functions:

   a. Thermal Overload shall be provided by the on-board microprocessor control. Basic protection shall be inverse time-current trip curves as defined by NEMA trip curve Classes. The trip curve classes shall be programmable from between Class 5 and Class 30 and the starter shall be UL listed to provide each individual class. As the most important protection feature of a starter, the overload protection shall be based on a Dynamic Thermal Register retained in memory and provide the following features:

i. Retentive Thermal Memory shall be used to ensure that the Dynamic Thermal Register does not lose track of motor temperature after the power is lost or shut down. Upon reapplication of power, the microprocessor shall be automatically updated as to the motor temperature and adjusted for real time cooling while the power is off.

ii. Dynamic Reset Capacity shall retain a snapshot of the thermal capacity necessary to restart the motor. The starter shall determine these requirements by recording and averaging the previous 3 success full start-ups. After an overload trip has occurred, the protection shall prevent resetting until enough cooling time has passed and sufficient motor thermal capacity is available.

iii. True Thermal Modeling shall be a feature of the overload and reset calculations. Once established at setup, the Dynamic Thermal Register shall be biased according to the following input information when available: Cold Stall Time, Hot Stall Time, Stopped Cool Down Time, Running Cool Down Time, and all of the real-time in format on from the RTD Option if ordered.

iv. Separate Trip Curves shall be provided for Start and Run, allowing a higher level curve to avoid nuisance tripping during acceleration, but dropping to another level for accurate motor protection while at full speed. To maximize flexibility, each trip curve shall be programmable as follows:

a. Basic, using the NEM Class ranges described above.
b. Locked Rotor programmable between 400-800% of FLA, and a trip time from 1–30 seconds.
c. Measured Start Capacity (I*I*T curve area) taken from the previous successful start (only applicable to the Start Curve).

v. Overload Alarm shall be provided to warn users of an impending overload trip. The Alarm level shall be programmable between 40 –95% of the Dynamic Thermal Register value. It shall provide an adjustable delay of 1 – 20 seconds.

vi. Manual or Automatic Reset shall be selectable in programming to provide for automatic reset in unattended remote applications.

2. Phase Monitoring shall be standard and based on motor current. In order to protect against disconnected motor leads, this feature will function even if the line voltage remains normal. All features shall be as follows and capable of being disabled if not needed:

a. Phase Loss shall shut down the starter if current through any leg drops to 20% of unit FLA or less. This protection shall be implemented via hardware and shall be non-adjustable. It shall provide an adjustable trip delay of 1- 20 seconds.

b. Phase Imbalance Protection shall be provided with programmable sensitivity to provide both Alarm and Trip points. The sensitivity shall be adjustable for phase-to-phase Imbalances of between 5% and 30%. Each point shall provide an adjustable delay of 1-20 seconds.

c. Phase Rotation protection shall be self-learning and field programmable. If phase rotation varies from the initial set pattern, the starter shall trip immediately. If phase rotation is correct, the starter can be re-taught to recognize the new rotation.

3. Short Circuit Detection with dual mode protection for starting and running operation shall be standard. This circuit MUST be provided to protect the starter from load failures. This protection shall be implemented via hardware and shall be non-adjustable.

a. In the starting mode, the starter shall employ a pre-check routine to determine if the load circuit has a fault condition and disable the ramping prior to reaching the Initial Voltage setting. This is to avoid additional equipment damage after a fault that may have occurred while the starter was off.

b. In the running mode, this feature will shut down the starter if current through any leg exceeds 10 times unit FLA for 12.5 milliseconds.

4. Over Current Protection shall be provided separate from the above to be used in the tripping circuit. It shall be adjustable at lower levels for protecting mechanical components from undue shock when rapid unexpected load changes occur.

a. Adjustment level shall be from 100% to 300% of the programmed motor FLA.

b. A time delay of up to 20 seconds shall avoid nuisance tripping from short duration transients.

5. Under Current Protection shall alarm the starter on an adjustable condition. This Load Loss sensor shall be programmable from 10% to 90% of the programmed motor FLA, and, with a time delay of up to 20 seconds shall avoid nuisance tripping from short duration transients.

6. Ground Fault protection shall be provided to protect the motor from damage using the Residual Current method. An Alarm and 2 trip levels, each adjustable from 5 – 90% shall be available with separate trip times as follows:

a. ALARM level preset at 5% with a 0.5 – 20 second delay.

b. LOSET Trip level preset at 7% with a 1- 20 second delay.

c. HISET Trip level preset at 10% with an 8-250 millisecond delay.

7. Line Frequency Window shall be programmable from a 1- 6Hz variance from the nominal line frequency as entered by the user. It shall provide an adjustable trip

delay of 1 -20 seconds.

8. Coast Down Lockout shall be provided to prevent restarting of the motor during backspin or other dangerous mechanical conditions after shutting off. The coast down lockout time shall be programmable between 0 and 60 minutes following a Stop command.

9. Starts-per-Hour Lockout shall be provided to prevent damage to the motor from rapid cycling of start commands for any reason. The maximum starts-per-hour shall be programmable between 1 and 10 starts.

   a. Time between Starts Lockout shall also be programmable to work with the above. A minimum time of between 0 and 60 minutes between start attempts shall prevent restarting too rapidly for the motor and load conditions as determined by the user.

B. Acceleration Control shall be fully adjustable in programming to match any application. As a minimum, starter shall come complete with the following settings:

1. Ramp Type: To ensure maximum flexibility in matching the load conditions in the field, the starter shall provide all of the following methods of closed loop acceleration ramp control: Voltage Ramp, Voltage Ramp with Current Limit, Current Limit Only (Current Step), Current Ramp (Torque Ramp) or up to 3 Custom Ramp profiles that can be programmed by the user.

2. Starting Torque: Initial torque output shall be programmable as either Current or Voltage output, and adjustable between 0-100% of maximum Locked Rotor Torque (600% current) available from the motor.

3. Maximum Current Limit: To ensure reliability of starting under any circumstance that the motor can function in, Current Limit shall be adjustable between 200 and 600% of the unit rating. This will allow locked rotor current to be delivered to the motor if necessary. Lighter duty starters with lower current limit settings will not be acceptable.

4. Ramp Time: The time between Initial Torque and Full Output shall be adjustable between 1 and 120 seconds.

5. Dual Ramps: To accommodate changing load conditions, the starter shall provide 2 separately adjustable ramp profiles, selectable via a dry contact closure. Each ramp will provide all of the above features.

6. Custom Ramp Curves shall be available that can be configured by the user to match any load or starting condition. Each of the 3 available custom curves can be profiled by entering 8 torque and time points. The starter shall create a smooth acceleration curve from these plotted axis points.

7. Kick Start: To provide for starting difficult loads, the starter shall include a Kick Start feature that will apply a high output for a short time on initial start command. The Kick-Start voltage level shall be adjustable from 10- 100% voltage, for 0.1-2 seconds max. **The manufacturer shall provide all the supporting calculations to**

confirm that the selected starter is capable of creating the required torque and starting the pump.

8. Jog: For checking rotation at start-up or other testing procedures, the starter shall provide a programmable.

9. Jog feature, adjustable from 5 - 75% of line voltage.

C. Deceleration Control (Ramp Down) shall be completely independent of any Accel Ramp settings and provide a fully adjustable Decel profile in order to avoid possible motor damage. Pre-programmed Decel "algorithm" systems that do not allow contouring to match load conditions are not acceptable.

1. Step Down Voltage: adjustable from 100 to 0% of line voltage, allowing the motor torque to drop off immediately to a level that affects output without waiting for a linear ramp.

2. Deceleration Ramp Time: adjustable from 0 – 60 seconds to allow gentle controlled deceleration in excess of the natural coast-to-stop time of the load.

3. Stop Voltage Level: adjustable from 100 – 0% of line voltage to automatically turn off the starter when the output torque has reached a desired level Programming shall not allow the Stop level to be set higher than the Step Down Level. External timers shall not be needed to turn off the starter.

4. Selectable Operation During Overload shall be available to allow the user to decide if the motor shall turn off or continue to Decel when an overload condition is detected.

D. Starter Protection shall be provided to maintain reliability of both the equipment and the circuit components, with the following features:

1. Shorted SCR Detection shall be standard. This function must automatically prevent a "start" sequence when at least one SCR is shorted. A means of having qualified service personnel defeat the lockout of this circuit MUST be provided to allow for "Must Run" situations.

2. Shunt Trip Circuit shall be standard. This feature will instantly energize a dry relay contact that can be wired to a "Shunt Trip" coil of the circuit breaker in order to protect the motor from damage. This protection shall only operate if there is current flowing through any phase of the starter when in the "Off" condition, such as when there are multiple shorted SCRs or a bypass contactor stuck on. This feature shall be independent of the above Shorted SCR protection so that it cannot be defeated.

3. Starter Over-temp Trip shall be built-in and protect the SCRs from excessive heat build-up in the enclosure or heat sinks. Thermal sensors on the heat sinks shall be pre-wired to one of the programmable inputs that has been factory preset as the Over Temp input.

E. Inputs shall be provided for the control and option selection of the starter as follows.

1. Digital Inputs: All input and control devices shall be rated for 120VAC control or shall require dry contact closures without the need for external power supplies or interposing relays.

   a. On-Off Control shall be 120VAC to avoid potential problems with voltage drop in long control wire runs. The starter shall provide for 2-wire or 3-wire control schemes. Seal-In relay contact for the 3-wire control scheme shall be internal dedicated to that use and not counted as an output contact. Terminals shall be provided for use in interlocking with programmable output relays or external devices.

   b. User Inputs: 4 programmable digital inputs shall be provided. Each input shall accept dry contact closures from external user supplied devices, and can be named for display on the DCU when energized. 2 of these inputs shall be preset as Temperature and Dual Ramp Select, but can be changed by the user. Inputs can be programmed as N.O. or N.C., and programmed with a de-bounce timer of 0 – 60 seconds. Each input can be assigned to operate any of the Programmable Outputs.

   c. Analog Input shall be provided for optional Tach Feedback Starting. This input shall accept 4-20ma with adjustable offset and gain.

   d. See Electrical/Controls drawings for additional interface information.

F. Outputs shall be provided for the following functions in addition to the seal-in relay used in 3-wire control scheme as mentioned above.

   1. Digital Outputs shall be eight (B) Form C contact relay outputs, rated for 240VAC, 5AMPS, 1200VA max., with each relay being programmable for any one of the following functions;

      a. Indicator Relay programmable to change state on any of the following conditions:
         i. Run Stop, Start End of Decel, Timed Output, At Speed, Dual Ramp Selected, Self-Test Fail.

      b. Fault Trip Relay programmable for each of the following fault conditions: Overload, Phase Imbalance / Loss / Reversal Lock Out Inhibits. External inputs, Short Circuit, Over Current / Shear Pin, Ground Fault HISET / LOSET, Over / Under Frequency, 12T Start Curve, Shorted SCR, Shunt Trip, Over Temp, Under Current / Load Loss.

      c. Alarm Relay including the following conditions:
         i. Overload Warning, Over-current Warning, Ground Fault Warning, Under Current Warning, Imbalance Warning, Thermal Register Warning.

      d. RTD Relay including Stator or Non-Stator Trip and/or Warning, and RTD Failure.

   2. Analog Outputs (2) shall be included for providing information to external controls and be programmable as RMS Current or Percentage of Motor FLA.

a. If the Tach Feedback Starting option is used, the Analog outputs can be programmed as RPM.

b. If the RTD input option is used, the Analog outputs can be programmed as Hottest RTD Temperature for Stator or Non-Stator RTDs.

G. Operator Interface Panel that provides simple to use adjustment and status indication on a dead-front shroud of the starter shall be provided.

1. Adjustments shall be made by keypad with tactile feedback keys for high noise environments. To prevent confusion, no binary coded dip switches shall be used for programming. Pass code protection shall be available to prevent unauthorized changes to the programming.

2. Alpha-Numeric Display shall be Backlit LCD with 2 lines by 20 characters.

3. Indicators using long life LED devices shall provide additional quick annunciation of Power, Run Alarm and Trip operation, as well as the status of the eight output relays.

4. Password Protection shall be provided, allowing 3 levels of access to program information, 2 of these levels requiring separate Passwords.

H. Metering functions shall be provided through the Alpha-Numeric Display for indicating the following:

1. Output Current for each individual phase or average of all 3. Indicating range to be 0.0-9999.9 amps.

2. Ground Fault Current

3. KVA, KW, MWH, KVAR, Power Factor, Peak On KW, KVAR, KVA Demand

4. Motor Load: FLA

5. Line Frequency

6. Phase order

7. Remaining Thermal Capacity to indicate heating effect and cooling rate of the motor. Range shall be 0-100% of the remaining capacity and count up towards 100% while cooling.

8. Thermal Capacity to Start indicating the required value that will be added to the thermal register as learned and averaged from the previous 3 successful starts.

9. Average Start Time learned from previous 3 successful starts

10. Average Start Current learned from previous 3 successful starts

11. I*I*T to Start measured from the previous start.

12. Last Start Time measured from Start Command to At-Speed.

13. RTD Metering (when RTD Option is ordered) for up to 12 Stator and Non Stator RTDs. displayed in degrees C and degrees F. Metering includes Hottest RTD, each RTD Temp, each RTD Max Temp Since Clear, Measured Run Cool Time in minutes, and Measured Stop Cool Time in minutes.

14. Starter Status including Ready, Starting, Running, Last Trip Cause

15. Remaining time for 0/L Trip, Thermal Inhibit, Coast Down Lock Out, Time Between Starts and Starts per Hour.

16. Event Recorder (last 60 events) with Phase and GF currents record at each event.

17. Last Trip including Cause, Phase and GF currents, Unbalance%, Hz, Hottest Stator and Non Stator RTD recorded.

18. Statistics including Elapsed Run Time, Total Trips, Trips on Short Circuit, Start 0/L, Run 0/L, Frequency, Over-current, Stator RTD, Non-Stator RTD,G/F LOSET and HISET, Acceleration Time, Start Under Curve, Start Over Curve, I*I*T Start, Fail Shunt Trip, Phase Loss, Tach Accel, and 4 External Inputs

19. Learned Start Curve. When enabled, the starter will record a start curve with 100 data points of current and time between Start and At-Speed. This data can be exported via the Comm. Port to be plotted on a graph or spreadsheet for baseline measurement and maintenance analysis.

I. Available control or protection options shall include the following:

1. Tach Feedback Starting. An input card shall be provided to allow linear speed acceleration based on closed loop feedback from a tachometer.

2. Where specified on Electrical/Control drawings, RVSS starter shall include an Integral Pump Vibration and Temperature Monitoring system. This system shall include monitoring for (12) motor/pump RTDs and for (6) vibration points from the tri-axial vibration sensors mounted on the pump. Data from the monitoring system shall include temperature and vibration levels from each RTD/vibration probe, provide pump diagnostic and troubleshooting information in graphical form based on the monitored vibration amplitude and frequency, as well as temperature alarm and trip set points. Information shall be communicated to the plant control system via Ethernet IP.

J. Serial Communications shall be built-in as a standard feature without the need for separate modules.

1. Communication protocol shall be EtherNet TCP/IP for connection to EtherNet switch. See Schematic Wiring Diagram for details.

K. The CPT fed fuses shall provide 120 VAC power to all 120 VAC located in RVSS cabinet and as shown on Electrical/Control drawings.

L. See Electrical/Controls drawings for additional features.

PART 4 DESIGN SPECIFICATIONS

A. Power Ratings

1. Input: 4160VAC, +10%-15%, 3 phase,-60Hz± 6Hz. Unit(s) will operate with any incoming phase sequence.

2. Output: Reduced voltage 3 phase AC derived from phase-angle fired inverse-parallel thyristors, ramped to full voltage.

3. Current Rating: 400 Amps or as shown on Electrical drawings.

4. Output Capacity: Heavy Duty, rated as follows: Overload Capacity "" 500% of unit rating for 60 seconds; 600% for 30 seconds; minimum 115% of nominal motor FLA continuous.

5. Control Power: 120VAC, 60Hz, derived from an integral transformer sized to be adequate to operate all associated devices in each starter and any associated 120 VAC loads (motor space heater, etc.).

B. Power Structure

1. Disconnect Switch: A "non-load break" rated disconnect switch shall be provided in the incoming power section of the starter assembly.

a. Disconnect switch design voltage shall be 5000V.

b. The non-load break switch shall be electrically and mechanically inter-locked with the inline vacuum contactor so that the switch cannot be opened under load.

c. The disconnect shall be pad-lockable in the "Open · position. Lockout coordination with adjacent compartments will be as follows;

i. The incoming line section door cannot be opened if the disconnect switch is in the closed position. The disconnect switch cannot be closed if the incoming line section door is open.

ii. All other associated doors in sections containing medium voltage potential shall be interlocked with the incoming line section door by either direct mechanical means or by use of Kirk-key interlock mechanisms.

d. A viewing window in the Main Incoming Power Compartment shall allow visual inspection of the disconnect blade status prior to opening the door.

e. A separate knife arm shall bond the disconnect mechanism to ground when fully open.

2. Power Fuses: As a NEMA class E2 controller, current limiting primary power fuses

shall be provided for each incoming phase.

a. Fuses shall be ANSI class “R" for motor starting duty, sized according to motor locked rotor current and coordinated with the overload relay. Fuse and overload coordination shall be designed to allow the controller and contactor to clear low and medium level faults without blowing and without exceeding the contactor interrupt ratings. Fuses shall be used to interrupt high level faults exceeding those ratings.

b. Fuse holders shall include blown fuse indicators, wired to the isolation contactor circuit to disconnect all three phases if any one of the fuses clears.

3. Isolation and Bypass Contactors: Vacuum contactors shall be provided for both ln-Line Isolation and SCR Bypass.

a. The contactor voltage ratings shall be 5000V minimum.

b. A sequencing feature shall control the contactors. Under normal operating conditions it will ensure that both contactors always make and break under no-load conditions to maximize contactor life.

c. Vacuum contactors shall be rated for maximum starting current of the unit design. The Bypass Contactor shall be rated to be capable of emergency across-the-line start.

d. Interrupt rating shall be in coordination with the primary fuses as per UL 347.

4. Bus Bars: Provide main horizontal phase bus bars extending the entire length of the starter lineup. Bus bar material shall be tin-plated or silver-plated copper. All bus ratings shall be as per UL Standard 347.

a. Bus bars shall be braced with non-tracking fire resistant non-hygroscopic insulation supports and shall have a minimum fault current rating of 78,000 Amps or as required by the facility short circuit study results.

b. All bus connections shall use 2 bolts minimum, with Belleville spring washers to ensure tightness. Splice kits for each snipping split shall be included.

c. A continuous ground bus bar with a minimum rating of 600 Amps shall extend the entire length of the starter lineup near the bottom of each enclosure. A grounding strap shall connect each vertically adjacent compartment and also tie the grounding arm of the disconnect switch to the main ground bus bar.

d. Splice kits for each shipping split shall be provided when horizontal bussing is specified.

5. Rated Short Circuit Amps: Starter and contactors shall be rated for 50 kAIC minimum or as required by short circuit study. The entire assembly as a NEMA

Class E2 controller shall have fault withstand ratings as per UL 347 for the loads as indicated on electrical drawings.

6. Overall BIL rating: Entire starter assembly shall have a BIL (Basic Impulse Level) rating of 60kV.

7. Insulation Rating: Standard insulation design shall be for 5kV. Insulation shall be tested for dielectric voltage withstand of 15kV for 60 seconds.

C. SCR Modules

1. PIV Ratings: SCRs will be connected as inverse parallel pairs in series circuits to attain the following Peak Inverse Voltage ratings as a minimum for each phase:

2. System Voltage: 4160V Series Pairs: 2; PIV Rating.; 13000V

3. Protection: RC snubber network circuits on each phase assembly. To avoid possible component damage, MOV protective devices shall be used only on the gate firing circuitry.

4. Efficiency: 99.7% through SCRs, 99.97% in bypass mode.

5. Control Method: To ensure reliable gate firing even when powered with on-site generators, firing circuits shall use individual phase transformer coupling method for maximum isolation and rapid rise of firing pulse.

6. Noise Immunity: The gate firing circuitry shall be protected from electrical noise and transients to ensure reliable starting and firing of the SCRs under all power conditions, regardless of the available fault current or motor lead length.

   a. They shall be amplified and isolated from the control voltages by means of rugged encapsulated ring transformers that provide separate power sources for each set of SCR gate drives. The design shall allow for a "back-porch" DC carry-over of the firing pulse to prevent the SCRs from falsely turning off due to ringing of the output current or line notching caused by other connected equipment. The gate drive shall be maintained for 240 electrical degrees from the zero cross point to avoid motor switching transients.
   b. For additional reliability and to protect against EMI/IRFI interface generated by the internal components, connections to the Digital Control Unit shall be fiber optic.

   c. When at all possible, the starter shall not require line reactors in the Medium Voltage power section. Those that do shall include them within the same enclosure as the starter and shall be UL listed in this configuration.

D. Ambient Conditions

1. Temperature: As a standard of unit design quality, starter shall be documented to show the design has been tested for 0- 50° C (-32 to 122° F) operation, and Overload Capacity shall be rated at this temperature.

2. Altitude: 3300 ft (1000 m) maximum without de-rating.

3. Humidity: 0-95% RH, non-condensing.

4. Thermal: Heat sink temperature switches designed to trip at 85° C.

E. Electronics

1. Non-Volatile Memory will be used throughout the control and protection systems. To prevent the possibility of losing protection values, stored programs or statistical data, battery back-up memory systems will not be allowed.

a. The starter shall store all factory defaults in a preset replaceable EPROM memory chip.

b. User Programming and statistical data shall be stored in EEPROM memory for ready alteration. Loss of power shall not affect memory status.

c. For fast updates and operation, running programs shall use DRAM memory. The starter shall store the DRAM memory contents to the EEPROM upon power failure, and restore it upon return to normal.

2. Data Sampling

a. Critical operating data such as instantaneous current for Short Circuit, Ground Fault and Immediate Overload calculations shall be sampled every 2 milliseconds to prevent lagging operation.

b. Non-Critical data shall be obtained from a true RMS calculation circuit, and sampled in a 350 millisecond moving window of individual phase currents.

3. Real Time Clock with automatic leap-year updating shall be provided. This clock alone shall use a battery back-up with a Lithium-ion battery rated for at least 10 years of continuous operation without power applied. The clock shall be capable of being reset in the field after changing the battery, without affecting any other stored information.

PART 5 MECHANICAL CONSTRUCTION

Enclosure shall contain the digital solid state controller and disconnect means and other components as required. Structure design shall be as follows:

A. Welded steel enclosures with a minimum thickness of 11 gauge shall be provided to form rigid freestanding dead front structures. Enclosure design shall be in accordance with NEMA ICS 3-2 and UL 347.

B. NEMA type 12 with full gasketing to protect internal components from contamination.

C. Engraved, laminated plastic nameplates with characters 1/2 inch (12.7 mm) high, or larger, shall be provided for each ASD to identify the load it serves. Nameplates shall have white letters on a black background. Meters, relays, switches, and other devices within the enclosure shall be permanently identified using the same name as those appearing on the schematic diagrams.

D. Three isolated compartments shall be provided, dividing each starter assembly into:

1. A Main Incoming Power Compartment housing the main disconnect switch and horizontal power bus bars.

2. One or more Starter Power Compartments containing the fuses, vacuum contactors, SCR power modules, instrument transformers and all other medium voltage devices.

3. A Low Voltage Control Compartment housing the digital microprocessor controller, LCD operator interface and all other low voltage devices and operator controls.

4. Compartment doors shall be rolled and formed to be capable of containing maximum fault forces. Doors shall open a minimum of 120° and include means for holding them open during servicing or testing. Door shall not blow open under internal fault conditions when properly secured.

5. Each power compartment shall be suitable for 5 kV shielded cables with stress cone terminations.

E. Removable conduit entry plates shall be provided in the top and bottom of the enclosures to facilitate drilling and punching of conduit holes without exposing the equipment to contamination from metal debris.

F. Enclosure finish shall be suitable for indoor use in non-corrosive environments. Paint shall be ANSI 61 gray polyurethane powder over a zinc phosphate pre-treatment. Paint thickness shall be minimum 2 mil.

G. Lifting eyes or angles capable of supporting the maximum weight of each shipping split shall be provided on the top of the enclosure.

H. Seismic Qualifications: The entire starter assembly and installation procedures shall be suitable to withstand vertical and horizontal accelerations typical of seismic Zone 2 as defined in the UBC. The assembly will not overturn or show significant lateral movement, but shall not be expected to continue operating during or after a seismic event.

PART 6 QUALITY REQUIREMENTS

A. All incoming material shall be inspected and/or tested for conformance to quality assurance.

B. Power semiconductors shall be fully tested for proper electrical characteristics (dv/dt, di/dt, etc.).

C. All subassemblies shall be inspected and/or tested for conformance to vendors engineering and quality assurance specifications.

D. Printed circuit boards shall be burned in for a minimum of 48 hours at 60°C.

E. The complete unit shall be functionally tested under load before shipment to assure proper operation per specification. Complete test reports shall be available upon request.

PART 7 DOCUMENTATION

Final documentation will consist of the following:

A. Complete schematics and "as built" wiring diagrams

B. Enclosure elevations and layout drawings

C. System installation and startup manuals

D. All drawings shall be done in AutoCAD

PART 8 SPARE PARTS

A manufacturer's recommended spare parts list, and associated pricing, will be supplied with each different solid state reduced voltage starter.

PART 9 FIELD ACCEPTANCE, TESTING AND TRAINING

A. Arrangements shall be made and costs included; for on-site inspection and start up assistance to be performed by a Factory Authorized Field Technician, prior to first energization.

B. Provide minimum of 4 hours of field training on site; by a Factory Field Technician, for operating and maintenance personnel, covering start up, parameter changes, operations, trouble-shooting and repair techniques. Adequate copies of job documentation and installation (Operation & Service manuals) shall be provided.

C. Demonstration will include complete operating sequence, simulating field controls if necessary, to the satisfaction of the ATL Department of Watershed Management while the Field Technician is on site. Adjustments will be made as necessary and a field start up report will be provided upon conclusion.

+++ END OF SECTION 16265 +++

SECTION 16270
MEDIUM VOLTAGE AC INDUCTION MOTORS – NON-SUBMERSIBLE TYPE

PART1 GENERAL

1.1 RELATED SECTIONS

A. This Section applies only when referenced by a non-submersible motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this Section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this Section.

1.2 SCOPE OF WORK

A. Provide induction motors, accessories, and appurtenances, complete and operable, in accordance with the motor-driven equipment specification and as specified herein.

B. The provisions of this section apply to all medium voltage non-submersible electric motors.

1.3 DEFINITIONS

A. WPII: Weather Protected II

B. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.4 SUBMITTALS

A. Actions Submittals:

1. Shop Drawings:
   a. Descriptive information.
   b. Machine name and specification number of driven machine.
   c. Nameplate data in accordance with NEMA MG1.
   d. Motor manufacturer.
   e. Motor type or model and dimension drawing. Include motor weight.
   f. Nominal horsepower.
   g. NEMA Design Letter.
   h. Voltage, phase and frequency ratings.
   i. Full load current at rated horsepower for application voltage.
   j. Full load speed.

k. Guaranteed minimum full load efficiency and nominal efficiencies at 1/2 and 3/4 load.
l. Description and rating of thermal protection or over temperature protection for stator windings.
m. Wiring diagram for devices such as motor winding temperature detection, space heaters, vibration sensors, as applicable.
n. Bearing data including type of bearings, lubrication and cooling system, recommended lubricants; and, description and method to insulate bearings from stray currents.
o. Bearing life with supporting calculations.
p. Power factor at 1/2, 3/4 and full load.
q. Additional Rating Information:

1. Service factor at rated temperature rise.
2. Locked rotor current and code letter.
3. No load current.
4. Safe stall time.
5. Multispeed load classification (e.g., variable torque).

r. Enclosure type and mounting, including rodent screens and filters.
s. Frame Size.
t. Winding insulation class and temperature rise class.
u. Starts per hour.
v. Conduit box dimensions and usable volume as defined in NEMA MG1 and ANSI/NFPA70.
w. Terminal junction boxes and dimensions for space heaters, vibration switch, and RTDs.
x. Space heater voltage and watts.
y. Motor free field sound pressure levels and equivalent or reference motor test report in accordance with ANSI/S12.51 and NEMA MG1.z. Design Information:

1. Thermal limit curves in accordance with IEEE620.
2. Speed torque curve.
3. Starting time-current curve.
4. Thermal capability during starting.
5. Thermal protection RTD alarm and trip settings.

aa. Suitability for use with ASD (where applicable).

B. Information Submittals:

1. Factory test reports, certified.
2. Manufacturer's Certificate of Proper Installation.
3. Manufacturer’s printed instructions for installation, operation, and maintenance.

1.5 Warranty

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

Warranty shall cover both parts and labor for required repairs.

B. The manufacturer shall provide warranty for a period of 24 months after Substantial Completion of the project or 36 months after delivery to the project site. The manufacturer shall guarantee that the equipment, products, or material furnished is suitable for the purpose specified and free from defects of design, material and workmanship for the duration of the warranty. In the event the equipment, products, or materials fails to perform as specified, the manufacturer shall promptly repair or replace the defective equipment, products, or material.

C. Seller must state clearly the details of warranty offered with this equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The pump manufacturer shall have the responsibility to select and supply suitable electric motors for the pumping equipment.

1. GE Motors, General Electric Company.
2. WEG.
3. Siemens Energy and Automation, Inc., Motors and Drives Division.
4. U.S. Electrical Motors.
5. TECO-Westinghouse Motor Company.
6. Hyundai Heavy Industries.

2.2 GENERAL

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall in all cases be no greater than the nameplate horsepower rating, exclusive of service factor and as verified with the approved submittal data of the driven machinery.

C. Motor Horsepower: All motors shall be sized to carry continuously all loads that may be imposed through their full range of operation. The motor horsepower shall be as specified for each driven machine.

D. All electric motors shall be squirrel-cage type in compliance with NEMA MG 1-Motors and Generators.

2.3 DESIGN REQUIREMENTS

A. Service Factor: l.l5 minimum at rated ambient temperature.

B. Motor Voltage Ratings: 4,000-volts, three-phase, 60-Hz, for use on a 4,160-volts, three-phase, 60Hz power supply, as specified in the driven equipment

specification.

C. Insulation: All motors shall be furnished with 5,000-volt, Class F insulation. Motors shall be rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in NEMA MG 1-12.42 at rated full load. Insulation shall include two cycles of vacuum pressure impregnation of epoxy resin followed by a coating of epoxy varnish. Suitable for use with VFD.

D. Leads: All winding leads shall be permanently tagged for identification and brought out from the motors.

E. Terminal (Conduit) Boxes:

1. Power terminal box shall be oversized to accommodate all power cables, stress cones and current transformers as required per NEC requirements. Minimum useable volume in percentage of that specified in NEMA MG 1, Section 1, paragraph 4.19 and NEC. Article 430 shall be 225 percent.
2. Space heater leads shall be routed to and terminated on terminal blocks in the control cable terminal junction box (NEMA 4 enclosure) mounted on and provided with the motor.
3. Motor winding RTD leads shall be routed to and terminated on terminal blocks in the instrumentation cable terminal junction box (NEMA 4 enclosure) mounted on and provided with the motor.
4. Terminal for connection of equipment grounding wire in each terminal box.
5. Provide tin plated copper bus for connection of power feeder conductors.

F. Space Heaters: Space heaters shall be provided for all outdoor mounted motors and where specified indoor so as to keep the motor windings 5 to 10 degrees C above the dew point during de· energized conditions. The space heaters shall be 120 V and shall be prewired to a control cable terminal junction box mounted on the motor.

G. Power Factor and Efficiency of Motors:

1. Motors shall be “premium efficiency” units. Motors shall be stamped with the efficiency on the nameplate with the caption “Guaranteed Minimum Full Load Efficiency.”
2. Procedures for poly phase induction motors and generators, Method B or F.
3. Power factor and efficiency of motors shall be as specified in the driven equipment specifications.

2.4 ACCESSORY REQUIREMENTS

A. General: Motors shall have a power terminal box and control and instrumentation cable terminal junction boxes. Power box shall be sized for 5 kV stress cone terminated cables. Cast, fabricated, or pressed steel boxes shall be provided with threaded hubs. All boxes shall have an internal ground lug.

B. Lifting Devises: All motors shall have suitable lifting eyes for installation and removal.

C. Nameplate: All motors shall be fitted with a permanent, stainless steel nameplate indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG 1-10.40.

D. Screen Air Openings: Stainless steel meeting requirements for Guarded Machine in NEMA MG 1.

E. A minimum of four (4) vibration sensors shall be included and wired to a NEMA 4X box mounted on side of motor. The vibration sensors shall provide adequate vibration protection and shall be types and models as recommended by motor manufacturer. The type of sensors shall be coordinated with vibration protection relays mounted in associated VFD.

2.5 BEARINGS

A. Vertical Motors: The manufacturer shall select the bearings for high thrust application with all supporting calculations based on the actual pump application.

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Oil lubricated.
   c. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer's standard bearing type.
   b. Oil lubricated.
   c. Minimum 100,000 hours L-10 bearing life.
3. Bearings for use with VFD driven motors shall be insulated.

B. Oil Lubrication Systems:

4. Oil reservoirs with sight level gauge.
5. Oil-fill and drain openings with opening plugs.
6. Provisions for necessary oil circulation and cooling.

2.6 NOISE

A. Measure in accordance with IEEE85 and NEMA MG1. The noise shall not exceed 83 dBA at 1 meter.

2.7 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1-12.06.

2.8 EQUIPMENT FINISH

A. External Finish: In accordance with the driven equipment specification.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.9 MOTOR THERMAL PROTECTION

A. Resistance Temperature Detectors (RTDs):

1. 100-ohm platinum precision resistors with calibrated resistance temperature characteristics.
2. One dual element RTD for the each bearing and (two each phase) RTD s positioned to detect highest motor winding temperature and located between coil sides in stator slots.
3. Compatible with monitoring instrumentation provided with the VFD.
4. Leads brought to separate instrumentation cable terminal junction box mounted on motor. Each lead shall be terminated at a dedicated terminal block terminal location.

2.10 FACTORY TESTING

A. Routine tests per NEMA 20.16 and as follows:

1. Air gap measured and recorded during assembly.
2. Surge test stator coils individually, before and after insertion in stator core to ensure no turn to turn shorts.
3. High potential tests conducted after all other tests completed to ensure no damage to insulation during setup and testing.
4. Inspect bearings and bearing insulation following testing.

B. Efficiency tests per NEMA 20.21 shall be witness tested as per Owner's or Engineer's request and shall be as follows:

1. All motors being furnished shall be tested.
2. Test report shall include rpm, efficiency, and power factor at 100, and 50 percent of rated load.

C. Sound Pressure Level Tests:

1. All motors shall be tested.
2. Test shall be IEEE Standard 85.

3. Calculation free field sound pressure levels at one meter in each octave frequency band.

D. Vibration Tests:

1. All motors shall be tested. Vibration Measurements shall be in accordance with NEMA MG 1 paragraph 20.54.

E. Test Reports

1. Test reports shall include test data sheets or description of results for all tests.
2. Test reports shall be certified by registered professional engineer.
3. Equipment shall not be delivered to OWNER until test reports are accepted.

PART3 EXECUTION

3.1 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Motor shall be tested for proper phasing/rotation and operated through complete range of testing required by specification section 16260 or 16265 depending on type of drive/starter connected.

3.3 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at site for installation assistance, inspection, equipment testing, and startup assistance. Plan on 2 site visits per motor, at a duration of 2 days per site visit.

B. Manufacturer's Certificate of Proper Installation.

+++ END OF SECTION 16270 +++

SECTION 16321
PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the pad mounted transformer(s) as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. The pad-mounted transformer(s) and all components shall be designed, manufactured and tested in accordance with the latest applicable NEMA (NEMA 210), IEEE and ANSI standards (ANSI C57).

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
   1. Front view elevation or outline drawing and weight
   2. Nameplate diagram
   3. Conduit entry/exit locations
   4. Ratings (on nameplate) including:
      a. kVA
      b. Primary and secondary voltage
      c. Taps
      d. Basic Impulse level
      e. Impedance
   5. Product data sheets

B. Where applicable, the following additional information shall be submitted to the Engineer:
   1. Busway connection
   2. Specified accessories

1.05 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:
   1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
   2. Wiring diagrams
   3. Production test reports
   4. Installation information

5. Seismic certification as specified

1.06 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. 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.

C. Provide Seismic qualified equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
2. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.
3. The IP rating of the equipment shall be 1.5
4. The Structural Engineer for the Site will evaluate the SDS values published on the Manufacturer's website to ascertain that they are "equal to" or "greater than" those required for the Project Site.
5. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
   a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
   b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

B. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

1.09 FIELD MEASUREMENTS

A. Measure primary and secondary voltages and make appropriate tap adjustments.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. Schneider Electric

C. General Electric.

D. Siemens.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

A. The ratings of the transformer shall be as follows or as shown on the drawings:

kVA Rating	As shown on the drawings, ONAN
Impedance	5.75% +/- 7-1/2%
HV	4.16kV Delta
HV BIL	60kV
HV de-energized Taps	.2 - 2-1/2% full capacity above and below normal
LV	480 Volts Wye
LV BIL	30kV

2.03 CONSTRUCTION

A. The unit shall use biodegradable electrical insulating fluid from high oleic vegetable oil sources filled and shall be in accordance with the latest edition of the NEC. Fluid shall be FR3, Beta Fluid, VG-100 or equivalent high fire point fluid that is Factory Mutual approved.

B. The transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall not exceed 65 degrees C rise, based on an average ambient of 30 degrees C over 24 hours with a maximum of 40 degrees C.

C. The transformer shall be designed to meet the sound level standards for liquid transformers as defined in NEMA and ANSI.

D. High-voltage and low-voltage windings shall be aluminum. Insulation between layers of the windings shall be by thermally set insulating paper or equal.

E. The main transformer tank and attached components shall be designed to withstand pressures greater than the required operating design value without permanent deformation. Construction shall consist of carbon steel reinforced with external, internal or sidewall braces. All seams and joints shall be continuously welded.

F. The assembly shall be individually welded and receive a quality control pressurized check for leaks. The entire tank assembly shall receive a similar leak test before tanking. A final six-hour leak test shall be performed.

G. The transformer(s) shall be compartmental-type, self-cooled and tamper-resistant for mounting on a pad. The unit shall restrict the entry of water (other than flood water) into the compartments so as not to impair its operation. There shall be no exposed screws, bolts or other fastening devices which are externally removable.

H. The transformer(s) shall consist of a transformer tank and full-height, bolt-on high- and low-voltage cable terminating compartments located side-by-side separated by a rigid metal barrier. Each compartment shall have separate doors, designed to provide access to the high-voltage compartment only after the low-voltage has been opened. There shall be at least one additional fastening device accessible only after the low-voltage door has been opened, which must be removed to open the high-voltage door. Doors shall be mounted flush with the cabinet frame. The low-voltage door shall have a handle-operated, three-point latching mechanism designed to be secured with a single padlock. A hex-head or penta-head bolt shall be incorporated into the low-voltage door latching mechanism. Both high and low-voltage doors shall be incorporated into the low-voltage door latching mechanism. Both high and low-voltage doors shall be equipped with stainless steel hinges and door stops to secure them in the open position.

I. Compartment sills, doors and covers shall be removable to facilitate cable pulling and installation. The high-voltage door shall be on the left with the low-voltage door on the right. Compartments shall be designed for cable entry from below.

J. Transformer(s) shall be supplied with a welded or bolted main tank cover and be of a sealed-tank construction designed to withstand a pressure of 7 psig without permanent distortion. The tank cover shall be designed to shed water and be supplied with a tamper-resistant access handhole sized to allow access to internal bushing and switch connections. Transformers supplied with “less flammable” fluids shall be manufactured to withstand 12 psig without rupture. The transformer shall remain effectively sealed for a top-oil temperature of -5 degrees C to 105 degrees C. When necessary to meet the temperature rise rating specified, cooling panels shall be provided.

K. The transformer manufacturer shall certify that the transformer is non-PCB containing less than 1 part per million detectable PCBs. Nonflammable transformer liquids including askarel and insulating liquids containing tetrachloroethylene, perchloroethylene, chlorine compounds, or halogenated compounds are not acceptable and shall not be provided.

L. When high-voltage taps are specified above, full-capacity taps shall be provided with a tap changing mechanism designed for de-energized operation. The tap changer operator shall be located within one of the compartments.

M. The coil windings shall be designed to reduce losses and manufactured with the conductor material as specified above. All insulating materials shall be rated for 120 degrees C class.

N. The core material shall be high-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10 percent overvoltage excitation. The cores shall be properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses.

O. The core frame shall be designed to provide maximum support of the core and coil assembly. The core frame shall be welded or bolted to ensure maximum short-circuit strength.

P. The core and coil assembly shall be designed and manufactured to meet the short-circuit requirements of ANSI C57.12.90. The core and coil assembly shall be baked in an oven prior to tanking to "set" the epoxy coating on the insulating paper and remove moisture from the insulation prior to vacuum filling.

Q. Transformer shall be vacuum-filled with the appropriate fluid as indicated above. The process shall be of sufficient vacuum and duration to ensure that the core and coil assembly is free of moisture prior to filling the tank.

2.04 ACCESSORIES

A. Transformer features and accessories shall include:

1. Dial-type thermometer
2. Liquid level gauge
3. Pressure-vacuum gauge
4. Drain valve with sample valve
5. Pressure relief valve
6. Non-PCB label
7. Upper fill/filter press connection or valve
8. Additional accessories:
   a. Alarm and Trip contacts (120VAC, 5 Amp rated dry contacts) for pressure, level, and temperature relays
   b. Rapid pressure rise relay
   c. Winding temperature relay
   d. Gas sampling valve

2.05 PRIMARY CONNECTIONS

A. Transformer primary connections shall be 200 A deadfront load break or 600 A dead break wells and inserts for cable sizes shown on the drawings.

2.06 OVERVOLTAGE PROTECTION

A. DEAD-FRONT BUSHINGS: Externally mounted, Distribution Class M.O.V.E. Dead-front elbow arresters shall be supplied. M.O.V.E. arresters are for installation on 200 A rated dead-front bushing interfaces only.

2.07 FINISH

A. Transformer units shall include suitable outdoor or indoor paint finish. The paint shall be applied using an electrostatically deposited dry powder system to a minimum of three (3) mils average thickness. Units shall be painted padmount green, Munsell No.7GY3.29/1.5.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest applicable ANSI and NEMA standards.
   1. Resistance measurements of all windings on the rated voltage connection
   2. Ratio tests on the rated voltage connection and on all tap connections
   3. Polarity and phase-relation tests on the rated voltage connections
   4. No-load loss at rated voltage on the rated voltage connection
   5. Exciting current at rated voltage on the rated voltage connection
   6. Impedance and load loss at rated current on the rated voltage connection
   7. Applied potential test
   8. Induced potential tests

B. The manufacturer shall provide three (3) certified copies of factory test reports to the Engineer upon request.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and startup of the equipment specified under this section for a period of 2 working days. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained herein.

B. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

A. The contractor shall provide a training session for up to five (5) owner's representatives for 1 normal workday at a job site location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers and major components within the assembly.

3.05 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the contractor.

3.06 FIELD ADJUSTMENTS

A. Adjust taps to deliver appropriate secondary voltage.

3.07 FIELD TESTING

A. Measure primary and secondary voltages for proper tap settings.

B. Megger primary and secondary windings

C. Liquid transformers – Test oil for dielectric strength.

+++ END OF SECTION 16321 +++

SECTION 16346
MEDIUM VOLTAGE SWITCHGEAR

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the equipment as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. The metal-clad switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA SG-4 and SG-5, and but not limited to, ANSI/IEEE 37.20.2.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
   1. Master drawing index
   2. Front view elevation
   3. Floor plan
   4. Top view
   5. Single line diagram
   6. Nameplate schedule
   7. Component list
   8. Conduit entry/exit locations
   9. Assembly ratings including:
      a. Short-circuit rating
      b. Voltage
      c. Continuous current
      d. Basic impulse level for equipment over 600 volts
   10. Major component ratings including:
      a. Voltage
      b. Continuous current
      c. Interrupting ratings
   11. Cable terminal sizes
   12. Product data sheets

B. Where applicable, the following additional information shall be submitted to the Engineer:
   1. Busway connection

2. Connection details between close-coupled assemblies
3. Composite floor plan of close-coupled assemblies
4. Key interlock scheme drawing and sequence of operations
5. Descriptive bulletins

1.05 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process.
2. Wiring diagrams
3. Certified production test reports
4. Installation information including equipment anchorage provisions
5. Seismic certification as specified

1.06 QUALIFICATIONS

A. Provide Seismic qualified equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
2. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.
3. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
   a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
   b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
   c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

C. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

D. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.08 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. Square D / Schneider Electric

C. General Electric.

D. Siemens.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date. All proposed equipment shall have dimensions not exceeding the ones shown on the Drawings.

2.02 RATINGS

A. The switchgear described in this specification shall be designed for operation on a 4.16 kV, three-phase, ·three wire, solidly grounded, 60-hertz system.

B. Each circuit breaker shall have the following ratings:

Maximum Voltage	4.76kV
LIWV (also called BIL):	60kV peak
Continuous Current	As Shown on the drawings
Short-Circuit Current at rated Maximum Voltage	40kA RMS sym

Rated Voltage Range Factor K	1.0
Closing and Latching Capability	104kA peak
Maximum Symmetrical Interrupting and 2-Second Rating	40ka RMS Sym
Rated Interrupting Time	3 cycle

2.03 CONSTRUCTION

A. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Hinged rear doors, complete with provisions for padlocking, shall be provided.

B. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device.

2.04 BUS

A. The main bus shall be tin-plated copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, glass polyester. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Main bus shall be rated as shown on the drawings. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

B. A tin-plated copper ground bus shall extend the entire length of the switchgear.

C. Include tapered bus and a transition vertical sections as required for connection to MV starter line ups bus.

2.05 WIRING/TERMINATIONS

A. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminals shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

B. Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

2.06 CIRCUIT BREAKERS

A. The circuit breakers shall be horizontal drawout type, capable of being withdrawn on extruded aluminum rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a permanently mounted manual charging handle. The primary disconnecting contacts shall be silver-plated copper.

B. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, removable self-aligning pole unit. The vacuum interrupter pole unit shall be mounted on glass polyester supports. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

C. The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

D. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from stationary structure, and to discharge stored energy mechanisms upon insertion or removal from the stationary structure. The breaker shall be secured positively in the stationary structure between and including the operating and test positions.

E. The breakers shall be electrically operated by the following control voltages:

   120- volt AC close and AC capacitor trip.

   Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.

F. 120V AC control voltage shall be supplied by purchaser from a remote UPS.

2.07 PROTECTIVE RELAYS

A. The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.

   1. Protective Relays on the Main and Tie breakers shall be equal to the Square D Sepam S84, Eaton EDR 5000 or Multilin 850 relay with the following functions: 51/50, 51N/50N, 50BF, 25, 32, 46, 55, 67, 27, 59, 59N, 47, 79, 81O, 81U and 86.

   The protective relay shall also have metering capabilities and ModBus TCP communications. See One Line Diagrams for more details.

   Protective relays shall be equipped with an Energy Reduction Maintenance system. The system shall allow the user to switch to more sensitive settings via a digital input while maintenance work is being performed downstream of the device. The switchgear manufacturer shall provide a selector switch for each breaker on the relay

panel of the switchgear. The selector switch shall engage the maintenance settings. The selector switch shall be provided with a padlockable cover to enable locking the relay in the maintenance mode. The switchgear manufacturer shall provide a blue indicating light which will be wired to a digital output on the relay which will indicate when the relay is in the maintenance mode.

2.08 AUXILIARY DEVICES

A. Ring type current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

B. Voltage and control power transformers of the quantity and ratings indicated in the detailed specification shall be supplied. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Rails shall be provided as applicable for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

C. Provide surge protection as shown on the drawings.

2.09 OWNER METERING

A. Provide owner metering devices where shown on the drawings. Where indicated, provide a separate owner metering compartment with front hinged doors. Include associated instrument transformers.

B. Provide current transformers for metering as shown on the drawings. Current transformers shall be wired to shorting type terminal blocks.

C. Provide potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.

D. Microprocessor-based metering system. Where customer meter is indicated, provide a meter equal to ”Square D” Model PM8244 or Eaton PXM2260 with EtherNet TCP/IP communication port.

2.10 AUTOMATIC THROW OVER SCHEME

A. The switchgear manufacturer shall provide a relay-based automatic throw over scheme for the Main and Tie Breakers with the Square D Sepam S84, Multilin 850 relays or approved equal.

B. The switchgear manufacturer shall provide any additional components required to achieve the sequence of operations described below.

C. The sequence of operations for the auto throw over scheme shall be as follows:

1. Normal plant operation is with both main breakers closed, tie breaker open, and selector switch in "automatic" mode.
2. The two incoming lines are electrically interlocked such that all three breakers cannot be closed at the same time and incoming line breakers cannot be paralleled.
3. In the event of the protective relay trip via lockout relay, the opened main and tie cannot be closed until the fault is removed and the lockout relay is reset.
4. Loss of voltage on either incoming line will cause its main breaker to open and then the tie breaker will close provided that voltage is present on the other incoming line.
5. When voltage is restored, the tie breaker will automatically open and then the opened incoming line breaker will close.
6. If the voltage is subsequently lost on the second line after the transfer has occurred as described above, the second line main breaker will open and then the tie will open.
7. Return of voltage to either line will cause its main breaker to close and then the tie breaker will close.
8. When voltage returns to the other line, the tie breaker will open and then the other line main breaker will close, restoring the system to normal.
9. Simultaneous loss of both sources will cause both main breakers to open, leaving the tie breaker open.
10. Simultaneous restoration for both sources will cause both main breakers to close, leaving the tie breaker open.
11. In the manual mode, each main and tie breaker can be closed by their respective breaker control switch subject to electrical interlock above.

2.11 ENCLOSURES

A. The switchgear described in these specifications shall be indoor construction, with devices arranged as shown on contract drawings.

B. Control power for the switchgear line up shall be furnished from a remote UPS fed panelboard. The switchgear line-up shall distribute the UPS control power on each side of the tie via separate circuits with overcurrent protection. These circuits shall extend to the close-coupled MV switch line-up.

2.12 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum. Furnish master nameplate for each switchgear lineup giving information in accordance with IEEE Std. C37.20.2-1999, Section 7.4.1. Circuit nameplates shall be provided with circuit designations as shown on purchaser's single-line diagrams.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.13 FINISH

A. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

2.14 ACCESSORIES

A. The switchgear manufacturer shall furnish accessories for test, inspection, maintenance and operation, including:

1. One – Maintenance tool for manually charging the breaker closing spring and manually opening the shutter
2. One – Levering crank for moving the breaker between test and connected positions
3. One – Test jumper for electrically operating the breaker while out of its compartment
4. One – Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails, when applicable
5. One – Set of rail extensions and rail clamps, when applicable
6. One – Portable lifting device for lifting the breaker on or off the rails
7. One – Simple electrical levering-in device with 15 feet of extension cable.

2.15 CORONA FREE DESIGN

A. The switchgear shall be corona free by design and shall be tested for partial discharges in accordance with EEMAC standard G11-1. The corona discharges measured during the tests shall be less than 100 picocoulombs.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.

1. Alignment test with master cell to verify all interfaces and interchangeability
2. Circuit breakers operated over the range of minimum to maximum control voltage
3. Factory setting of contact gap
4. One-minute dielectric test per ANSI standards
5. Final inspections and quality checks

B. The following production test shall be performed on each breaker housing:

1. Alignment test with master breaker to verify interfaces
2. One-minute dielectric test per ANSI standards on primary and secondary circuits
3. Operation of wiring, relays and other devices verified by an operational sequence test

4. Final inspection and quality check

C. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and startup of the equipment specified under this section for a period of 5 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for 3 normal workdays at a job site location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

3.05 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.06 FIELD ADJUSTMENTS

A. The relays shall be set in the field by:

1. A qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required elsewhere in the contract documents.

+++ END OF SECTION 16346 +++

SECTION 16349
MEDIUM VOLTAGE MOTOR CONTROL CENTER LINE UP

PART 1 - GENERAL

A. SCOPE

1. The Contractor shall furnish and install the medium voltage motor starters as specified herein and as shown on the contract drawings.

B. RELATED SECTIONS

1. 16265 – MV RVSS STARTER
2. 16346 – MV SWITCHGEAR

C. REFERENCES

A. The medium voltage load interrupter switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards as follows:

1. NEMA ICS 3 Part 1 & 2, 1993 (R2000)
2. Underwriters Laboratories, Inc. (UL):
   1. UL 347, “Medium Voltage AC Contactors, Controllers, and Control Centers”

D. SUBMITTALS – FOR REVIEW/APPROVAL

1. The following information shall be submitted to the Engineer:

- Master drawing index
- Front view elevation
- Floor plan
- Top view
- Schematic diagram
- Single Line
- Nameplate schedule
- Component list
- Conduit entry/exit locations
- Assembly ratings including:
  a. Short-circuit rating
  b. Voltage
  c. Continuous current
  d. Basic impulse level
- Major component ratings including:
  a. Voltage

b. Continuous current
c. Interrupting ratings

- Cable terminal sizes
- Descriptive bulletins
- Product data sheets

2. Where applicable, the following additional information shall be submitted to the Engineer:

- Busway connection
- Connection details between close-coupled assemblies
- Composite floor plan of close-coupled assemblies
- Key interlock scheme drawing and sequence of operations.
-

E. SUBMITTALS – FOR CONSTRUCTION

1. The following information shall be submitted for record purposes:

A. Final as-built drawings and information for items listed in Paragraph 1.04 above, and shall incorporate all changes made during the manufacturing process.
B. Wiring diagrams
C. Certified production test reports
D. Installation information, including equipment anchorage provisions
E. Seismic certification as specified

F. QUALIFICATIONS

2. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
3. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
4. 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.
5. Provide Seismic tested equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
2. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.
3. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
   a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the

manufacturer based upon the above criteria to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

G. DELIVERY, STORAGE AND HANDLING

1. Equipment shall be handled and stored in accordance with manufacturer's instructions.
2. One (1) copy of these instructions shall be included with the equipment at time of shipment.

H. OPERATION AND MAINTENANCE MANUALS

1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 3 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. Square D / Schneider Electric

C. General Electric.

D. Siemens.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

A. Assembly and components shall be rated for 31.5kA symmetrical at 4.16kV.

2.03 BUS

A. All bus bars shall be copper tin-plated. Bus shall be rated for continuous current as shown on the drawings. The bus supports between units shall be flame-retardant, track-resistant, glass polyester.

B. Provide a 1/4 x 2-inch ground bus throughout the entire lineup.

C. All standoff insulators on switches and fuse mountings shall be glass polyester.

D. The Bus in the end structures shall be provided with provision for future expansion.

2.04 WIRING/TERMINATIONS

A. One (1) terminal pad per phase shall be provided for attaching contractor-supplied cable terminal lugs for a maximum of two (2) conductors per phase of the sizes indicated on the drawings. Sufficient space shall be allowed for contractor supplied electrical stress relief termination devices.

B. Small wiring, fuse blocks and terminal blocks within the vertical section shall be furnished as indicated on the drawings. Each control wire shall be labeled with wire markers. Terminal blocks shall be provided for owner's connections to other apparatus.

2.05 COMPONENTS MV MOTOR CONTROLLER

A. The non-load break isolating disconnector shall be a two position externally operated manual three-pole device, such that in the open position it grounds and isolates the line side from the load compartment. The switch-operating handle shall be removable. The operating mechanism shall be rugged, simple and shall have provisions for three padlocks in the on or off position.

B. Mechanical Interlocks: An interlocking system shall be provided to prevent the opening of the high voltage access door with the no-load disconnector closed. To access the medium voltage compartment, the no-load disconnector must be opened to the ground position; the operating port must be closed to allow padlocking the disconnector open. The interlock must be directly attached to the operating mechanism and should not rely on long cables and linkages.

C. A viewing port shall be installed in the disconnector enclosure to enable visible verification of the blade position.

D. Current limiting fuses shall be type "R" for motor loads or type "E" for non-motor loads. A blown fuse indicator shall be provided. The blown fuse indicator shall be an "Extended Travel" type with a minimum of 1 inch of travel. Fuses shall have a 50,000 Amperes interrupting capability. The type "R" fuses shall incorporate time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum protection. This coordination shall be such that under a low fault condition the interrupting rating and dropout time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be vertically mounted permitting easy inspection and replacement without the need for removing the contactor.

E. Provide a shunt trip, single phase protection system to automatically open the vacuum contactor when a fuse blows. This is intended for backup protection only to the motor overload relay. The system shall further prevent potential single phasing conditions by blocking the closing of the contactor when a fuse is blown. Provide 1NO/1NC contact for trip indication.

F. The vacuum contactor shall have single-break high-pressure type main contacts. The vacuum contactor contact wear shall be easily checked with the use of a "go / no-go" feeler gauge, included with each contactor. A built-in test circuit shall be included within each controller to permit checking the control and pilot circuits, with the contactor in open position. The test circuit shall be capable of being energized through a polarized plug connector from an external 120-volt supply while in the test mode. The plug connector shall be electrically interlocked with the disconnector.

G. The contactor shall withdraw on a rail system. When the contactor is lowered it will disconnect the contactor and when raised, it will connect the contactor and lock it in position.

2.06 FULL VOLTAGE NON-REVERSING LATCHED CONTACTORS

A. Each Induction Motor Full Voltage Non-Reversing Controller shall include.

1. Medium Voltage Compartment containing.
   a. one - three-pole non-load break isolating disconnector.
   b. three - Current limiting power fuses.
   c. one - Draw-out three-pole vacuum contactor assembly.
   d. one - Control circuit transformer
   e. two - Control circuit primary current limiting fuses.
   f. set - Electrical and Mechanical interlocks.
   g. three - Load terminals
   h. Current Transformer Options: (Max 3)

      Each section containing a contactor shall include Three phase donut Type Low Power Current Transformer use with SEPAM relay

2. Low-Voltage Compartment Door:
   a. one - Feeder protection relay (FPR) Sepam Series 20.
   b. Mounting space for any additional low voltage control, protection, or metering specified

3. Low-Voltage Compartment
   a. Two - Control relay's.
   b. one - Control circuit secondary fuse.
   c. Set of control circuit terminal blocks.
   d. Customer terminal blocks with screw compression type connections.
   e. Mounting space for any additional low voltage control, protection, or metering specified.

1. One Test circuit receptacle requiring no access to the MV components.

4. Operator Panel
   a. Disconnector operator mechanism
   b. Mechanical open-close indication
   c. Disconnector Viewing Window
   d. two – 22 mm pushbuttons
   e. two 22 mm indicating lights

B. Mechanically-latched contactor shall be provided when specified for transformer disconnect circuits, and other uses when it is required to have contactor remain closed, regardless of system and/or controller voltage condition.

C. Latched controllers shall have all the same features as a Full voltage Non-reversing Controllers except shall be closed electrically from a standard local or remote "close" push-button, and be tripped by a solenoid from a local or remote "open" push-button. An easily accessible, door mounted mechanical trip device shall be provided to allow the contactor to be opened when control power is not present.

2.07 REDUCED VOLTAGE SOFT STARTER (RVSS)

A. See specification 16265.

2.05 ENCLOSURES

A. Provide NEMA 1 enclosures for indoor applications where shown on the contract drawings.

B. A minimum of one (1) 250-watt, 120-volt space heater shall be provided in each vertical section. Power for the space heater(s) shall be furnished by an external UPS and distributed from the Main Breaker Sections of the MV Switchgear as shown on the drawings.

2.07 FUSES

A. Fault protection shall be provided by fuses with continuous ratings as shown in the contract documents. Any fuse/switch integrated momentary and fault close ratings specified shall have been verified by test.

2.08 NAMEPLATES

A. Nameplates shall be 2-inch high x 2-1/2 inch wide, laminated black with white core.

B. Unit nameplate and device marker lettering shall be 3/16-inch high.

2.09 FINISH

A. The finish for internal and external parts shall consist of a coat of ANSI 61 (gray) thermosetting, polyester, powder paint applied electrostatically to pre-cleaned phosphatized steel and aluminum surfaces.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
   1. Wiring check
   2. Dielectric Test (Hi Pot) per NEMA ICS 3 Part 2 at 2000 volts plus 2.25 times nominal voltage, for 60 seconds, phase-to-phase and phase-to-ground

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to provide startup of the equipment specified under this section for a period of 3 working days.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:
   1. Megger bus
   2. Ground test
   3. Verify that all mechanical interlocks are functioning properly

C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 TRAINING

A. The Contractor shall provide a training session for five (5) owner representative(s) for 2 normal workday(s) at a job site location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative and include instructions on assembly, starters and other major components.

3.04 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

C. Check all bolted connections to assure that they are in accordance with the manufacturer's recommended torque requirements.

+++ END OF SECTION 16349 +++

SECTION 16429
LOW VOLTAGE SWITCHBOARDS

PART 1- GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install, where indicated, a free-standing, dead-front type low voltage distribution switchboard, utilizing group mounted circuit protective devices as specified herein, and as shown on the contract drawings.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. The low voltage distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:
   1. NEMA PB-2
   2. UL Standard 891

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
   1. Master drawing index
   2. Front view elevation
   3. Floor plan
   4. Top view
   5. Single line
   6. Schematic diagram
   7. Nameplate schedule
   8. Component list
   9. Conduit entry/exit locations
   10. Assembly ratings including:
      a. Short-circuit rating
      b. Voltage
      c. Continuous current
   11. Major component ratings including:
      a. Voltage
      b. Continuous current
      c. Interrupting ratings
   12. Cable terminal sizes
   13. Product data sheets

B. Where applicable, the following additional information shall be submitted to the Engineer:

1. Busway connection
2. Connection details between close-coupled assemblies
3. Composite floor plan of close-coupled assemblies
4. Key interlock scheme drawing and sequence of operations

1.05 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
2. Wiring diagrams
3. Certified production test reports
4. Installation information
5. Seismic certification and equipment anchorage details as specified

1.06 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. 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.

1.07 REGULATORY REQUIREMENTS

A. The low-voltage switchboard shall be UL labeled.

1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Schneider Electric / Square D

B. Eaton

C. General Electric

D. Or approved equal.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as shown on the drawings.

B Voltage rating to be as indicated on the drawings.

2.03 CONSTRUCTION

A. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

B. All sections of the switchboard shall be front and rear aligned with depth as shown on the drawings. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.

C. The assembly shall be provided with adequate lifting means.

D. The switchboard shall be suitable for use as service entrance equipment where shown on the drawings and be labeled in accordance with UL requirements.

2.04 BUS

A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.

C. A copper ground bus (minimum 1/4 x 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

2.05 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.06 MAIN AND FEEDER PROTECTIVE DEVICES, 2000A AND BELOW

A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

D. Circuit breakers 400-ampere frame and below shall be have thermal-magnetic trip units and inverse time-current characteristics.

E. Circuit breakers 600-ampere and above shall have microprocessor-based rms sensing trip units with the following characteristics:

1. Microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.

2. An adjustable trip setting dial mounted on the front of the trip unit shall establish the continuous trip ratings of each circuit breaker.
3. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
    a. Adjustable long-time setting (set by adjusting the trip setting dial)
    b. Adjustable short-time setting and delay with selective curve shaping
    c. Adjustable instantaneous setting
    d. Adjustable ground fault setting and delay, where indicated on the drawings
4. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

2.07 ACCESSORIES

A. Provide shunt trips, bell alarms and auxiliary switches/contacts as shown on the contract drawings.

2.08 MISCELLANEOUS DEVICES

A. Key interlocks shall be provided as indicated on the drawings.

B. Control power transformers with primary and secondary protection shall be provided, as indicated on the drawings, or as required for proper operation of the equipment.

2.09 METERING

A. Metering section shall include a Microprocessor-Based power meter capable of measuring as a minimum Volts, Amps, kW and Power Factor. All meter parameters shall be available for transferring to the Plant SCADA system through an integral EtherNet port via EtherNet TCP/IP protocol. Any deviations in the proposed protocol shall be coordinated with SCADA system integrator.

2.10 ENCLOSURES

A. NEMA 1 Enclosure unless listed otherwise on Electrical Drawings.

2.11 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.12 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

2.13 SURGE PROTECTIVE DEVICE

A. Provide integral surge protective devices with short circuit rating as shown on Electrical Drawings.

2.14 AUTOMATIC THROWOVER SYSTEM

A. Main-Main Automatic Throw over System

1. Main-Main Standard functions shall include the following:

a. Automatic Transfer to Alternate Source, Manual Return to Normal Source for Main-Main
b. Open Transition with control program interlocking to prevent paralleling
c. Bypass of Retransfer delay if alternate source fails
d. Electrically Interlocked
e. Manual Circuit Breaker Close Buttons Inhibited
f. Time Delay on Transfer
g. Time Delay on Retransfer, Open Transition
h. Source Stabilization Before Retransfer
i. Undervoltage sensing on both sources (27 Device), adjustable with LED indication
j. Phase Sequence reverse phase sensing on both sources (47 Device), 2 cycles with local LED indication
k. Phase Loss (47 Device), Adjustable with local LED indication
l. Phase Imbalance (47 Device), Adjustable with local LED indication
m. Auto/Manual Switch with Removable Key and light indication
    1. White Light for Auto
    2. Blue Light for Manual
n. Control Power Transfer between sources
o. Open (Green)/Close (Red) Lighted Pushbuttons for Manual Operation of the Circuit Breakers
p. Test switch for simulating loss of either source
q. Circuit Breaker electrical trip lockout with amber light indication
r. Uninterruptable Power Supply for 120Vac Control Power
s. UPS Bypass relay
t. White lights for sources available
u. Operator Interface Panel
v. Wire labels for control wiring
w. Fused control circuits with individual blown fuse indication

2. Optional functions shall include the following:

a. Automatic return from Alternate Source for Main-Main
b. Remote alarm contact (system inoperative), 5A @120Vac

c. Preferred source selector
d. Pilot Lights test switch

3. Documentation shall include the following:

a. Wiring diagram of each assembly in system
b. System schematic diagram
c. Input/output listing
d. Sequence of operation
e. Test procedures

4. The manufacturer shall provide a qualified service representative for one day to start up the automatic throw over system.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volt for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volt for one (1) minute between live parts and ground.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills provided the floor is level to 1/8 inch per 3-foot distance in any direction. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

C. Install Switchboard on a 4-inch housekeeping pad and secure to sills imbedded in the concrete with 1/2-inch threaded bolts and nuts.

D. Touch up paint scratches and vacuum to remove construction debris and dirt. Install all doors, wireway covers etc., and plug any unused device holes.

E. Properly set and level channel sills.

F. Furnish complete, clear, and concise instructions for installation, operation, and maintenance of the equipment.

3.03 FIELD ADJUSTMENTS

A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.

B. Necessary field settings of devices, adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.04 TESTS

A. Set all breakers parameters based on the Power Study recommendations.

B. Megger each bus, phase-to-phase and phase-to-ground.

+++END SECTION 16429+++

SECTION 16470
LIGHTING AND POWER DISTRIBUTION PANELBOARDS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Three phase, four wire 208Y/120 or 480Y/277 volt, dead front, circuit breaker type panelboard with current rating of 600amperes or less.

B. Single phase, three wire 120/240 volt, dead front, circuit breaker type panelboards with current rating of 400 amperes or less.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturing Association
NFPA 70	National Electrical Code (NEC)
UL 50	Cabinets and Boxes
UL 67	Underwriters Laboratories, Electric Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 1449	Surge Suppression Devices

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:

1. Eaton / Cutler-Hammer: PRL1a and PRL3a
2. General Electric: AQ and AD
3. Siemens: S1, SE, and S3
4. Square D: NQOD and NF
5. Or Engineer Approved equal.

2.02 ARRANGEMENT AND CONSTRUCTION

A. The front of the panel shall have concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring-loaded door pulls. The fronts shall not be removable with doors in the locked position. Panelboard locks shall be keyed alike.

B. Gutter space shall be provided on all sides of the breaker assembly to neatly connect and arrange incoming wiring.

C. Panelboard shall be composed of individually mounted circuit breakers designed to be removable without disturbing other breakers.

D. A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door.

2.03 BUS

A. Bus shall be tin-plated copper and shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test.

B. The minimum bus size shall be 100 amperes. Panel fault withstand rating shall be not less than the interrupting rating of the smallest circuit breaker in the panel. Series rating is prohibited.

C. Panelboards shall be provided with a separate ground bus and, where specified, with a full capacity neutral bus. The neutral bus shall be mounted on insulated stand-offs.

2.04 CIRCUIT BREAKERS

A. Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers shall be bolt-on type. Circuit breakers shall be listed in accordance with UL 489 for the service specified. Load terminals of circuit breakers shall be solderless connectors.

B. Circuit breakers rated 120/208 volt and 120/240 volt alternating current shall have a minimum interrupting current rating of 18,000 amperes symmetrical at 240 volt AC.

C. Circuit breakers rated 277/480 volt alternating current shall have a minimum interrupting current rating of 25,000 amperes symmetrical at 480 volt or as specified on the panelboard schedule.

D. Provide circuit breakers with special features such as ground fault interrupting (GFI), heating air conditioning and refrigeration (HACR) rating, or locking capability as shown on the Drawings or Schedules.

2.05 FINISH

A. Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have a gray, baked enamel finish.

2.06 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 16000.

2.07 PRODUCT DATA

A. The following information shall be provided in accordance with the General Conditions:

1. Manufacturer's certification that bus bracing is capable of withstanding the specified short circuit condition.

2. Operation and maintenance information as specified in Section 01730.

3. Quantity and rating of circuit breakers provided with each panelboard.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor shall type in the circuit description on the circuit directory as shown on the final record drawings or panelboard schedule.

B. Provide "Circuit Directory and Circuit Identification" in accordance with NEC 408.4. Each circuit shall be of sufficient detail to allow each circuit to be distinguished from other circuits. Circuit identification shall include load location and provide equipment or instrument Tag Number and Tag Description, where shown on the drawings.

3.02 TESTING

A. Panelboards shall be tested for proper operation and function.

+++END OF SECTION 16470+++

SECTION 16485
CONTACTORS

PART 1 - GENERAL

1.01 SCOPE

A. Lighting contactors.

B. Enclosures.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
   1. Product data. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General Electric.
B. Square D.
C. Westinghouse.

2.02 LIGHTING CONTACTORS

A. Contactors: NEMA ICS-2; magnetically held, 2 wire control.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Contacts: as indicated.

D. Enclosure: NEMA ICS-6; Type 1.

E. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

+++**END OF SECTION 16485+++**

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-state luminaires that use LED technology.
2. Lighting fixture supports.
3. Exterior light poles, foundations and supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires and housing.

4. Include physical description and dimensions of poles, foundations and supports.
5. Include emergency lighting units, including batteries and chargers.
6. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
7. Photometric data and adjustment factors based on laboratory tests

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

D. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of luminaires and accessories involving color and finish selection.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule: For luminaires and lamps, use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Site lighting plan(s), Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment and luminaires will be attached.

5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

    a. Other luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Ceiling-mounted projectors.

7. Moldings.
8. Pole and arm assemblies for exterior site lighting.
9. Foundations and supports for poles.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.

1. Obtain Engineer's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

B. Provide manufacturer’s standard provisions for protecting pole finishes during transport, storage, and installation. Do not store poles on ground. Store poles so they are at least 12 inches (305 mm) above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. Bulb shape complying with ANSI C79.1.

F. Lamp base complying with ANSI C81.61 or IEC 60061-1.

G. CRI of 80 CCT (4100 K) minimum.

H. Rated lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 120 V ac.

1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

L. Housings:

1. Extruded-aluminum housing and heat sink.
2. Anodized finish.

2.3 CYLINDER

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

C. With integral mounting provisions.

2.4 DOWNLIGHT

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

C. Universal mounting bracket.

D. Integral junction box with conduit fittings.

2.5 HIGHBAY, LINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

2.6 HIGHBAY, NONLINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Universal mounting bracket.

D. Integral junction box with conduit fittings.

2.7 LINEAR INDUSTRIAL

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

C. Housing and heat sink rated to the following:

1. Class 1, Division 2 Group(s) (A) (B) (C) and (D).
2. NEMA 4X.
3. IP 54.
4. IP 66.
5. Marine and wet locations.
6. CSA C22.2 No 137.

2.8 LOWBAY

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

C. Universal mounting bracket.

2.9 RECESSED LINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 85 lumens per watt.

C. Integral junction box with conduit fittings.

2.10 STRIP LIGHT

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

2.11 SURFACE MOUNT, LINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

2.12 SURFACE MOUNT, NONLINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 8**0** lumens per watt.

C. Integral junction box with conduit fittings.

2.13 SUSPENDED, LINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 85 lumens per watt.

2.14 SUSPENDED, NONLINEAR

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 85 lumens per watt.

C. Integral junction box with conduit fittings.

2.15 POLE-MOUNT, SITE AREA

A. SEE LIGHTING FIXTURE SCHEDULE

B. Minimum lumens per fixture schedule. Minimum allowable efficacy of 85 lumens per watt.

2.16 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Tempered Fresnel glass, prismatic glass, diffuse glass, clear glass, prismatic acrylic, clear, UV-stabilized acrylic
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Anodized finish.

E. Poles:

1. Poles shall be as shown on the drawings, and as specified. Finish shall be as specified on the drawings.
2. The pole and arm assembly shall be designed to meet the wind loading conditions at project site, with an additional 30% gust factor and supporting luminaire(s) and accessories such as shields, banner arms, and banners that have the effective projected areas indicated.
3. Poles shall be embedded, or anchor-bolt type (Aluminum or Steel, per ASTM requirements) designed for use with underground supply conductors. Poles shall be seamless extruded or spun seamless type.
4. Poles shall contain handhole(s) having a minimum clear opening of 2.5 x 5 inches (65 x 125 mm). Handhole covers shall be secured by stainless steel captive screws.
5. Poles shall include a steel-grounding stud (opposite handhole openings), designed to prevent electrolysis when used with copper wire.
6. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts.

7. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.

F. 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.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.17 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.18 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 15.... "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12-gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer's recommendations.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls; to a minimum 20-gauge backing plate (attached to wall structural members); or attached using through-bolts and backing plates on either side of wall(s).
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch (4 mm) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
2. Ceiling mount or four-point pendant mount with 5/32-inch (4 mm) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Pole Foundations:

1. Excavate only as necessary to provide sufficient working clearance for installation of forms and proper use of tamper to the full depth of the excavation. Prevent surface water from flowing into the excavation. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath, and the end of conduit.

2. Set anchor bolts according to anchor-bolt templates furnished by the pole manufacturer.

3. Install poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.

4. After the poles have been installed, shimmed, and plumbed, grout the spaces between the pole bases and the concrete base with non-shrink concrete grout material. Provide a plastic or copper tube, of not less than 9 mm (0.375-inch) inside diameter through the

grout, tight to the top of the concrete base to prevent moisture weeping from the interior of the pole.

K. Comply with requirements in Section 16... "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

L. Ground noncurrent-carrying parts of equipment, including metal poles, luminaires, mounting arms, brackets, and metallic enclosures, as specified in Section 16… "Grounding and Bonding…exterior lighting and metal poles".

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 16050 "Electrical Identification".

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 15... "Addressable-Fixture Lighting Controls."

B. Comply with requirements for startup specified in Section 15..."Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to project site during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Engineer.

END OF SECTION 16500

SECTION 16999
ACCEPTANCE TESTING AND CALIBRATION

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes the field testing, inspection and adjusting of all material and equipment installed. Other Electrical Sections covering individual types of equipment may have additional testing requirements.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electrical Code.
2. NEMA, National Electrical Manufacturers Association
5. ASTM, American Society for Testing Materials.
4. IEEE, Institute of Electrical and Electronics Engineers.
5. NETA, National Electrical Testing Association.
6. ANSI, American National Standards Institute.
7. IPCEA, Insulated Power Cable Engineers Association.
8. OSHA, Occupational Safety and Health Act.

B. Items not passing test will be rejected and shall be repaired or replaced with acceptable new items. The repaired and replacement items shall be tested.

PART 2 - PRODUCTS Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL

A. Inspect, test and calibrate in accord with manufacturer's instructions supplemented by this Specification.

B. Institute and maintain rigorous precautions for all test procedures. Maintain telephone or voice radio contact between the potential source location and energized remote locations during any potential testing operations.

C. Contractor shall utilize the services of a testing firm, approved by the Engineer, which is regularly engaged in the testing of electrical equipment, devices,

installations and systems to conduct all of the testing specified in this Section. The testing firm shall meet the qualification criteria set forth in NETA acceptance testing specification.

3.02 POWER CIRCUIT BREAKERS

A. Preparatory Work: Prior to testing, remove each breaker from its compartment. Clean, lubricate, inspect and adjust each breaker in accord with manufacturer's published maintenance instructions. Inspect contacts, arc quenchers, primary and secondary disconnects, current sensors, small wiring and trip devices. Examine contacts for condition, clearance, pressure and wipe.

B. Tests and Data: Determine and record the following data:

1. Breaker identification, including City's designation, manufacturer's ratings, serial number, trip device type, ranges and time bands.

2. Test each breaker electrically for proper tripping characteristics by passing 60 Hz. sinusoidal low voltage current through each pole, one at a time, with test current injection at the primary disconnects. Adjust trip devices for required pickup characteristics. Perform tests at operating trip device settings as specified. Include this information in the report plus the record of the settings "as left" after calibration.

3. Apply sufficient current to actuate each mode of trip device, i.e., long time pickup, long time delay band, short time pickup, short time delay band, instantaneous pickup, ground pickup and ground delay band as applicable. Test current and elapsed time at tripping. For each pole, state whether or not breaker tripping is within the manufacturer's tolerances.

4. Perform insulation resistance test on each breaker. With contacts closed, apply 1000 volts DC for each 600 V and under and 250 V DC up to 5 KV and make readings after one-minute energization between each pair of poles and from each pole to the breaker frame.

C. Molded Case Circuit Breakers and Motor Circuit Protectors. Test automatic molded case circuit breakers for acceptance. Quantity to be tested is indicated below.

1. Thermomagnetic Trips. (Breakers Only). Test breakers having thermomagnetic trips in a temperature controlled environment maintained at 40^0 C plus or minus 3^0 C. A temperature stabilization period of 15 minutes is required prior to testing the inverse-time automatic tripping characteristics. Test each pole of each breaker at 90% and 200% of its continuous current rating. Replace any breaker or trip device which trips within 10 minutes at

90%, or which fails to trip at 200% within the time indicated in the following table:

Rated Continuous Current, Amperes	Max. Tripping Time, Minutes	Breakers tested per Panel or Switchboard
15 - 40	2	10% (not less than 2)
50	4	20% (not less than 1)
60 - 100	6	50% (not less than 1)
125 - 225	8	100%
250 - 400	10	100%
500 - 600	12	100%
700 - 800	14	100%
1000	16	100%
1200	18	100%

2. Instantaneous Trips. Test each pole of each breaker and motor circuit protector for automatic instantaneous tripping with slowly rising current. Replace any breaker or trip device which fails to operate within the following values:

   Non Adjustable Trips - plus or minus 20% of fixed setting.
   Adjustable Trips - plus or minus 10% of the high setting of the rms values of the instantaneous tripping current.

3. Motor Circuit Protectors after testing shall be placed in service at the minimum position which permits motor starting based on motor nameplate data following MCP manufacturer's instructions.

3.03 MOTORS AND MOTOR CONTROLS

A. Inspect and test motors and motor wiring, power and control for proper connection, circuit continuity, wire identification, insulation resistance and proper functioning or operation. Test insulation resistance from line to line and from each line to ground with a test instrument. Make tests prior to energizing circuits. Test motors for correct rotation. Test proper operation of starters and control devices. Record the nameplate data of motors for the selection of the proper overload relay heater size.

B. Test and inspect power distribution equipment for damage, defects and for proper functioning of all electrical and mechanical components. Test line and load bus, connections and conductors and test circuit breakers for proper electrical and mechanical operation.

C. Place motor circuit protectors in service at the minimum position which permits motor starting, based on motor nameplate data and following MCP manufacturer's instructions.

3.04 LIQUID FILLED TRANSFORMERS

A. Inspect for physical damage, cracked insulators, leaks and tightness of connections. Verify proper auxiliary device operation. Verify proper liquid level in all tanks and bushings. Perform specific inspections and mechanical tests as recommended by manufacturer. Verify proper equipment grounding.

B. Perform insulation-resistance tests, winding-to-winding, and windings-to-ground. Perform a turns-ratio test between windings at all tap positions. Sample insulating liquid in accordance with ASTM D-923. Sample shall be laboratory tested for, acid neutralization number, specific gravity, interfacial tension and color.

C. Perform all other tests not specified here, but required to conform to the requirements of NETA.

3.05 MEDIUM VOLTAGE MOTOR STARTERS

A. Inspect for physical, electrical and mechanical conditions. Check for proper anchorage, required area clearances and physical damage. Verify that fuse sizes and types correspond to Drawings. Verify that instrument transformer ratios correspond to Drawings. Check all bus and cable connections and bolt tightness. test all electrical and mechanical interlock systems for proper operation. verify proper barrier and shutter installation and operation. Inspect contactors for mechanical operation. Inspect and adjust contact gap, wipe, alignment, pressure, etc., per manufacturer's requirements. Compare overload protection rating with motor to verify proper size. Set adjustable devices per protective device coordination study.

B. Perform ration and polarity tests on all current and voltage transformers. Perform insulation-resistance tests on each bus section, phase-to-phase, and phase-to-ground. Perform insulation-resistance test at 1000 volt DC on control wiring. Perform insulation-resistance tests on contactor, phase-to-ground across the open contacts. Perform bottle integrity test on each pole for vacuum contactors.

C. Perform all other tests not specified here, but required to conform to the requirements of NETA.

3.06 SPECIAL SYSTEMS

A. Exercise care in the testing of electrical systems so as not to damage special, electronic or instrumented circuits. Do not undertake to check or test special electronic or instrumented circuits beyond the manufacturer's instructions included with the equipment and performed for equipment installation. Test the continuity

only for alarm, instrumentation, or similar special wiring systems prior to the final equipment connections.

3.07 INSULATION TESTS

A. Furnish the necessary test equipment and labor to test the insulation of electrical equipment and circuits before they are energized. Use a 1000 volt "Megger" or other approved instrument, to test the insulation resistance of circuits insulated for 600 volts, associated motors and transformers, low-voltage motor control centers and low voltage switchboard.

B. Insulation Tests: Include, but are not limited to, the following:

1. Transformers: Test primary to ground, secondary to ground and primary to secondary.

2. Services: Test phase to phase and each phase to ground.

3. Cables: Test phase to phase and each phase to ground.

4. Perform continuity test to ensure proper cable connection.

5. Motors: Test winding to ground.

6. Load Side of 600 Volt Circuits: Test each phase to ground and phase to phase.

7. Minimum Acceptable Megger Readings (Megohms at 20 C) for 600 volt class equipment:

Transformers	Megohms
Primary to ground	20
Primary to Secondary	20
Secondary to Ground	5
Services - Motor Starters and Buses	20
Motors	1
Load side of 600 volt circuits less motor	20

C. Control power transformers, potential transformers and other devices connected phase to phase or phase to ground and any devices not designed to withstand the test voltages must be disconnected when testing insulation resistance in switchboard, motor control centers and other apparatus.

D. Keep written record of tests performed on forms approved for the purpose and turned over to Engineer upon request, or at the termination of the Work. Identify each circuit or piece of apparatus tested, the date of the test, the temperature at the time of testing, the instrument used, the test voltage applied, the resistance values found and the name of the person in charge of and witnessing the test.

3.08 FINAL INSPECTION AND TEST

A. Upon completion of the various phases of the project, or at convenient times during progress of the Work, check and/or test as herein specified all equipment and wire installed.

B. Upon receipt of written notice that the work has been completed, including tests herein specified, Engineer's representative will give the entire work a thorough inspection. Any defects or omissions noted shall be corrected before acceptance of the work.

C. The inspections and tests to be made by the Contractor shall include, but are not limited to, the following:

1. Visually inspect wires and cable connections including internal wiring of switchgear, transformers and other equipment.

2. Verify continuity of power and control conductors.

3. Make insulation tests as herein specified.

4. Check control circuits for short circuits and extraneous grounds.

5. Check equipment for proper mechanical adjustment and freedom of operation and removal of shipping blocks and/or stops.

6. Check closing, tripping, supervision and alarm functions of the controlled equipment.

7. Operate motor controllers, contactors, etc., from their control devices.

8. Check operation of alarm circuits.

9. Check motors for proper rotation and motor currents measured under load conditions. Any motor found to be operating incorrectly shall be inspected to determine the cause and the condition shall be corrected to the satisfaction of Engineer. Furnish a record of these tests to Engineer.

END OF SECTION 16999